Promising Climate Resilient Technologies for JHARKHAND

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

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NICRA
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Front Cover: Interventions of NICRA in Jharkhand
Back Cover: 151 districts involved in NICRA and their climatic vulnerabilities

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FOREWARD

In a rapidly changing climate, the pursuit of sustainable and resilient technologies is no longer optional but imperative. Regions such as Jharkhand play a crucial role in exploring innovative solutions that mitigate environmental impacts and improve socio-economic progress. Jharkhand's unique environmental and socio-economic landscape offers rich indigenous knowledge and technological advancements. The viability of agriculture in Jharkhand depends on the implementation of sustainable practices, technological advancements, and effective management of natural resources. There is a growing emphasis on enhancing climate resilience, promoting agro-processing industries, and fostering agricultural diversification to enhance income levels and overall rural prosperity in the Jharkhand state.

Combined efforts by the Indian Council of Agricultural Research and State Agricultural Universities led to the development of technologies that enhance resilience to withstand climate variability. As a part of the Technology Demonstration Component of National Innovations on Climate Resilient Agriculture (NICRA), promising climate resilient technologies are being taken up by way of field demonstrations to enhance the adoption of respective technologies in 151 risk-prone districts of the country. Village institutions such as custom hiring centres, seed and fodder production systems and village climate risk management committees are being established to disseminate the technologies to reach every household.

This book focused on promising climate resilient technologies for Jharkhand state, is a significant contribution to understand how local innovations can effectively address global challenges. It emphasizes interdisciplinary approaches and knowledge sharing crucial for tackling environmental challenges. May this compilation spark further exploration and action towards building climate-resilient societies on a global scale.

I compliment the authors, editors and contributors for bringing out the publication, expressing my hope that these technologies would be integrated with development programs that will enhance the adaptive capacity of farmers in the region.

(Himanshu Pathak)

Dated the 27th August, 2024
New Delhi

PREFACE

Welcome to "Promising Climate Resilient Technologies for Jharkhand State." This book explores innovative technologies that help Jharkhand deal with climate change while promoting sustainable development. Climate change is a global phenomenon but the rate of change and its expected consequences is region-specific. The state has diverse landscapes, from forests to plateaus making it a unique place for developing ways to handle climate challenges. The changing pattern of Jharkhand climate thus, calls for reevaluating agriculture strategies and prioritizing research related to climate resilience to make agriculture more sustainable.

National Innovations on Climate Resilient Agriculture (NICRA) is the Indian Council of Agricultural Research flagship project that addresses multiple aspects of climate change with a focus on the agricultural sector. The Technology Demonstration Component (TDC) of National Innovations on Climate Resilient Agriculture (NICRA) aims at identifying climate resilient technologies in partnership with the farming community to build the capacities of farmers to enhance their adaptive capacity. On farm demonstrations of various technologies for natural resource management, crops and cropping systems and livestock are being conducted. These strategies were assessed 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.

I want to thank all the contributors, authors, researchers, practitioners, and policymakers for sharing their knowledge and experiences. Let this book help in finding innovative solutions for a sustainable and resilient future. Together, we can turn challenges into opportunities that benefit generations to come. We take this opportunity to gratefully acknowledge the constant guidance and support from Dr. Himanshu Pathak, Secretary (DARE) & Director General (ICAR), members of the High-Level Monitoring Committee, Zonal Monitoring Committee Chairman and members, Directors of Extension of the State Agricultural and Veterinary Universities, officials of Development Departments and KVKs of the state. We gratefully acknowledge the valuable contribution of farmers, VCRMC members and other project stakeholders.

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

1. Introduction

Introduction

Jharkhand is geographically situated between 21°58’ - 25°26’ N latitude and 83°22’ - 87°57’ E longitude. Jharkhand, a state of India, is located in the North-Eastern part of the country and bordered by the states of Bihar to the North, West Bengal to the East, Odisha to the South, Chhattisgarh to the West, and Uttar Pradesh to the Northwest. Its capital is Ranchi. Jharkhand state was created in the year 2000 by bifurcating the hilly and plateau regions of erstwhile Bihar state. The state has an area of 79714 km^2 (Fig. 1) and is home to 3.3 crore people (Government of Jharkhand, 2009). Jharkhand is predominantly an agrarian state with 80% of the population still depending on agriculture and allied industries for economic development and sustenance. Jharkhand is broadly categorized into three agro-climatic zones viz. Central and North Eastern Plateau sub-zone, Western Plateau sub zone and South Eastern Plateau sub zone. Physiographically, the Jharkhand state consists of a series of four distinct plateaus, the highest plateau is formed by the Western Ranchi plateau or the pat region, which is 800 to 1100 meters above the mean sea level. It covers the North-Western part of the Ranchi district and the Southern edge of Palamu district. The next plateau is known as the Ranchi, except for the pat region. This plateau is about 600 meters above mean sea level. The Ranchi plateau is separated from the other surface of the same elevation by the Damodar trough. The third plateau has an elevation of 300 meters above mean sea level and is termed as the Lower Chotanagpur plateau. The fourth plateau is a uniform surface formed by the river valleys, plains and lower parts of the outer plateau lying between 150-300 meters above mean sea level, Rajmahal hills and the Kaimur plateau belong to this category.

Jharkhand’s varied landscape contains a diverse range of soils, each with distinct characteristics, locations and benefits. The soils are crucial in shaping the state’s agricultural practices, ecological balance and economic activities. Red soils are predominantly found in regions like Hazaribagh, Giridih, Ranchi and Singhbhum. Laterite soils are prevalent in districts like Gumla, Lohardaga and Palamu. Black soils are found in certain pockets of Jharkhand, including parts of Ranchi and Hazaribagh. Alluvial soils are found in the river valleys and floodplains, including areas along rivers like Damodar and Subarnarekha. Laterite soils are present in parts of Palamu, Lohardaga and other regions with rocky terrain. Forest soils are widespread in the forested regions of Jharkhand, covering districts like Latehar, Simdega, and Gumla. Sandy soils are found in parts of Godda, Deoghar, and Sahebganj.

The state’s undulating hilly terrain and soil structure do not support a canal-based irrigation system. As much as 92 per cent of the cultivated area in the state is unirrigated in contrast, states like Punjab have as high as 95 per cent of their sown area under irrigation. The lack of irrigation facilities has restricted the agriculture sector growth of the state, in addition, small farm holdings and economic limitations resulted in low agricultural productivity. Jharkhand experiences a tropical climate, characterized by high humidity and a distinct seasonality pattern. The state’s climatic conditions are primarily influenced by its geographical location and topography, with variations across its different regions. The rainfall in the state ranges from 1200-1600 mm per year. Precipitation is variable. Winter season precipitation is meagre and highly variable. About 60 per cent of the rainy days have rainfall below 2.5 mm. On about 40 per cent of rainy days, the evaporation level is more than 2.5 mm per day. As per one estimate, out of the average annual precipitation of 10-million-hectare meter in the state about 20% is lost in the atmosphere, 50% flow as surface runoff and balance 30% soaks into the ground as soil moisture and ground water. Presently, the availability of water resource is only 327790 lakh m^3, out of which 275280 lakh m^3 is from surface water (Second Bihar State Irrigation Commission report – 1994) and rest 52510 lakh m^3 is from groundwater (Report of Central Ground Water Board – 2004). The total utilization of surface and groundwater in the state for irrigation purposes so far is only 47360 lakh m^3 out of which, 39640 lakh m^3 is surface water and 7030 lakh m^3 is groundwater (Report of Central Ground Water Board – 2004).

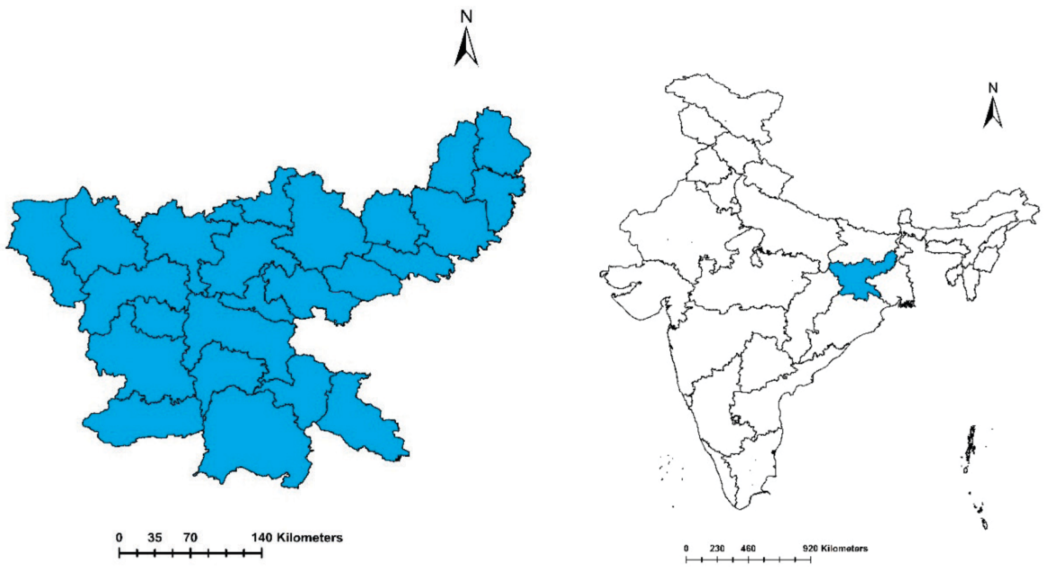


Fig. 1: Location map of Jharkhand

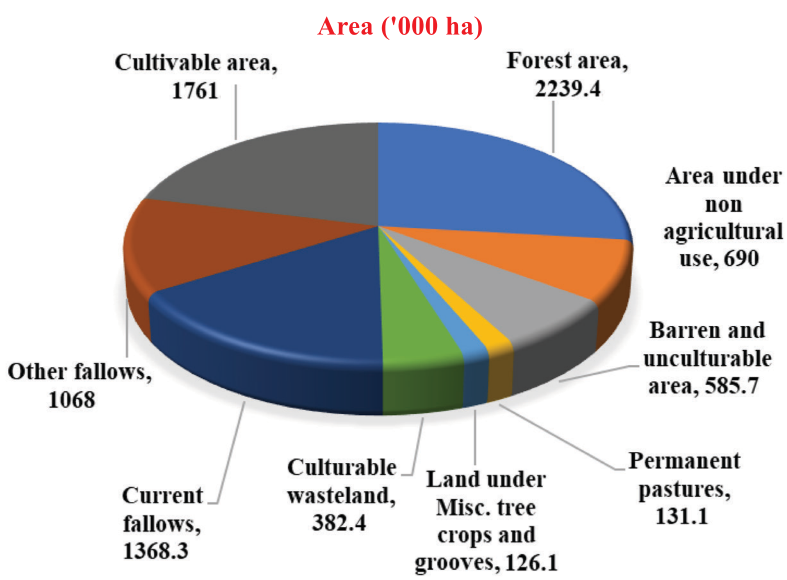


Fig. 2: Land use system of Jharkhand

Climate of Jharkhand

Agriculture in Jharkhand is heavily monsoon dependent and irrigation facilities in the state are limited. The state receives 80-82% of the annual rainfall during SW monsoon, hence the majority of the state's agriculture production is confined to the *kharif* season (June-September). Due to poor irrigation facilities (only 6-10% of the agriculture area is supported by irrigation infrastructure) and scanty rainfall, raising *rabi* crops is not an option for a large number of farmers in the state. Hence, 40% of the area in the state is under mono cropping (Department of Agriculture & Sugarcane Development, 2009). In a typical year, 40-60 mm of rainfall is received, aiding farmers in land preparation for the upcoming season. Approximately 80%, of the rainfall occurs from mid-June to the first week of October, which is crucial for *kharif* cultivation. Additionally, around 100 mm of rain is received during October and November. The winter rain is received during December to February, which is particularly beneficial for *rabi* cultivation, contributing to agricultural productivity in the region. The district (Koderma) of Jharkhand experiences three main seasons throughout the calendar year. Winter extends from November to February, characterized by cold early mornings and nights, with the temperature dropping to as low as 5ºC or even lower. In contrast, the summer season spans from March to May, bringing hot and unpleasant weather, with temperatures soaring up to 44ºC. The rainy season lasts from June to October. The annual average rainfall in Koderma is 1126 mm, with the region receiving more rainfall in comparison to areas further East. The climate in Koderma is classified as humid and sub-humid tropical monsoon, characterized by distinct wet and dry seasons.

Cropping pattern in Jharkhand

The economy of Jharkhand is significantly influenced by agriculture, which provides food crops, raw materials, and various other products. Crops in the state are categorized into three types: *kharif*, *rabi* and *zaid* crops. *Kharif* crops include paddy, maize, pulses, bajra, jowar and sugarcane. These crops are cultivated during monsoon season (July to September) and *rabi* crops also known as winter crops, are sown in November and harvested in the spring, around February to March. The primary *rabi* crops in Jharkhand are wheat, barley, mustard and peas. *Zaid* crops, also referred to as *Garma* crops, are grown in certain parts of the state from March to June. These include musk melon, watermelon and various vegetables. The most important agricultural crops in Jharkhand are wheat, paddy, maize, pulses and oilseeds.

1.1 Climate change in Jharkhand

The rainfall pattern in the state has undergone significant changes over the past decades. Seasonal pattern of rainfall (1956-2008) for the Ranchi region, the maximum annual rainfall (82.2%, 1149.3 mm) was received during South West monsoon season (June to September) and only 6.5%, 92.3 mm was received during North East Monsoon (October to December) in the state. The remaining rain was received in winter (3.7%, 52.4 mm), from January to February, and summer (7.5%, 104.7 mm) from March to May, respectively. Hence the state receives the majority of rains during monsoon and only 17.7% of the annual rainfall is received during other seasons. The variability is high in case of NE Monsoon (October to November), winter (January to February) and summer (March to May) and comparatively less variation was observed in South West monsoon (June to September). District level climate change scenarios for Jharkhand, generated through WORLDCLIM for A2B scenario, indicate rise in average rainfall in all the districts. The rainfall in all the three seasons will increase in future and this increase will be significantly large for some of the districts. The average temperature in the city of Ranchi in recent years has seen high deviations from normal temperature in comparison to the historic data available. Also, the highest average annual temperature (for the month of May) has remained comparatively higher. Maximum temperature is expected to gradually rise in all the districts of Jharkhand during 2020 to 2080. The summer as well as the winter is expected to become hotter by 2080. The summer temperature is expected to rise by 2.3ºC -3.0ºC between 2020-2080, whereas, winter temperature is expected to increase by 4.78ºC to 5.2ºC during the same period.

1.2 Challenges to agriculture in the context of climate change

Climate change is one of the biggest challenges ever faced by the human race. The projected rise in global mean temperature and associated weather pattern shifts and sea level rise will have far reaching implications on the balance of stock and flow of the environmental resources, with potential of wiping a large number of species from the face of earth. The climate change models suggest that the direct short-term impacts of the climate change will be on fresh water availability, food security, energy security, biodiversity, and human health. It is clear from all the climate change projections that Jharkhand will be witnessing unprecedented precipitation and temperature variations in the coming years. The temperature rise will affect the minimum as well as maximum temperatures. Further, the precipitation will go up significantly in most of the districts. The agriculture sector is flawed with multiple issues, which include lack of irrigation facility, a major infrastructural bottleneck. Due to slow growth in irrigation, the agricultural sector has not been able to perform to its full potential both in terms of food production as well as crop diversification. However, the expansion of area under irrigation in the state faces several techno-economic challenges. Agriculture is heavily dependent on rain, and farm productivity falls sharply if rainfall is not adequate. In addition, there are certain zones in the state which face water shortages throughout the year. Gumla, parts of Kodarma and Hazaribagh, Chatra and Palamu are the districts worst affected by water shortage. An increase in temperature from 1 to 40ºC reduced the grain yield of rice (0 to 49%), potato (5 to 40%), green gram (13 to 30%) and soybean (11 to 36%). The linear decrease per ºC temperature rise was 14%, 9.5%, 8.8%, 7.3% and 7.2% in rice, potato, soybean, wheat and green gram, respectively. The stimulating effect of CO_2 could offset the negative impact of climate on cotton production, hence the cotton production will largely remain unchanged.

1.3 Overview of agro-ecosystems and predominant production systems in the selected districts under NICRA

Jharkhand, with its diverse topography and geographical features, is divided into four different agro-climatic zones of Jharkhand, each characterized by specific climatic conditions that influence agricultural practices and crop patterns:

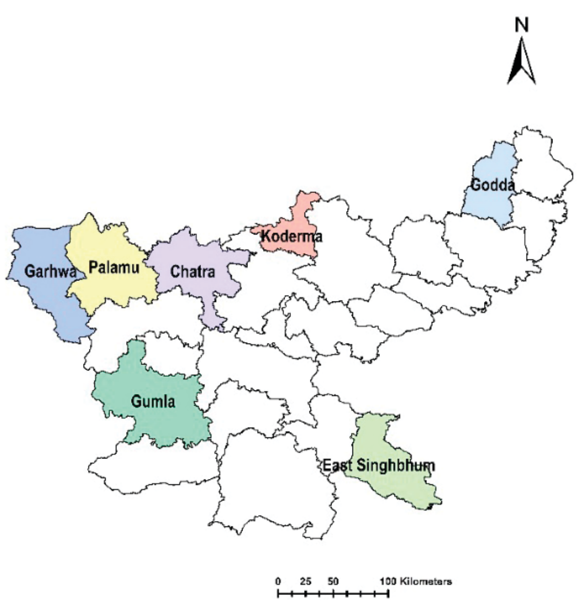
North-Western Plateau Zone: This zone encompasses the hilly regions of Hazaribagh, Koderma, parts of Ramgarh and Bokaro districts. It experiences a subtropical climate with moderate temperatures and well-distributed rainfall. Rice, maize and pulses are the main crops cultivated in this region.

North-Eastern Plateau Zone: This zone includes areas like Ranchi, Gumla, and Lohardaga districts, furthermore, this zone is characterized by undulating plateaus and hills. The climate is temperate, and rainfall is relatively higher than in other zones. Crops like rice, pulses and oilseeds thrive in this region.

South-Western Plateau Zone: Comprising Latehar, Palamu, and Garhwa districts, this zone has a sub-humid to humid climate. The rainfall is relatively lower, leading to a drier environment. Farmers in this zone predominantly cultivate oilseeds, pulses and coarse grains.

South-Eastern Plateau Zone: The districts of Singhbhum, East Singhbhum and West Singhbhum constitute this zone. The climate is sub-humid to humid with a higher amount of rainfall. Agriculture in this region mainly focuses on paddy, pulses, oilseeds and vegetables.

These agro-climatic zones play a crucial role in shaping the agricultural landscape of Jharkhand, influencing crop choices, farming practices, and overall food production in the state. Understanding these zones helps optimize agricultural productivity and ensure sustainable development in the region.



Overview of the districts

1.3.1 Koderma

Koderma district is located between 24° 15' to 24° 48' N Latitude and 85° 17' to 85° 56' E Longitude with an altitude of 210 m above MSL. The district is categorized into Northern Plain, hot humid (Dry) Eco-Region (ICAR), Eastern Plateau and Hills Region (Planning Commission) and South Bihar Alluvial Plain Zone (NARP). The district is located in the Northern part of North Chhotanagpur Commissionary and is bounded by Nawada and Gaya district of Bihar state in the Northwest and West. Chatra and Hazaribag districts in the Southwest and Giridih district in the East (Fig. 3). The geographical area of the district is 1.496 lakh ha, out of which cultivable area and forest area are 0.158 lakh ha and 0.5935 lakh ha, respectively and different land use patterns of the districts are indicated in Figure 4. The gross cropped area of the district is 0.1368 lakh ha out of which 0.112 lakh ha is net sown area and 0.024 lakh ha area is double-cropped area (sown more than once). The area under rainfed and irrigated situations is 0.1 lakh ha and 0.03 lakh ha. The sources of irrigation in the district are open wells, canals, tanks and other sources. Maize, wheat, paddy, rapeseed & mustard, chickpea and vegetables like cauliflower and cabbage are the major crops grown in the district (Table 1.1). Non-descriptive cattle, descript buffalo, goat and sheep farming are widely adopted. The average annual rainfall of the district is 1135 mm (Fig. 5). The predominant soils in the district are red lateritic soils (Ultic Paleustalfs), Loam (Haplustalfs), Fine loam (Rhodustlafs) and Fine mixed loam (Paleustalfs) soils.

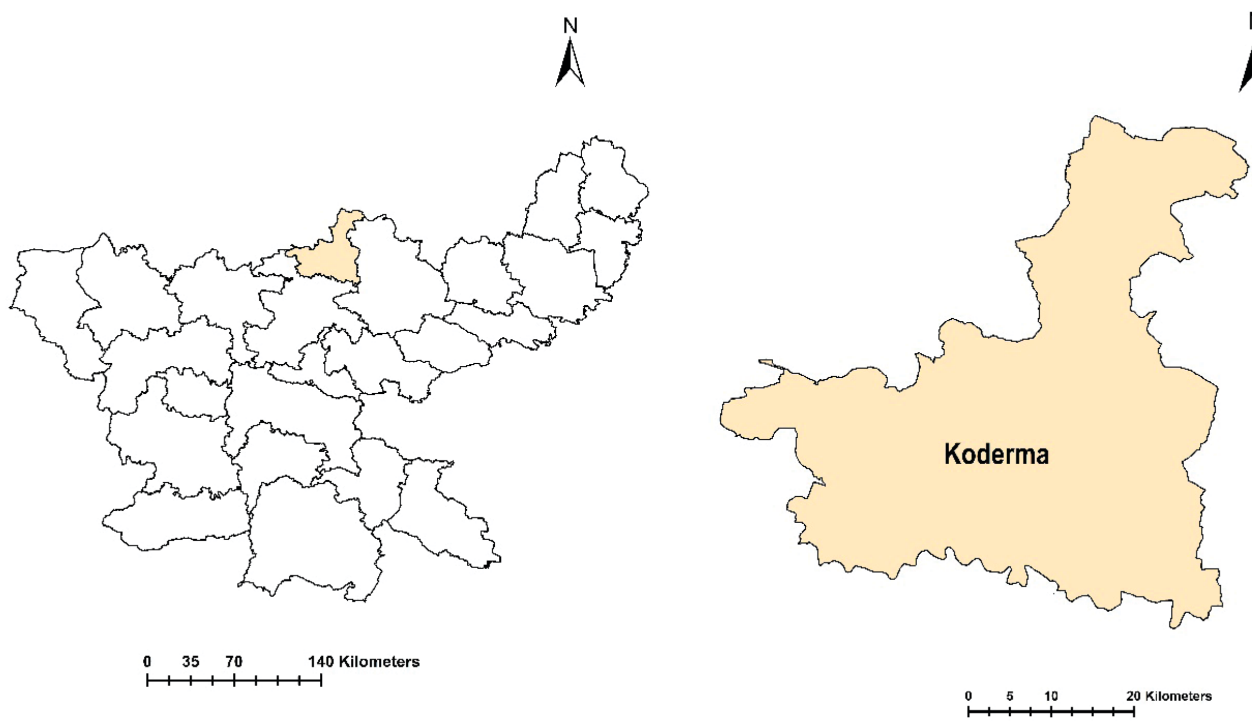


Fig. 3: Location map of Koderma district

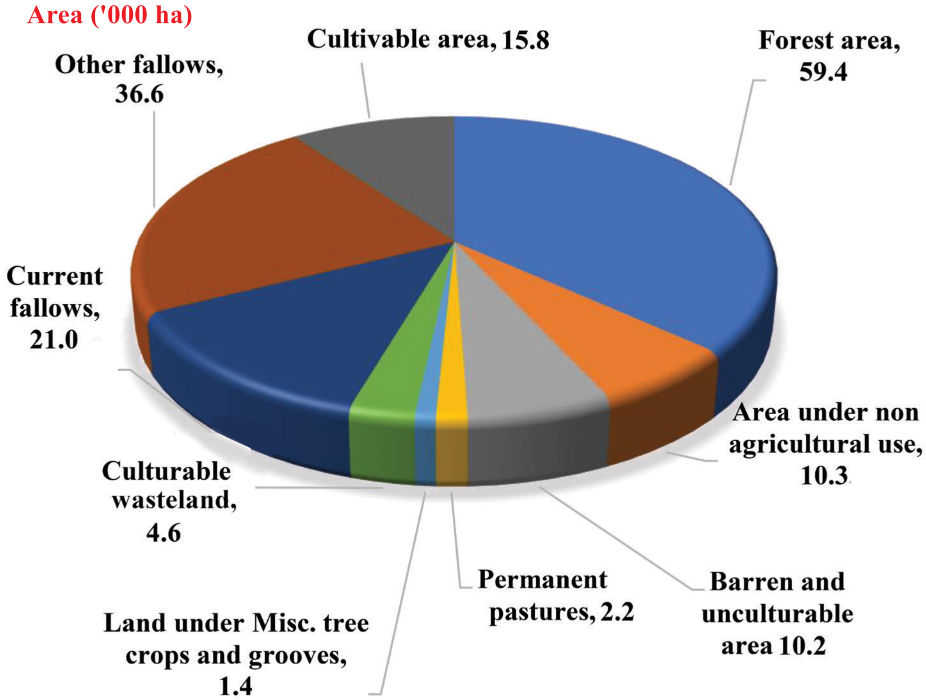


Fig. 4: Land use system of Koderma

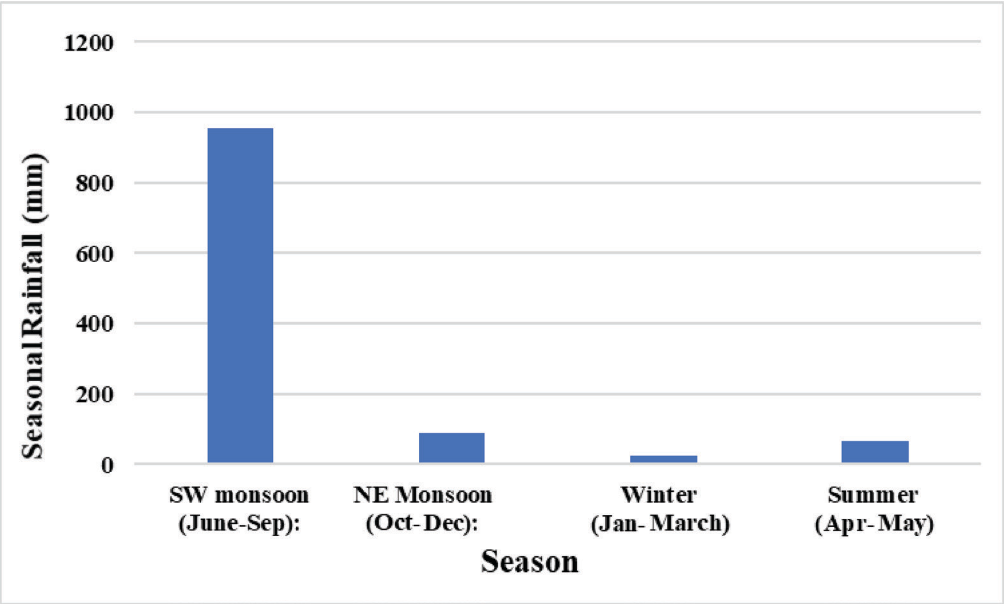


Fig. 5: Season wise rainfall (mm)

Table 1.1: Area, production and productivity of major crops in Koderma district during 2021-22

Major crops	Area (ha)			Production (t)			Productivity (t ha^{-1})	
	Kharif	*Rabi*	Total	*Kharif*	*Rabi*	Total	*Kharif*	*Rabi*
Red gram	6900	-	6900	8280	-	8280	1.2	-
Chickpea	-	9240	9240	-	11088	11088	-	1.2
Groundnut	652	-	652	848	-	848	1.3	-
Horsegram	470	-	470	376	-	376	0.8	-
Jowar	45	-	45	23	-	23	0.51	-
Linseed	-	2130	210	-	1491	1491	-	0.7
Maize	7757	-	7757	16135	-	16135	2.08	-
Masoor	-	4546	4546	-	5455	5455	-	1.2
Greengram	679	-	679	611	-	611	0.9	-
Other *rabi* pulses	-	627	627	-	502	502	-	0.8
***Other kharif* pulses**	391	-	391	274	-	274	0.7	-
Peas &beans (pulses)	-	2750	2750	-	4125	4125	-	1.5
Ragi	575	-	575	460	-	460	0.8	-
Rapeseed & mustard	-	16322	16322	-	14690	14690	-	0.9
Rice	16490	-	16490	42874	-	42874	2.6	-
Blackgram	2300	-	2300	2070	-	2070	0.9	-
Wheat	-	8210	8210	-	20525	20525	-	2.5

1.3.2 Palamu

Palamu district is located between 23° 20' to 24° 40' N latitudes and 83° 20' to 85° 00' E longitudes with an altitude of 228.6 m above MSL. The district is categorized into moderately to gently sloping Chhattisgarh Mahanadi Basin, Hot Moist/dry humid Transitional eco sub-region (ICAR), Eastern plateau and hills region (Planning Commission) and Western Plateau Zone (NARP). The district is

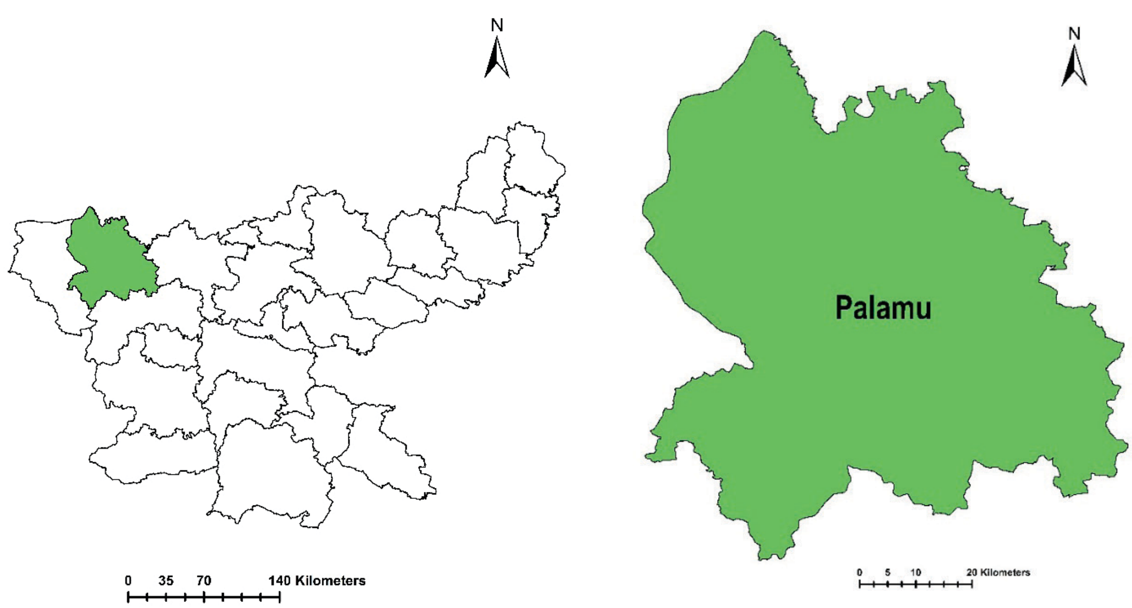


Fig. 6: Location map of Palamu district

bounded in the North by the Rohtas and Aurangabad districts of Bihar, in the South by Lohardaga and Gumla districts and in the East by Gaya (Bihar), Chatra and part of Ranchi district and in the West by Surguja district of Chattisgarh and Garhwa district (Fig 6). The geographical area of the district is 4.59 lakh ha, out of which cultivable area and forest area are 0.841 lakh ha and 1.69 lakh ha, respectively and different land use pattern of the districts are indicated in Figure 7. The gross cropped area of the district is 1.33 lakh ha out of which 0.76 lakh ha is net sown area and 0.56 lakh ha area is double-cropped area (sown more than once). The area under rainfed and irrigated situations is 0.7 lakh ha and 0.5 lakh ha, respectively. The source of irrigation in the district are open wells, canals, tanks and other sources. Rice, wheat, maize, red gram, chickpea, rapeseed & mustard are the major crops grown in the district (Table 1.2). Non-descriptive cattle (local low yielding), crossbred cattle, non-descript buffalo, goat and sheep farming is widely adopted. The average annual rainfall of the district is 1285 mm (Fig. 8). The predominant soils in the district are Alfisols/Ultisols, Entisols and Inceptisols.

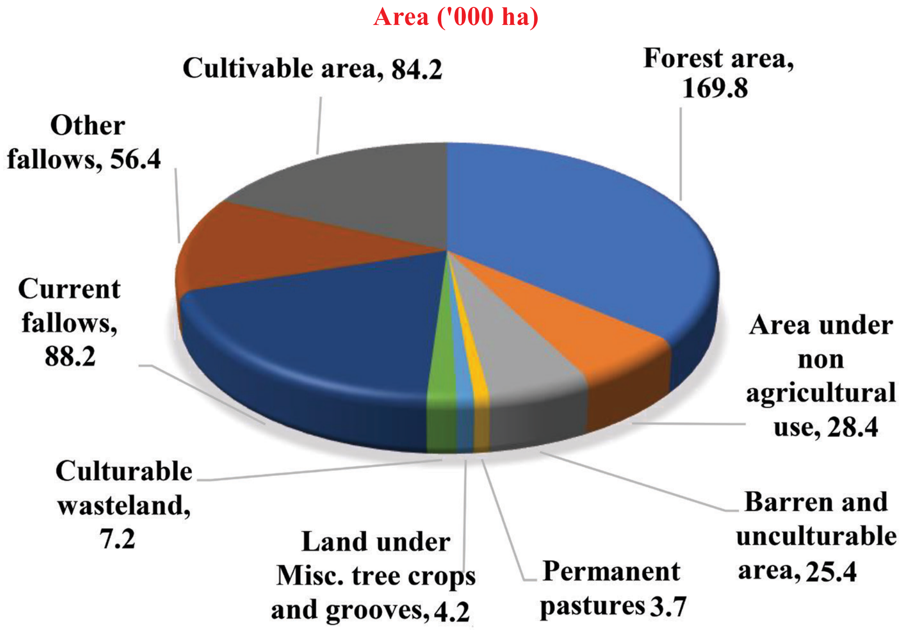


Fig. 7: Land use system of Palamu district

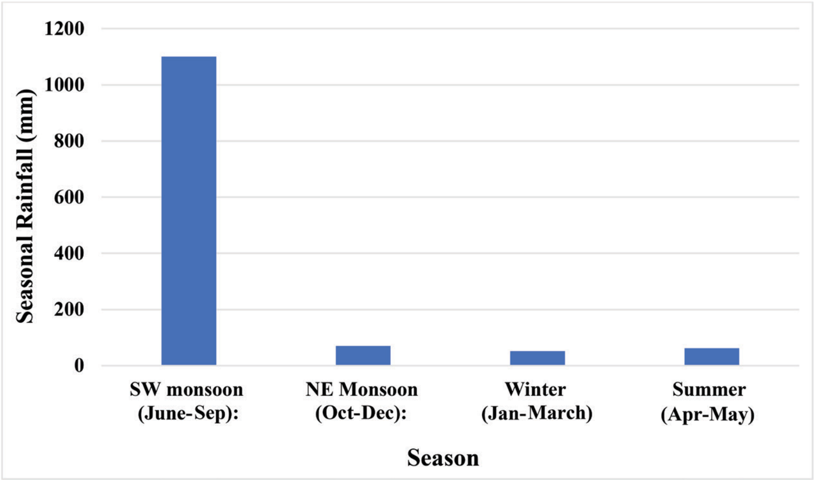


Fig. 8: Season wise rainfall (mm)

Table 1.2: Area, production and productivity of major crops in Palamau district during 2021-22

Major crops	Area (ha)			Production (t)			Productivity (t ha^{-1})	
	Kharif	*Rabi*	Total	*Kharif*	*Rabi*	Total	*Kharif*	*Rabi*
Red gram	30086	-	30086	32974	-	32974	1.1	-
Chickpea	-	17273	17273	-	13922	13922	-	0.81
Groundnut	1167	-	1167	1403	-	1403	1.2	-
Horsegram	355	-	355	242	-	242	0.68	-
Linseed	-	2919	2919	-	1430	1430	-	0.49
Maize	25580	528	26108	37679	835	38514	1.47	1.58
Masoor	-	5376	5376	-	4000	4000	-	0.74
Greengram	660	-	660	565	-	565	0.86	-
Other *rabi* pulses	-	1062	1062	-	680	680	-	0.64
***Other kharif* pulses**	550	-	550	392	-	392	0.71	-
Peas & beans (pulses)	-	2352	2352	-	2211	2211	-	0.94
Ragi	479	-	479	379	-	379	0.79	-
Rapeseed & mustard	-	23758	23758	-	17866	17866	-	0.75
Rice	50123	-	50123	132525	-	132525	2.64	-
Black gram	9728	-	9728	8366	-	8366	0.86	-
Wheat	-	16811	16811	-	33000	33000	-	1.96
Sesamum	499	-	499	262	-	262	0.53	-

1.3.3 East Singbhum

East Singbhum district is located between 86° 04’ to 6° 54’ E Longitudes and 22° 12’ to 23° 01’ N longitudes with an altitude of 244 m above MSL. The district is categorized into Eastern plateau (chotanagpur) and Eastern Ghats, Hot Sub humid Eco-Region (ICAR), Eastern plateau and hills region (Planning Commission) and South Eastern Plateau Zone (NARP). The geographical area of

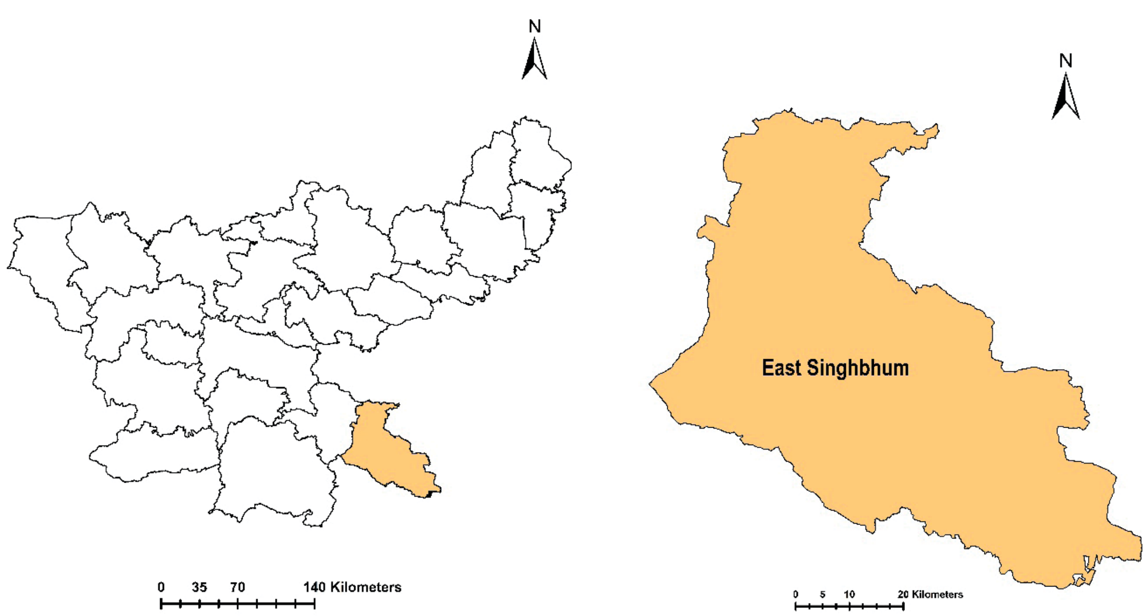


Fig. 9: Location map of East Singhbhum

the district is 3.47 lakh ha, out of which cultivable area and forest area are 1.072 lakh ha and 1.248 lakh ha (Fig 9), respectively and different land use pattern of the districts are indicated in Figure 10. The gross cropped area of the district is 0.683 lakh ha out of which 0.609 lakh ha is net sown area and 0.074 lakh ha area is double-cropped area (sown more than once). The area under rainfed and irrigated situations is 0.6 lakh ha and 0.01 lakh ha. The source of irrigation in the district are open wells, canals, tanks and other sources. Maize, red gram, paddy, black gram and vegetables like cauliflower, cabbage and tomato are the major crops grown in the district (Table 1.3). Rearing of non-descriptive cattle (local low yielding), goat, sheep and others (camel, pig, yak etc.) is widely adopted. The average annual rainfall of the district is 1376 mm (Fig.11). The predominant soils in the district are Red lateritic soils, Loam, Fine loam and Fine mixed loam soils.

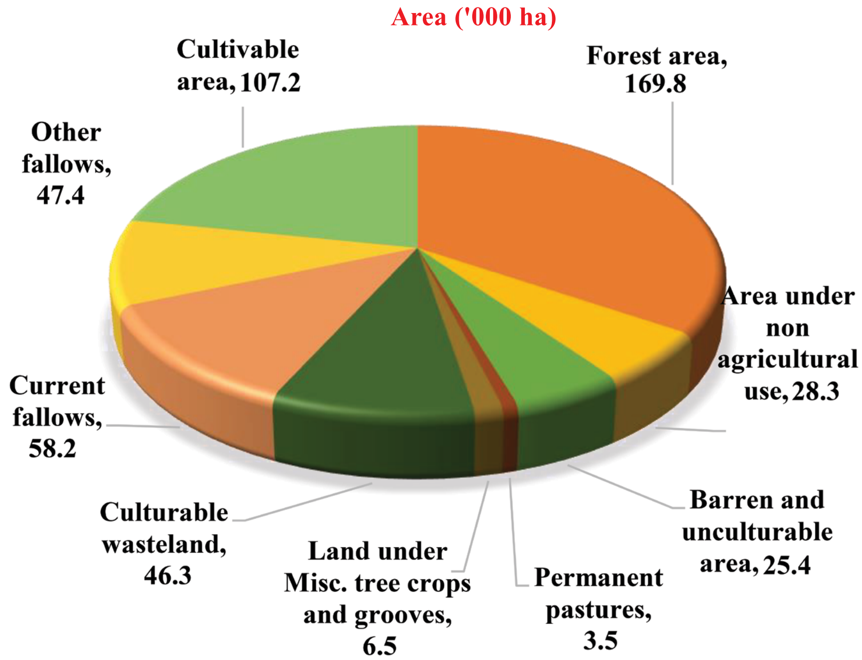


Fig. 10: Land use system of East Singbhum

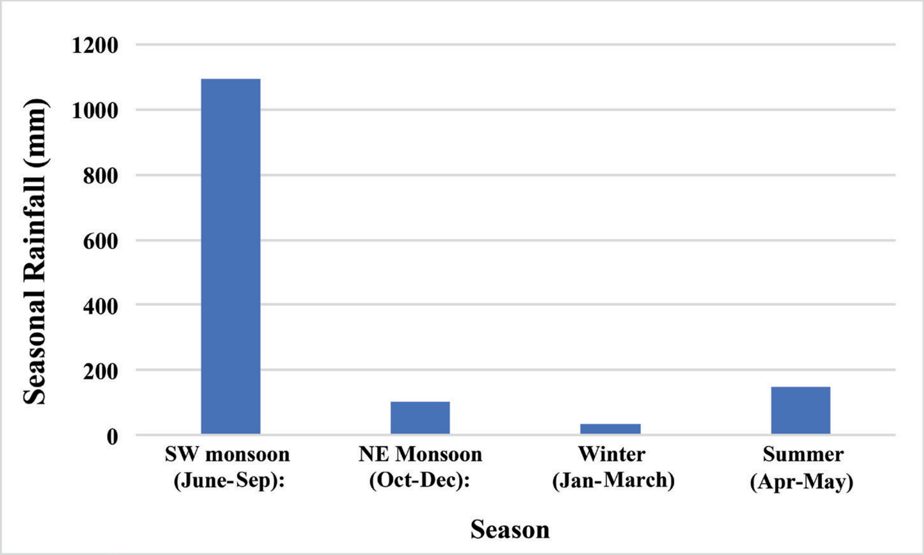


Fig. 11: Season wise rainfall (mm)

Table 1.3: Area, production and productivity of major crops in East Singbhum district during 2021-22

Major crops	Area (ha)			Production (t)			Productivity (t ha^{-1})	
	Kharif	*Rabi*	Total	*Kharif*	*Rabi*	Total	*Kharif*	*Rabi*
Red gram	4000	-	4000	3940	-	3940	0.99	-
Chickpea	-	6320	6320	-	6067	6067	-	0.96
Horsegram	1480	-	1480	977	-	977	0.66	-
Linseed	-	1360	1360	-	898	898	-	0.66
Maize	7210	420	7630	17304	798	18102	2.4	1.9
Masoor	-	2984	2984	-	2462	2462	-	0.83
Other *rabi* pulses	-	336	336	-	215	215	-	0.64
***Other kharif* pulses**	561	-	561	348	-	348	0.62	-
Peas & beans (pulses)	-	3360	3360	-	2906	2906	-	0.86
Rapeseed & mustard	-	13760	13760	-	12522	12522	-	0.91
Rice	108075	-	108075	378263	-	378263	3.5	-
Black gram	4680	-	4680	3182	-	3182	0.68	-
Wheat	-	4270	4270	-	8113	8113	-	1.9

1.3.4 Gumla

Gumla district is located between 22° 42’ and 23° 36’ N latitude and 84° 02’ and 85° 01’ E longitude with an altitude of 620 m above MSL. The district is categorized into moderately to gently sloping Chhattisgarh Mahanadi basin, hot moist/dry humid transitional eco sub-region (ICAR), Eastern plateau and hills region (Planning Commission) and Western plateau zone (NARP). The district is bounded in the North by the Lohardaga and Latehar districts, in the East by Ranchi district, in the South by Simdega district and in the West by the Chhatisgarh state (Fig 12). The geographical area

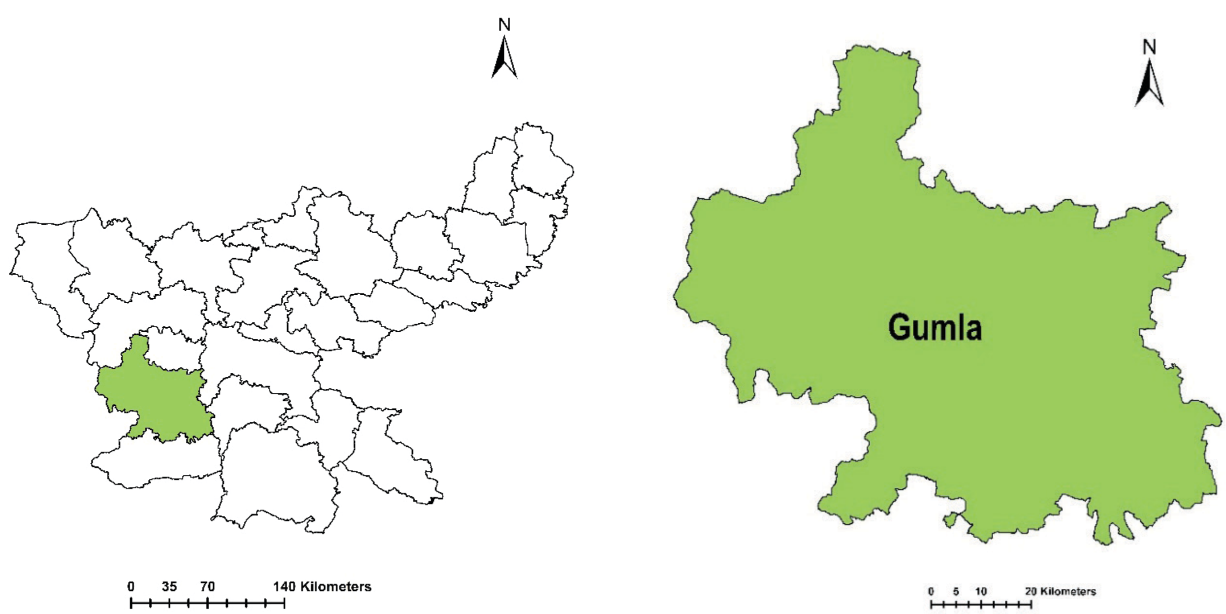


Fig. 12: Location map of Gumla district

of the district is 5.3 lakh ha, out of which cultivable area and forest area are 1.63 lakh ha and 1.35 lakh ha, respectively and different land use pattern of the districts are indicated in Figure 13. The gross cropped area of the district is 1.65 lakh ha out of which 1.31 lakh ha is net sown area and 0.33 lakh ha area is double-cropped area (sown more than once). The area under rainfed and irrigated situations is 1.5 lakh ha and 0.1 lakh ha. The source of irrigation in the district are open wells, bore wells, lift irrigation schemes and other sources. Rice, wheat, maize, red gram, chickpea and other horticulture crops like guava, mango, banana and vegetables like brinjal, bhindi and tomato are the major crops grown in the district (Table 1.4). The average annual rainfall of the district is 1285 mm (Fig. 14). The predominant soils in the district are Inceptisols, Entisols and Alfisols.

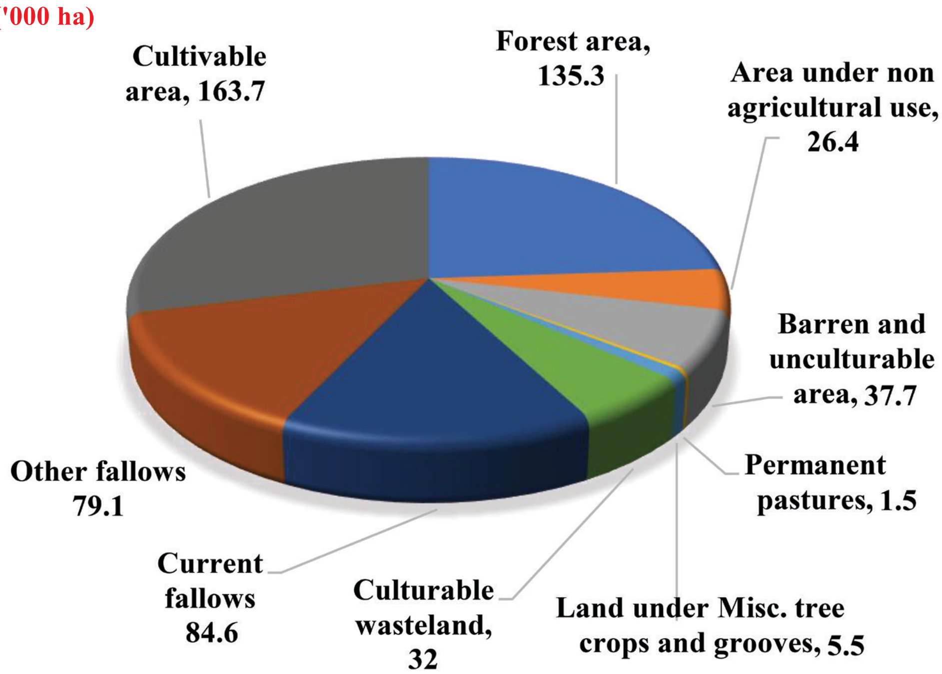


Fig. 13: Land use system of Gumla

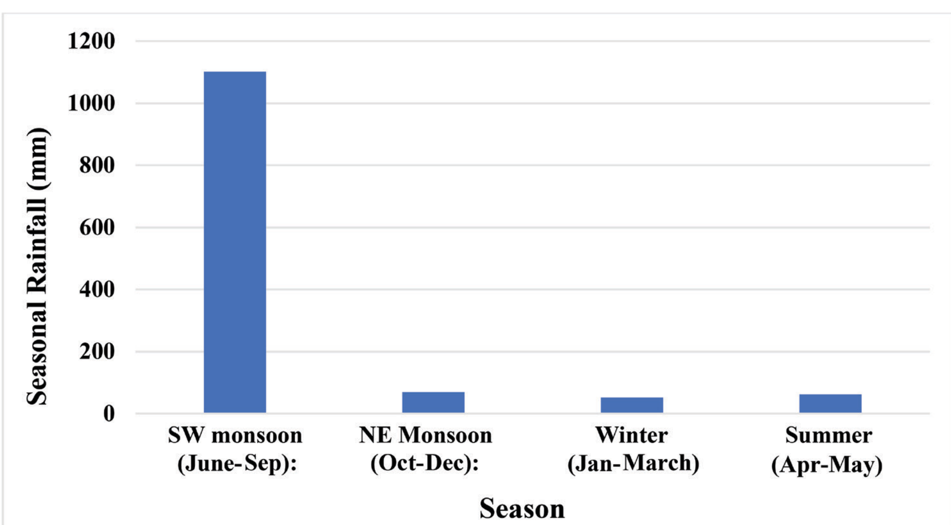


Fig. 14: Season wise rainfall (mm)

Table 1.4: Area, production and productivity of major crops in Gumla district during 2021-22

Major crops	Area (ha)			Production (t)			Productivity ($t\ ha^{-1}$)	
	Kharif	*Rabi*	Total	*Kharif*	*Rabi*	Total	*Kharif*	*Rabi*
Red gram	15784	-	15784	22255	-	22255	1.41	-
Chickpea	-	10485	10485	-	10695	10695	-	1.02
Groundnut	5000	-	5000	7430	-	7430	1.49	-
Horsegram	840	-	840	336	-	336	0.4	-
Linseed	-	1629	1629	-	660	660	-	0.41
Maize	8100	920	9020	26908	2420	29328	3.32	
Masoor	-	3092	3092	-	2798	2798	-	0.9
Greengram	1468	-	1468	1057	-	1057	0.72	-
Other *rabi* pulses	-	958	958	-	417	417	-	0.44
***Other kharif* pulses**	2147	-	2147	1106	-	1106	0.52	-
Peas & beans (pulses)	-	4518	4518	-	3004	3004	-	0.66
Ragi	1588	-	1588	1939	-	1939	1.22	-
Rapeseed & mustard	-	16452	16452	-	6828	6828	-	0.42
Rice	187200	-	187200	620194	-	620194	3.31	-
Black gram	8000	-	8000	9592	-	9592	1.2	-
Wheat	-	10560	10560	-	14805	14805	-	1.4
Niger	657	-	657	71	-	71	0.11	-

1.3.5 Chatra

Chatra district is located between 23°38' to 24°27' N latitude and 84°26' to 85°23' E longitude with an altitude of 525 m above MSL. The district is categorized into moderately to gentle slope. Chattisgarh Mahanadi basin, hot moist/dry sub humid transitional ESR with deep loamy to clayey red and yellow soils (ICAR), Eastern plateau and hills region (Planning Commission) and Western

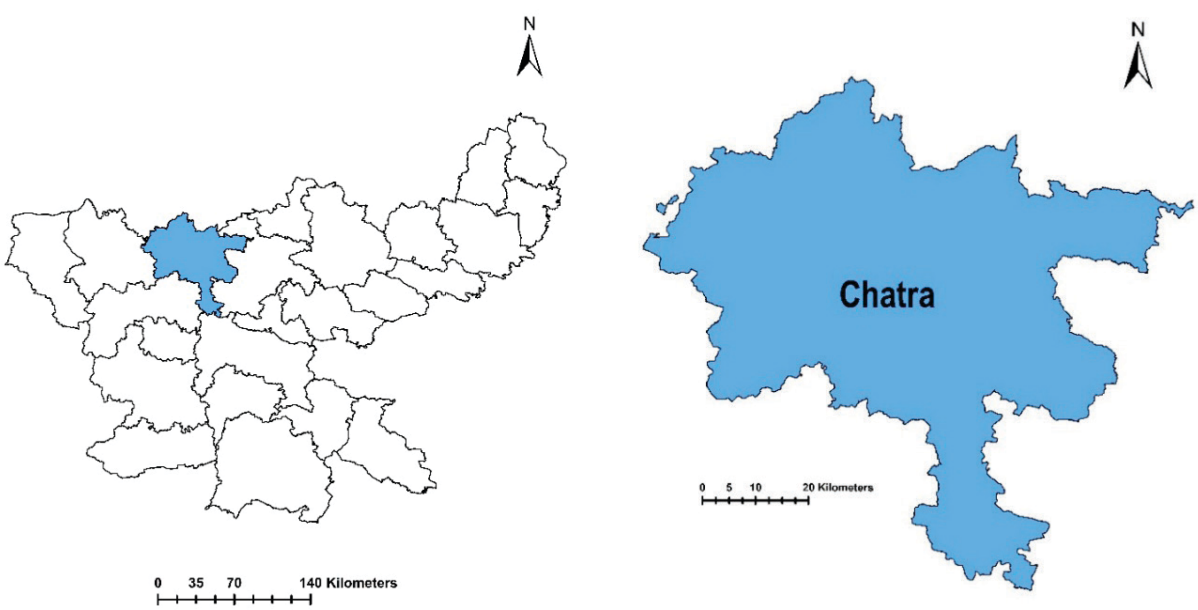


Fig. 15: Location map of Chatra district

plateau zone (NARP). Chatra district is located on the Hazaribagh plateau. The district is bounded in the north by Gaya district of Bihar State, in the West by Palamu district, in the South by Latehar, Ranchi and Hazaribagh districts, in the East by Koderma and Hazaribagh districts (Fig 15). The geographical area of the district is 3.69 lakh ha, out of which cultivable area and forest area are 0.273 lakh ha and 2.16 lakh ha, respectively and different land use patterns of the districts are indicated in Figure 16. The gross cropped area of the district is 0.33 lakh ha, out of which 0.22 lakh ha is net sown area and 0.10 lakh ha area is double-cropped area (sown more than once). The area under rainfed and irrigated situations is 0.2 lakh ha and 0.07 lakh ha respectively. The source of irrigation in the district are open wells, bore wells, canals, tanks, lift irrigation schemes and other sources. Paddy, wheat, chickpea, Rapeseed & mustard and other horticulture crops like mango, guava and vegetables like potato, okra, tomato and brinjal are the major crops grown in the district (Table 1.5). Non-descriptive cattle (local low yielding), improved cattle, crossbred cattle, non-descriptive buffaloes (local low yielding), descript buffaloes, goat and sheep farming are widely adopted. The average annual rainfall of the district is 1250 mm. The predominant soils in the district are different variants of acidic to alkaline soils.

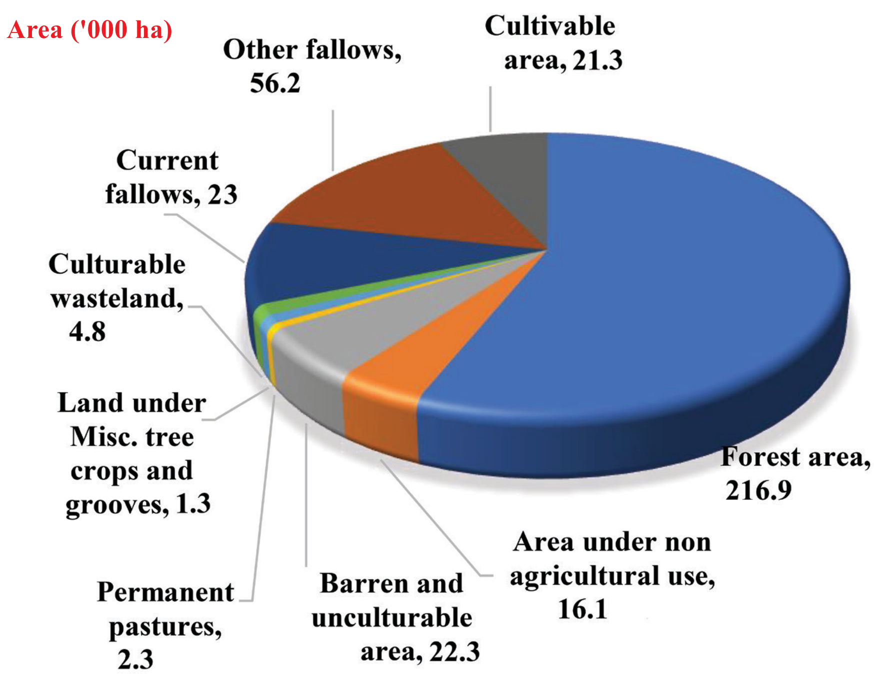


Fig. 16: Land use system of Chatra district

Table 1.5: Area, production and productivity of major crops in Chatra district during 2021-22

Major crops	Area (ha)			Production (t)			Productivity (t ha^{-1})	
	Kharif	*Rabi*	Total	*Kharif*	*Rabi*	Total	*Kharif*	*Rabi*
Red gram	8010	-	8010	10814	-	10814	1.35	-
Chickpea	-	16836	16836	-	19698	19698	-	1.17
Groundnut	525	-	525	509	-	509	0.97	-
Horse gram	1224	-	1224	991	-	991	0.81	-
Linseed	-	1825	1825	-	1451	1451	-	0.8
Maize	9916	48	9964	21617	94	21711	2.18	1.96
Masoor	-	2350	2350	-	1673	1673	-	0.71
Green gram	728	-	728	626	-	626	0.86	-
Other *rabi* pulses	-	940	940	-	865	865	-	0.92
***Other kharif* pulses**	1335	-	1335	861	-	861	0.64	-
Peas & beans (pulses)	-	3420	3420	-	3762	3762	-	1.1
Ragi	1011	-	1011	1481	-	1481	1.46	-
Rapeseed & mustard	-	13440	13440	-	9139	9139	-	0.68
Rice	36408	-	36408	121967	-	121967	3.35	-
Black gram	3240	-	3240	3661	-	3661	1.13	-
Wheat	-	11915	11915	-	22400	22400	-	1.88

1.3.6 Godda

Godda district is located between 24°30' to 25°13' N latitudes and 87°02' to 87°31' E longitudes with an altitude of 210 m above MSL. The district is categorized into the Eastern plain, hot sub-humid (moist) eco-region (ICAR), Eastern plateau and hills region (Planning Commission) and Central and North-Eastern plateau zone (NARP). The district is bounded in the Northwest by Bhagalpur

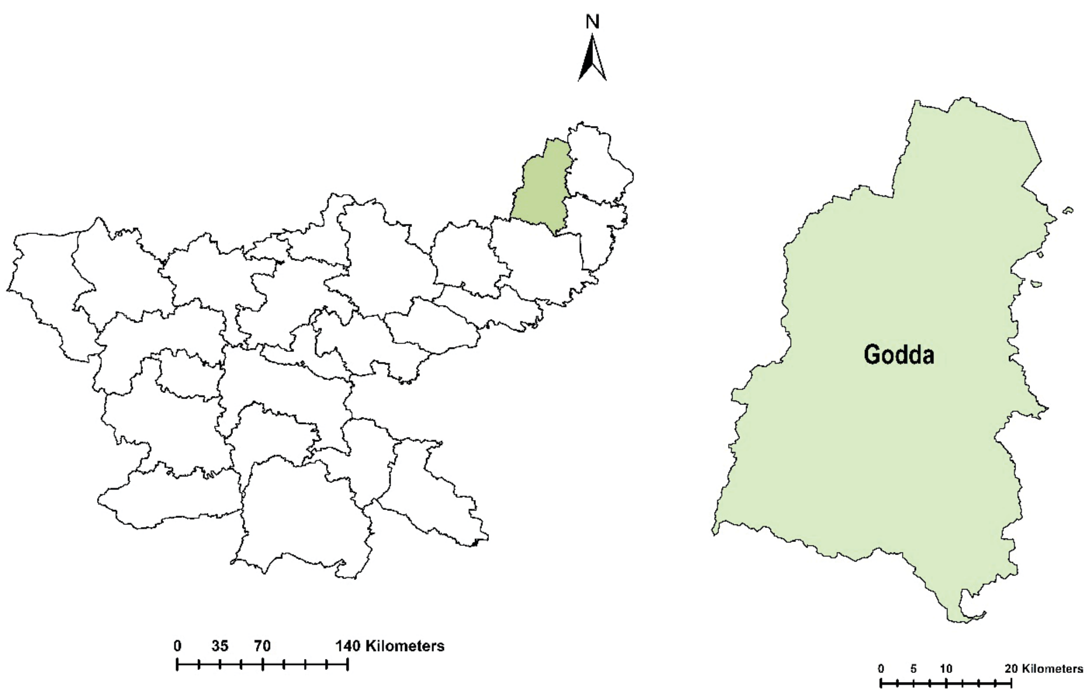


Fig. 17: Location map of Godda

district of Bihar, in the South by Dumka, in the West by the Banka district of Bihar, in the East by Sahebganj and Pakur districts (Fig. 17). The geographical area of the district is 2.11 lakh ha, out of which cultivable area and forest area are 0.58 lakh ha and 0.23 lakh ha, respectively and different land use patterns of the districts are indicated in Figure 18. The gross cropped area of the district is 0.57 lakh ha out of which 0.48 lakh ha is net sown area and 0.08 lakh ha area is double-cropped area (sown more than once). The area under rainfed and irrigated situations is 0.4 lakh ha and 0.08 lakh ha respectively. The sources of irrigation in the district are open wells, canals, tanks, micro irrigation and other sources. Maize, wheat, paddy, rapeseed & mustard, chickpea and other horticulture crops like mango, guava and banana and vegetables like cauliflower and tomato are the major crops grown in the district (Table 1.6). Non descriptive cattle, crossbred cattle, descript buffaloes, goat, sheep and duck farming are widely adopted. The average annual rainfall of the district is 1530 mm (Fig. 19). The predominant soils in the district are red lateritic, loam, fine loam and fine mixed loam soils.

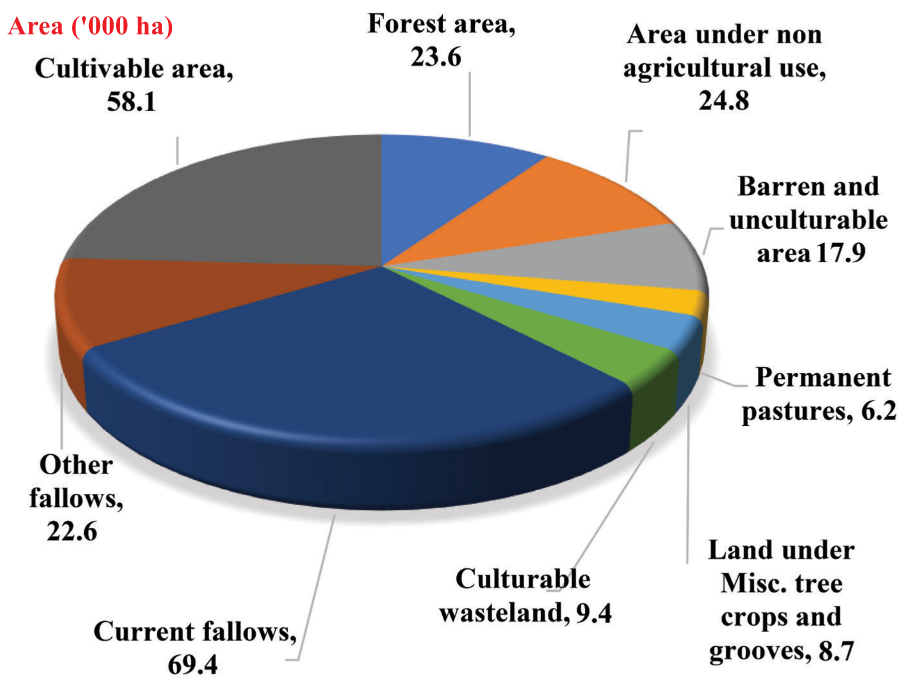


Fig. 18: Land use system of Godda

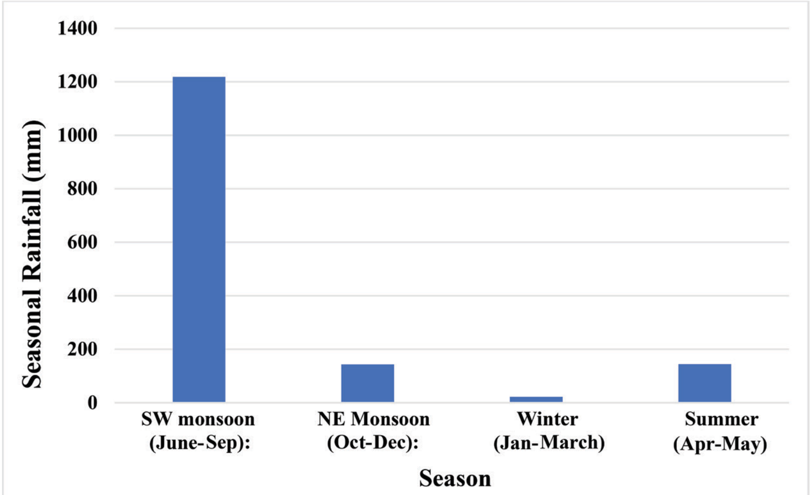


Fig. 19: Season wise rainfall (mm)

Table 1.6: Area, production and productivity of major crops in Godda district during 2021-22

Major crops	Area (ha)			Production (t)			Productivity (t ha^{-1})	
	Kharif	*Rabi*	Total	*Kharif*	*Rabi*	Total	*Kharif*	*Rabi*
Red gram	9000	-	9000	7110	-	7110	0.79	-
Chickpea	-	12998	12998	-	18587	18587	-	1.43
Groundnut	800	-	800	664	-	664	0.83	-
Horsegram	549	-	549	401	-	401	0.73	-
Linseed	-	3184	3184	-	2006	2006	-	0.63
Maize	12330	661	12991	30825	1606	32431	2.5	2.43
Masoor	-	4140	4140	-	4595	4595	-	1.11
Green gram	670	-	670	422	-	422	0.63	-
Other *rabi* pulses	-	910	910	-	664	664	-	0.73
***Other kharif* pulses**	765	-	765	344	-	344	0.45	-
Peas & beans (pulses)	-	1196	1196	-	2177	2177	-	1.82
Ragi	800	-	800	600	-	600	0.75	-
Rapeseed & mustard	-	23265	23265	-	19077	19077	-	0.82
Rice	54356	-	54356	168504	-	168504	3.1	-
Black gram	3125	-	3125	1938	-	1938	0.62	-
Wheat	-	13665	13665	-	33343	33343	-	2.44

1.3.7 Garhwa

Garhwa district is located between 23° 60' to 24° 39' N latitude and 83° 22' to 84° 00' E longitude with an altitude of 364 m above MSL. The district is categorized into moderately to gently sloping Chattisgarh Mahanadi basin, hot moist/dry sub humid transitional ESR (ICAR), Eastern Plateau and Hills Region (Planning Commission) and Western Plateau zone (NARP). The district is bordered

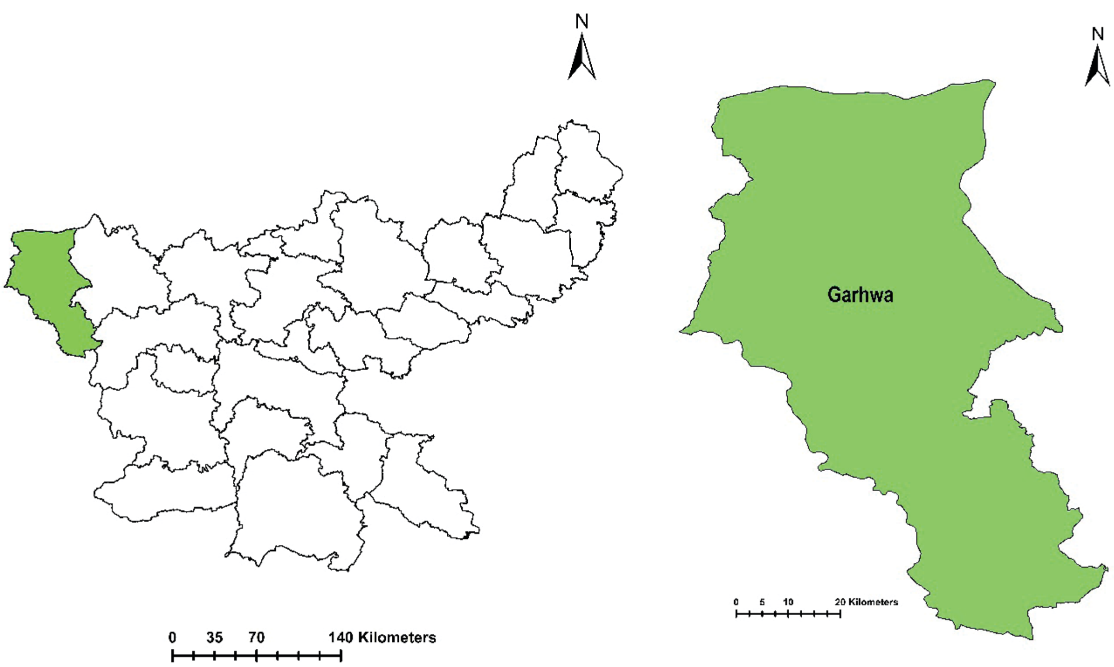


Fig. 20: Location map of Garwah district

by river Sone on the North, Palamau district of Jharkhand state on the East, Surguja district of Chhattisgarh state on the South, and Sonebhadra district of Uttar Pradesh on the West (Fig 20.). The geographical area of the district is 4.28 lakh ha, out of which cultivable area and forest area are 0.82 lakh ha and 1.91 lakh ha, respectively and different land use patterns of the districts are indicated in Figure 21. The gross cropped area of the district is 0.99 lakh ha out of which 0.73 lakh ha is net sown area and 0.25 lakh ha area is double-cropped area (sown more than once). The area under rainfed and irrigated situations is 0.5 lakh ha and 0.4 lakh ha, respectively. The sources of irrigation in the district are open wells, bore wells, canals, tanks and other sources. Rice, wheat, maize, red gram, chickpea and rapeseed & mustard and vegetables like potato and okra are the major crops grown in the district (Table 1.7). Non-descriptive cattle, crossbred cattle, non-descriptive buffaloes, goat, sheep and pig farming is widely adopted. The average annual rainfall of the district is 866 mm (Fig. 22). The predominant soils in the district are sandy loam, red loam and grey soils.

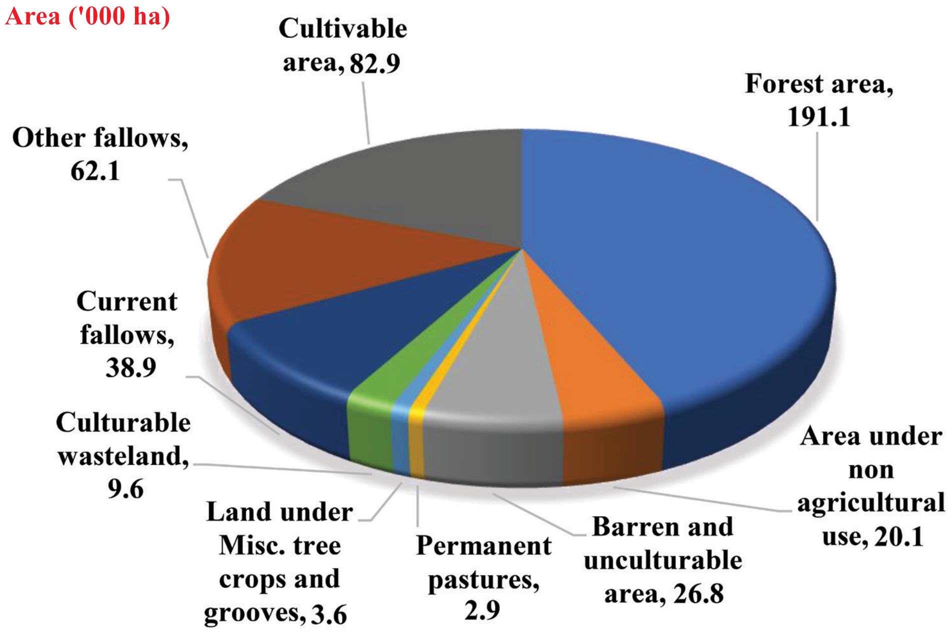


Fig. 21: Land use system of Garwah

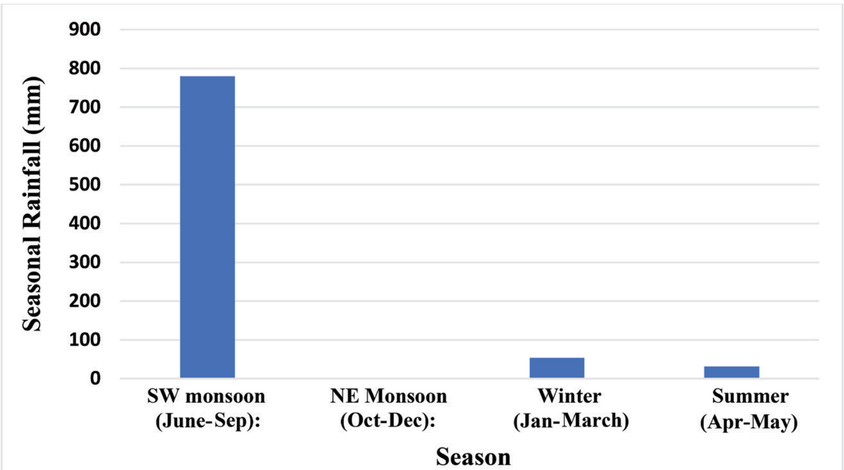


Fig. 22: Season wise rainfall (mm)

Table 1.7: Area, production and productivity of major crops in Garhwa district during 2021-22

Major crops	Area (ha)			Production (t)			Productivity (t ha^{-1})	
	Kharif	*Rabi*	Total	*Kharif*	*Rabi*	Total	*Kharif*	*Rabi*
Red gram	21565	-	21565	21134	-	21134	0.98	-
Chickpea	-	15841	15841	-	23508	23508	-	1.48
Groundnut	2285	-	2285	2440	-	2440	1.07	-
Linseed	-	2470	2470	-	1606	1606	-	0.65
Maize	22130	260	22390	56432	538	56970	2.55	2.07
Masoor	-	4845	4845	-	5688	5688	-	1.17
Green gram	215	-	215	158	-	158	0.73	-
Other *rabi* pulses	-	1120	1120	-	599	599	-	0.53
***Other kharif* pulses**	195	-	195	100	-	100	0.51	-
Peas & beans (pulses)	-	2030	2030	-	2071	2071	-	1.02
Rapeseed & mustard	-	27950	27950	-	24876	24876	-	0.89
Rice	52330	-	52330	153327	-	153327	2.93	-
Black gram	6010	-	6010	4958	-	4958	0.82	-
Sesamum	1145	-	1145	457	-	457	0.4	-
Wheat	-	17960	17960	-	43463	43463	-	2.42

2. Promising Climate Resilient Technologies

2.1 Promising Natural Resource Management Technologies

DSR with var. IR64 Drt-1: for mitigation of drought in rainfed medium lands

Climate vulnerability: Moisture stress

Background

The rainfall in Garhwa region was low as it situated in rain shadow region. IR64 is a traditional variety grown in rainfed regions. But this variety was not drought tolerant and yields were low. Hence, water saving rice cultivation methods with drought tolerant variety which suits for direct seeded rice is the need of the hour.

Resilient technology

Direct sown rice is an efficient resource-conserving technology. This is a labour and water-saving technology suited for low-rainfall areas like Garhwa. Rice seeds are directly drilled into the fields at optimum moisture level to a depth of 2-3 cm in contrast to the traditional method of transplanting rice seeding to puddled fields. Pendimethalin is sprayed as pre-emergence @ 3 litre ha^{-1} and Bispyribac sodium 10% SC weedicide @ 200 g ha^{-1} is sprayed at 2-3 leaf stage. DRR Dhan 42 (IR64 Drt1) the first drought-tolerant rice variety released in 2014, which was developed using Marker Assisted Selection by ICAR-Indian Institute of Rice Research, Hyderabad. This variety produces higher yields even though moisture stress is prevalent at reproduction and grain filling stages. On an average this variety records 20 % higher yield over IR64 under drought. This variety suits for rain shadow regions like Garhwa where intermittent dry spell occurs during the *kharif* season.

Performance and impact of technology

The DSR with var. IR64 Drt-1 and transplanting prevalent varieties (Lalat & IR64) of rice under drought stress conditions were demonstrated by KVK Garhwa in rainfed medium lands in 2 NICRA villages (Tenar and Sangbariya) of Garhwa district of Jharkhand, in 36 farmers fields during *Kharif* season. DSR var. IR64 Drt-1 recorded 37.7% higher yield than Lalat, and Lalat at Tenar and 38 % higher yield over IR 64 at Sangbariya villages (Table 2.1.1). The rice varieties under transplanted situation were affected adversely due to water stress since there was low rainfall and intermittent dry spells during vegetative as well as grain filling stages whereas the DSR IR64 Drt-1 thrived well in this drought situation.

Table 2.1.1: Performance of IR64 Drt -1 with prevalent rice varieties in Tenar & Sangbariya

Intervention	Village	Yield (kg ha^{-1})	Cost of cultivation (₹ ha^{-1})	Net return (₹ ha^{-1})	B C ratio
DSR var. IR64 Drt-1	Tenar	3140	38000	26056	1.69
DSR var. IR64 Drt-1	Sangbariya	3450	38000	32380	1.85
TransplantingLalat (Farmer's practice)	Tenar	2280	35000	11512	1.33
Transplanting IR-64 (Farmers Practice)	Sangbariya	2500	35000	16000	1.46

Scope for upscaling

The DSR with var. IR64 Drt-1 is being popularized by KVK through its trainings, FLDs and other extension activities. Apart from this the KVK distributed and sold 20 q foundation seeds from their farm among farmers of the district. The 2 NICRA villages have also produced 60 q seeds of IR64 Drt-1 during *kharif* 2022, which has been sold among other farmers during *kharif* 2023. The District Agriculture Department has also distributed large quantities of seed during *kharif* 2023 in Garhwa district. Thus, upscaling potential is available by converging with state agriculture department.

DSR with var. IR64 Drt-1 at Sangbariya village of Garhwa district

Green manuring *for In-situ* moisture conservation

Climate vulnerability: Moisture stress

Background

The moisture stress is a major climatic constrain in Gumla due to ill rainfall distribution. To ensure and enhance the moisture availability in the field, *in situ* moisture conservation technology like green manuring is recommended to save time, energy, and improve soil health management, enhancement of water holding capacity and use of residual moisture through piara and sequential cropping.

Resilient technology

The *in-situ* moisture conservation in view, resource conservation technology with dhaincha green manuring in the Gumla district.

Performance and impact of technology

Demonstrations on green manuring with Dhaincha in lowland paddy fields was demonstrated in 6 farmer fields and their extent was 20-25% of the total paddy field. Application of green manure helped the farmers of NICRA village to reduce one top dressing of urea in low land paddy, this helped in saving ₹ 200-300 ha^{-1}. Rice with green manuring recorded 35% higher yield over rice without green manuring. Rice with green manuring registered 9675 additional returns over no green manuring rice (Table 2.1.2). The farmers expressed that green manuring with dhaincha not only improved soil fertility but also enhanced the soil moisture retention.

Table 2.1.2: Impact of *in-situ* moisture conservation

Technology demonstrated	Yield (kg ha^{-1})	Gross returns (₹ ha^{-1})	Net returns (₹ ha^{-1})	B C Ratio
Green manuring (Dhaincha) in Paddy (var.Sahbhagi Dhan)	3870	32255.00	18055.00	1.56
Paddy without green manuring	2860	28800.00	8380.00	1.29

Scope for upscaling

The technology can be upscaled by converging with the State agriculture department

Demonstration of *in-situ* moisture conservation at Gumla district

Zero tillage: Alleviating heat and moisture stress in *rabi* crops

Climate vulnerability: Moisture stress/ Heat wave

Background

Cultivation of wheat, maize and lentil after the paddy harvest is a common practice in Jharkhand. Ploughing the field and sowing the *rabi* crops delays wheat and maize sowings. Due to delayed sowing, the crops are affected by terminal heat stress, in addition moisture stress is common. To sow the crops with tillage, paddy straw is removed or burnt. Hence, zero tillage sowing of the crops with the crop residues is recommended.

Resilient technology

Conservation tillage is sowing the crop with minimum soil disturbance and leaving crop residues on the field. This technology helps to retain soil moisture, reduce erosion and improve soil structure. Conservation tillage is a cornerstone of climate-resilient agriculture. It promotes biodiversity and enhances the soil's natural fertility, this practice not only conserves water but also sequesters carbon in the soil, hence this is more resilient technology to extreme weather events. and ensures sustainable productivity in the face of climate challenges. Sowing of maize var. HQPM-1 and lentil var. NDL-1 and wheat varieties PBW-343 and HD 2733 with zero tillage machine was demonstrated in the Gunia village of Gumla district.

Performance and impact of technology

The yields of maize, wheat and lentil in zero tillage were slightly higher than the conventional tillage. But the net returns in wheat var HD2733, maize and lentil were ₹ 22538, 16756 and 21500, respectively (Table 2.1.3). This higher net returns were due to lower cost of cultivation since there was saving in irrigation water.

Table 2.1.3: Influence of zero tillage (NICRA farmers) on the yield and economics

Technology demonstrated (NICRA farmers)	No. of farmers	Yield (kg ha^{-1})	Gross return (₹ ha^{-1})	Net return (₹ ha^{-1})	B C Ratio
Sowing of wheat with ZTD machine (var. PBW-343)	11	2903	18415.00	17173.00	1.93
Sowing of wheat with ZTD machine (var. HD 2733)	02	3575	31087.00	22538.00	1.72
Sowing of wheat with tillage (var. PBW-343)	11	3010	19800.00	18102.00	1.86
Sowing of wheat with tillage (var. HD 2733)	02	3360	32100.00	18300.00	1.57
Sowing of maize with ZTD machine (var. HQPM-1)	20	3330	18247.00	16756.00	1.92
Sowing of maize with tillage (var. HQPM-1)	20	3240	20400.00	14140.00	1.69
Sowing of lentil with ZTD machine (var. NDL-1)	07	1280	10500.00	21500.00	3.04
Sowing of lentil with tillage (var. NDL-1)	07	1320	12000.00	21000.00	2.75

Scope for upscaling

This is a successful technology and can be upscaled by convergence with the State department of Agriculture.

Sowing of *rabi* crops in zero tillage

Zero tillage wheat

Zero till maize at Gunia village of Gumla district

Field bunding for artificial groundwater recharge

Climate vulnerability: Moisture stress/ Heat wave

Background

The huge volume of water huge volume of water along with fertile topsoil was washed out in to nearby rivulets, nalas and rivers. This resulted in siltation of the ponds, the depth and water table of the existing bore wells decreased. Field bunding is a solution for this. usually field bunding was not done by the farmers.

Resilient technology

Keeping the slogan "Khet ka pani khet me aur gaon ka pani gaon me" in the center, KVK Gumla has tried to educate the farmers to conserve the maximum of rainwater in their fields through field bunding and in the pond to recharge groundwater.

Performance and impact of technology

Field bunding was taken as a mass campaign in 39 ha of 85 farm fields during 2011-17 under NICRA in Gunia village, Gumla district. Paddy was raised. Field bunding has increased the rice yields and net returns by 4 and 11%, respectively over no field bunding practice. The B C ratio of field bunded paddy was 1.68 as compared to 1.61 of no field bunding (Table 2.1.4). These results created a big impact on farmers of NICRA and adjoining villages. Field bunding was done every year in more than 800 ha area by the farmers

Table 2.1.4: Impact of field bunding on the yield and economics of transplanted paddy

Technology demonstrated	No. of farmers	Yield (kg ha^{-1})	Gross return (₹ ha^{-1})	Net return (₹ ha^{-1})	B C ratio
Field bunding for paddy (var. Lalat)	85	2948	19582	13344	1.68
Without field bunding (var. Lalat)	85	2820	19500	11999	1.61

Scope for upscaling

This initiative by NICRA in cluster villages, was accepted by all the farmers. The state government has initiated "Medh Bandi" scheme and an amount of ₹ 5000 ha^{-1} was spent to the beneficiaries as a promotional activity. In convergence with this scheme NICRA implemented field bunds in 143 ha in Ghaghra block.

Paddy crop with field bunding at Gunia village of Gumla district

Bora bandh (Sandbag check dam)

Climate vulnerability: Moisture stress

Background

Moisture stress is the major constraint in rainfed farming. NICRA village has also experienced a moisture stress for decades in different crops. The water shortage is not only for crops but livestock and humans also experienced water crisis. The ill distribution of rainfall like high intense rainy events and intermittent rains in between aggravated the situation. The intense rains cause runoff and soil loss and the dry spells in between cause moisture stress. To overcome this situation water storage sand bag check dam was recommended.

Resilient techechnology

The sandbag check dam is popularly called "Bora Bandi" was constructed across a drainage channel to reduce the velocity of water downstream at Gunia village of Gumla district. The bags are filled with sand and are placed across the drainage channel. This reduces runoff losses, the stored water can be utilized by the farmers for pre-sowing irrigation and supplemental irrigation during dry spells. The supplemental irrigation was given for the wheat and okra crops resulting in significant improvement in yield over farmers' practice.

Performance and impact of technology

The sand bag check dam was done in Gunia village of Gumla district. The stored water was recycled and was used for supplemental irrigation to wheat crop. The pre-sowing and supplemental irrigation, resulted in 14 and 12% higher yield over farmer's practice in wheat, okra. The net monetory returns increased by 32 and 24% in wheat and okra, respectively (Table 2.1.5). The sandbag check dam benefitted 95 wheat growing farmers and helped in recharging ground water. Before NICRA, the cropping intensity of the village was 86.15% only, which has increased to 117.7%. The Sandbag technique increased an irrigation potential of 411 ha. In addition this technique also helped in recharging of the water table, which is 7-8 ft below in hot summer. After the intervention, the water table was recharged and it was 3-4 ft.

Table 2.1.5: Impact of bora bandh on wheat and okra yield and economics

Technology demonstrated	No. of farmers	Area (ha)	Yield (kg ha^{-1})	Gross return (₹ ha^{-1})	Net return (₹ ha^{-1})	B C Ratio
Bora bandh wheat (var.PBW-343)	95	50	3200	17300.00	17900.00	2.03
Farmers practice wheat (var.PBW-343)			2750	18000.00	12250.00	1.68
Bora bandh Okra (Avinash)	9	5	9860	31200.00	67400.00	3.16
Farmers practice Okra (Avinash)			8750	33200.00	54300.00	2.63

Scope for upscaling

The technology is well accepted and similarly, other defunct canals and bore wells can be recharged through convergence with the state department, MNERAGA, CGWB, NABARD, and watershed development programs.

Bora bandh, wheat and okra crop at Gunia village of Gumla district

Crop residue mulching in ginger & turmeric for climate resilience

Climate vulnerability: Drought

Background

Ginger and turmeric are prone to moisture stress due to intermittent dry spells. Mulching with crop residues like paddy straw, and locally available plant leaves helps to conserve soil moisture and reduce heat stress, number of irrigations and weed control.

Resilient technology

Use of paddy straw and locally available plant leaves can be used as mulching material in ginger and turmeric. In ginger and turmeric, one-inch thin paddy straw and available plant leaves are spread in the field immediately after the sowing. Besides, moisture conservation, the residues add organic matter to the soil. Decomposed material improves soil health, increase the soil's water holding capacity and reduce the weed growth.

Performance and impact of the technology

Mulching of ginger and turmeric were done in Mardanpur village of Chatra district. In ginger and turmeric, one inch depth mulching with paddy straw and the crop leaves reduced the number of irrigations due to moisture conservation and saved the water by 42 and 46%, respectively. The mulching increased the yields of ginger and turmeric by 19 and 16% respectively over no mulching. The net returns were 40 and 22% higher with mulching in ginger and turmeric, respectively (Table 2.1.6). Besides the yield improvement and net returns, mulching improved the health of the crop, reduced the duration of the crop and also the tubers were large, uniform and had attractive colour.

Table 2.1.6: Impact of mulching in ginger and turmeric

Demonstrations	Area (ha)	Water saving (%)	Yield (kg ha^{-1})	Cost of cultivation (₹ ha^{-1})	Gross return (₹ ha^{-1})	Net return (₹ ha^{-1})	B C ratio
Ginger- Var. Suparbha (with mulching)	1.5	42	22600	192000	564000	372000	2.93
Ginger-Var. Local (without mulching)- farmers practice	1.5	-	19000	168000	434000	266000	2.58
Turmeric-Var. Nadiya (mulching)	1.5	46	6700	122000	234500	112500	1.92
Turmeric (without mulching)-farmers practice	1.5	-	5800	111000	203000	92000	1.82

Scope for upscaling

This practice covered 80 ha of the area with 160 farmers. This technology can be upscaled in convergence with state department of agriculture.

Mulching in turmeric field at Mardanpur village of Chatra district

Community farm pond – A boon for the village Bhelwa

Climate vulnerability: Moisture stress

Background

The erratic and ill distribution of rainfall with high intense rains and dry spells were common in Godda district. This ill distribution of rainfall cause runoff and soil loss during high intense rains and moisture stress during dry spells. Hence, rain water harvesting during high intense rains and recycling of this harvested water to crops is the solution.

Resilient technology

Ex-situ water conservation in farm ponds and recycling of this water can be done. With this harvested water, supplemental irrigations can be given to both *kharif* as well as *rabi* crops. Two farm ponds (30 m x 30 m x 1.25 m) were constructed on the community land of Bhelwa and Gunghasa villages of Godda district. The water harvesting capacity of the pond was 675 m^3.

Performance and impact of technology

The farm pond helped to increase the cropping intensity due to water availability for the *rabi* crops. After the establishment of farm pond, 60 ha area of the village Bhelwa was brought under *rabi* cultivation while in the village Gunghasa, about 45 ha area came under double cropping system. The major crops being grown during *rabi* were wheat, mustard, and vegetables. Wheat variety, Sabour Nirjal and mustard variety, Pusa mustard – 28 were taken for demonstration in 125 ha and 254 ha area, respectively in the Bhelwa and Gunghasa villages for the farmers where the field has accessibility to water harvesting structure. Wheat and mustard cultivation have increased the net returns by 53 and 43% respectively over farmers practice. The B C ratio was 1.58 and 1.63 in wheat and mustard, respectively (Table 2.1.7). Apart from increased profits the cropping intensity of the village has increased and the ground water was also recharged. Before the construction of pond, cultivation of *rabi* crops was not possible in both villages due to lack of irrigation water. The water table has also raised by approximately 0.50 to 0.75 m and the defunct tube well became functional. It also improved the microclimatic condition of adjoining areas.

Table 2.1.7: Average performance of wheat and mustard cultivation under farm pond

Intervention	Yield (kg ha^{-1})	Cost of cultivation (₹ ha^{-1})	Net return (₹ ha^{-1})	B C Ratio
Wheat var.: Sabour Nirjal	3500	37750	21750	1.58:1
Farmers practice (Before farm pond)	2950	35900	14250	1.40
Mustard var.: Pusa Mustard-28	1050	25750	16250	1.63:1
Farmers Practice (Before farm pond)	875	23600	11400	1.48:1

Scope for upscaling

This technology was replicated in five adjoining villages viz. Draupad, Machkar, Pasai, Garhi and Kairadih through Integrated watershed management scheme which was funded by NABARD. In a convergence mode, 15 new water harvesting structures were created by NABARD. GVT – Krishi Vigyan Kendra runs the programme of seed production. The technology can further be spread by converging with the state government programmes.

Farm ponds

Mustard Var.: PM - 28

Wheat Var.: Sabour Nirjal

Farm pond, wheat and mustard at Gunghasa village of Godda district

Rennovation of farm ponds for rainwater harvesting

Climate vulnerability: drought and heat stress

Background

The major vulnerability of the East Singhbhum in Jharkhand is drought / heat stres, which occurs frequently due to late onset and early cessation of monsoon, uneven distribution of rainfall and continuous long dry spell periods (i.e., >20 days). Efficient water harvesting during excess rain and recycling the water for supplemental irrigation during dry spells is an efficient technology for the mitigation of drought. Due to drought, mono-culture was predominant in these districts. Hence renovation of the existing ponds to minimise the water losses is an important strategy. Efficient water management through the renovation of ponds was considered, as a significant loss of rainwater was due to lack of maintenance of the structures.

Desilting of farm ponds

Resilient technology

A baseline survey was conducted in three villages Lowkeshra, Barunia and Pathergora of East Singhbhum district having shallow silted farm ponds. Hence, desilting of existing shallow farm ponds helped in increasing storage capacity of farm ponds. This helped to alleviate moisture stress and increase cropping intensity in NICRA-adopted villages. 24 silted and shallow farm ponds were identified for treatment which resulted to increase in water storage thereby increasing irrigation potential and cropping intensity in this region. The collected rain water was used for providing life-saving or supplemental irrigation for *kharif* crops and also to *rabi* and summer crops. The harvested water was also used for drinking by livestock during heat waves.

Performance and impact of technology

In three villages Lowkeshra, Barunia and Pathergora of East Singhbhum district, 24 farm ponds were de-silted, deepened and irrigation channels were constructed to store, recharge groundwater, percolate and raise groundwater table. Water harvesting through desilting of farm ponds, increased the availability of soil moisture and increased harvested water helped in the cultivation of second crops in *rabi/summer*. Vegetables, pulses and oilseeds were cultivated as *rabi* crops. The pulses (eg. chickpea, moong, urad, arhar, etc.) and oilseeds (eg Mustard and Linseed) area increased to a tune of 118% and 76%, respectively (Table 2.1.8). These resilient technologies helped to raise the water table up to 5-6 feet in the demonstrated areas. Before the intervention, farmers practiced only monoculture but after the increase in available water resources, second and third crops can be cultivated by using available soil moisture just after harvesting rice crop.

Table 2.1.8: Details of rainwater harvesting structures

Demonstration	Volume of water harvested (m^3)	Area provided with supplemental irrigation during *kharif* (ha)	Area brought under *rabi* cultivation (ha)	No of farmers benefitted
Farm pond desilting	100213	70	45.8	197
No farmers practice	NA	NA	NA	NA

De-silted farm pond in Barunia village of East Singhbhum district

Renovation of ponds for water harvesting

Climate vulnerability: Drought

Resilient technology

An old pond of 28 ha with 3-4 feet depth having low water storage capacity was existing. The KVK has convinced the water use groups of farmers about renovation of ponds and also stressed the importance of renovation of water bodies to increase the storage and utilization of harvested water.

Performance and impact of technology

The renovation of farm pond increased water storage. With the harvested water, protective irrigation was given to *kharif* crops during dry spells. This supplemental irrigation created the irrigation potential to 120 ha area in *rabi* season. The cropping intensity has increased to 120% compared to 75% before the pond renovation. Due to the renovation of farm pond, an additional area of 80 ha of wheat was cultivated. This contributed to ₹ 2200000 extra income in the village (Table 2.1.9). Due to the non-availability of water in *rabi* season, 180 ha of land remained fallow but after creation of additional water through renovation in the same land 120 ha land came under cultivation in *rabi* season which contributed to 300 t extra grain in the village, which directly influenced livelihood of the villagers. The additional advantage of the harvested water is (i) Life saving irrigation to *kharif* during drought spells, Increase in cropping intensity through cultivation of rabi crops with irrigation, besides this the water table of the village increased. The recharge capacity of pond increased.

Table 2.1.9: Impact of pond renovation

Demonstrations	Storage capacity (cum)	Yield (kg ha^{-1})	Cost of cultivation (₹)	Gross return (₹ ha^{-1})	Net return (₹ ha^{-1})	B C ratio
Paddy –Local variety (before renovation)- farmers practice	61266	1700	19000	34000	15000	1.78
Paddy – Anjali (After renovation)	1645184	2600	21000	52000	31000	2.47

Demonstration	Storage capacity (m^3)	No of farmers benefitted	Protective irrigation potential created in *rabi* (ha)	Cropping intensity (%)	Gross return through *rabi* crops (₹)
After renovation	420000	120	120	120	3300000
Before renovation	147000	30	40	75	1100000

Scope for upscaling

The broader dissemination of climate resilient technologies like deepening & renovation of old farm ponds through various programs implemented by district soil conservation departments & State government schemes can be promoted through convergence with state departments, MNERGA or NABARD.



Renovation of pond at Mardanpur village of Chatra district

Nadikund

Climate vulnerability: Drought

Background

Under rainfed upland, most of the farmers from Chopnadih village in Koderma district are practicing monoculture in large areas due to the unavailability of irrigation water during *rabi* and *zaid* seasons despite good annual rainfall (>1250 mm). This is due to ill distribution of rainfall and high intense dry spells. Only few farmers were growing *rabi* crops by using water in small perennial rivers, creeks, ponds and wells.

Resilient technology

The runoff rainwater from a roof like surface can be collected and redirected to a tank, cistern, deep pit (well, shaft, or borehole) or reservoir with percolation, so that it seeps down and restores the groundwater. The collected water can be used for irrigating gardens, livestock, domestic use with proper treatment, and domestic heating. The harvested water can also be committed to longer-term storage.

Performance and impact of the technology

Nadikund increased the possibility of growing the second crop after rice. The second crop can be cultivated in about 1 ha per nadikund through supplemental irrigation from the nadikund. This technology helped in increasing the cropping intensity and higher net returns. This technology also helps to reduce flooding of low-lying areas, and increase in groundwater levels. This technology helps in improving the quality of groundwater by diluting salinity. It does not cause pollution and is eco-friendly and cost-effective. Helps in the availability of potable water, as rainwater is substantially free of salinity and other salts.

Scope for upscaling

Awareness and demonstrations are to be conducted through various programs implemented by district soil conservation departments & State government departments. This technology can be up scaled through convergence.

Nadikund at Chopnadih village of Koderma district

2.2 Promising Crop Production Technologies

B & S nutrition and management of wilt and pod borers/fly/sucking bugs built pigeon pea climate resilient with yield improvement

Climate vulnerability: Moisture stress/ Heat wave

Background

Pigeon pea is the foremost important pulse crop which is remunerative in rainfed uplands of the district that it is being grown by the majority of farmers of Garhwa district. The total area under pigeon pea is 26962 ha (2023-24). The productivity of crop in the district is only 9.8 q ha^{-1} (2022-23). The major causes of this low yield are deficiency of B & S in soil, wilting of crop at pre-flowering and flowering stages and heavy infestation of pod borers, pod fly and bug at the flowering stage of the crop. Wilt is an important soil-borne fungal disease of pigeon pea which causes significant yield losses throughout the pigeon pea growing area.

Resilient technology

Boron and Sulphur nutrition and wilt management through nutrient sprays in red gram in the NICRA village of Garhwa district.

Performance and Impact of Technology

An FLD of rainfed pigeon pea was conducted during *kharif* 2022 at 25 farmers fields in 2 NICRA villages namely Tenar and Sangbaria with the intervention of a package of technologies- basal application of B & S @ 1:20 kg ha^{-1} + drenching of Blue copper @ 2.0 g $litre^{-1}$ water in root zone thrice at 1-month interval starting from knee high stage of crop + 2 sprays of Indoxacarb @ 1 g $litre^{-1}$ water at 1-month interval during flowering with 1 spray of Imidacloprid + Fipronil insecticides in between the 2 sprays of Indoxacarb. The crop was sown from 20 to 30 July in 2022. The result revealed that there was a considerable impact of technological intervention on yield and net return. The yield was increased by 45% and 39.2% and the net return by 64.9% and 52.80% in Tenar and Sangbaria villages, respectively (Table 2.2.1a and b).

The 2 sprays of indoxacab at 1-month interval with 1 spray of a combination of Imidacloprid + fipronil in between 2 sprays of Indoxacarb gives good control over 2 sprays of indoxacab at 1 month interval gives good control. The addition of B to soil effectively controls the fusarium wilt. Drenching of Blue copper or, Carbendazim or, a combination of carbendazim + mancozeb fungicides in the root zone thrice at 1-month interval is effective for the management of wilting of pigeon pea crop.

Table 2.2.1a: Available nutrients status in surface soil (%)

	N	P	K	S	B	Zn	Fe
Low	16.6	36.6	8.6	39.6	71.9 (Insufficient)	3.9 (Insufficient)	0.8 (Insufficient)
Medium	74.7	49.9	66.2	32.3	16.8 (sufficient)	15.0 (sufficient)	0.5 (sufficient)
High	8.6	13.5	25.2	28.1	11.3 (sufficient)	81.1 (sufficient)	98.7 (sufficient)

Table 2.2.1b: Impact of Boron and Sulphur nutrition, fungicides and insecticides on yield and economics of pigeon pea

Intervention	Village	Year (Normal/ stress)	Yield (kg ha^{-1})	Cost of cultivation (₹ ha^{-1})	Net return (₹ ha^{-1})	B C ratio
Basal application of B & S @ 1:20 kg ha^{-1} in addition to NPK (FP) + Drenching of Blue copper @ 2.0 g $litre^{-1}$ water thrice in the root zone at 1month interval starting from knee high stage + 2 spray of Indoxacarb @ 1g $litre^{-1}$ water at 1 month interval during flowering with 1 spray of Imidacloprid 40%+Fipronil 40 % W/W @ 1ml 5$litre^{-1}$ water in between 2 spray of Indoxa carb.	Tenar	Stress	1320	26000	61120	3.35
	Sangbaria	Stress	1420	26000	67720	3.60
Only N:P:K::18:46:15 kg ha^{-1} as basal + 2 spray of Imidacloprid @ 1 ml $litre^{-1}$ water at flowering stage (Farmers practice)	Tenar	Stress	910	23000	37060	2.61
	Sangbaria	Stress	1020	23000	44320	2.93

Scope for upscaling

The respective technology can be popularized through trainings, FLDs and other extension activities and by providing soil health cards to farmers after soil testing in their fields. A considerable number of farmers have started applying Boron and Sulphur in pulses, oilseeds as well as vegetables grown in B & S deficient uplands.

Demonstration of redgram crop at Garwah district

Boron and Sulphur: An effective nutrition to minimize moisture stress and improves yield of black gram

Climate vulnerability: Moisture stress/ Heat wave

Background

Garhwa district is having an annual rainfall of 1100-1200 mm. The major portion of rainfall drains out through seasonal rivers due to undulated sloppy topography which favours cultivation of rice in lowlands and low water requiring crops like pulses in uplands during the *Kharif* season. The majority of uplands of the district are having medium status of NPK but are deficient in Sulphur and Boron. The deficiency of S & B is the major limiting factor in realizing good yield of pulses in the district. The black gram is one of the major *kharif* pulse grown in rainfed uplands of Garhwa district. The soils of Garhwa district are medium to low in fertility.

Resilient technology

Plants with sufficient B nutrition have shown an elevated resistance to drought stress due to improved nutritional status and enhanced water uptake from rhizosphere soil by growing more root hairs and mycorrhizae. It also contributes to drought tolerance by protecting against oxidative damage to cell membranes. Sulphur is essential for nitrogen metabolism, enzyme activity, protein and oil synthesis. It plays a pivotal role in overall pulse production by the synthesis of sulphur-containing amino acids, enhancing protein content and nodule formation.

Performance and impact of technology

A demonstration was conducted in rainfed black gram during *kharif* 2022 at 2 NICRA villages namely Tenar and Sangbariya. Basal application of B & S @ 1:20 kg ha^{-1} along with NPK @ 18:46:15 kg ha^{-1}. The FLD was conducted at 11 locations in Tenar and 14 in Sangbariya. The crop was sown from 20 to 30 July and harvested between 10 to 25 October 2022. The crop suffered due to intermittent dry spells during 2nd fortnight in August and 1st and last weeks of September 2022. The result presented in the table revealed that there was a considerable positive impact of B & S on the yield and net return of *kharif* black gram in both villages. The yield was increased by 17.64% and 19.32% and net return by 20.6% and 22.8% in Tenar and Sangbariya villages, respectively by applying B & S @ 1:20 kg ha^{-1} as basal dose (Table 2.2.2a and b).

Table 2.2.2a: Available nutrients status in surface soil (% area)

	N	P	K	S	B	Zn	Fe
Low	16.6	36.6	8.6	39.6	71.9 (Insufficient)	3.9 (Insufficient)	0.8 (Insufficient)
Med	74.7	49.9	66.1	32.3	16.8 (Sufficient)	15.0 (Sufficient)	0.5 (Sufficient)
High	8.6	13.5	25.2	28.1	11.3 (Sufficient)	81.1 (Sufficient)	98.7 (Sufficient)

Table 2.2.2b: Impact of B and S on yield and economics of *Kharif* black gram in Tenar & Sangbariya villages of Garhwa.

Intervention	Village	Yield (kg ha^{-1})	Cost of cultivation (₹ ha^{-1})	Net return (₹ ha^{-1})	B C ratio
Basal application of B & S @ 1:20 kg ha^{-1} + NPK	Tenar	1000	25000	41000	2.64
	Sangbariya	1050	25000	44300	2.77
Only N:P:K::18:46:15 kg ha^{-1}	Tenar	850	22000	34000	2.55
	Sangbariya	880	22000	36080	2.64

Scope for upscaling

The KVK, Garhwa has popularised application of Boron & Sulphur @ 1:20 kg ha^{-1} as basal dose in pulses. It was popularized through trainings, FLDs, Gosthies & other extension activities and by providing soil health cards to farmers after soil testing of their fields. A considerable number of farmers has started applying B & S in pulses, oilseeds as well as vegetables grown in Boron and Sulphur deficient uplands.

Field demonstration of black gram in the NICRA village of Garwah district

Elephant foot yam based multilayer Vegetable Cropping System (MLVCS)

Climate vulnerability: Moisture stress

Background

The improved variety of elephant foot yam (Gajendra) and hybrid variety of bitter gourd (US – 6214) were grown simultaneously on the same piece of land with leafy vegetables under the demonstration of NICRA project. So, it has been named elephant foot yam-based multilayer vegetable cropping system. A machan-like structure was erected with the help of bamboo, wire and threads over 6.5 feet height from the ground level over the main crop i.e. EFY to spread the vines of bitter gourd.

Resilient technology

Elephant foot yam (EFY) variety Gajendra was planted during the second fortnight of June at 75cm x 75cm spacing in a plot size of 1000 m^2. A pit Size of 30 cm x 30 cm x 30 cm was dug out and 2 kg well decomposed cow manure was filled 3/4th of the pit. 500 g cut tubers of elephant foot yam were treated with cow dung slurry (one kg of fresh cow dung in one litre of water) one day before planting on the pit and then filled the pit with the remaining soil and a small mound was formed on the pit. The seeds (hybrid) of bitter gourd were sown in between two rows of the main crop i.e. elephant foot yam at the recommended spacing. All the plots were fertilized with 150 N, 100 P_2O_5 and 150 K_2O kg ha^{-1}. Half dose of nitrogen and potash and a full dose of phosphorus were applied at the time of planting of the main crop in pits and the rest half of nitrogen and potash were applied after harvesting the companion crops i.e. at 95 days after planting (DAP). The recommended dose of fertilizer was also given to the companion crops i.e. bottle gourd, ridge gourd and bitter gourd as per schedule. All other cultural practices are as per schedule for the cultivation of main crop as well as companion crops were followed to raise healthy crops.

Performance and impact of technology

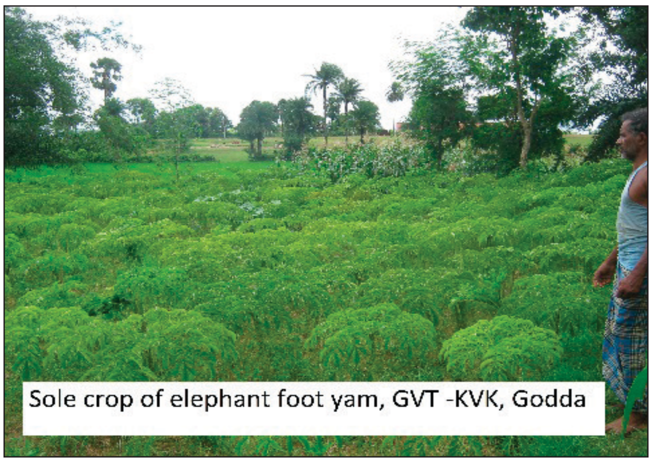
The improved variety of elephant foot yam (Gajendra) and hybrid variety of bitter gourd (US – 6214) was grown simultaneously in the same piece of land with leafy vegetables under the demonstration of NICRA project. The yield of elephant foot yam in the demonstration plot was 358 q ha^{-1} along with the 150 q ha^{-1} bitter gourd, while the sole crop of elephant foot yam under farmers practice was 360 q ha^{-1} and the sole crop of bitter gourd yielded 156.40 q ha^{-1}. The B C ratio of demonstration plot (Elephant foot yam + bitter gourd) was 3.99:1 while it was 3.32:1 and 2.38:1 in the sole crop of elephant foot yam and bitter gourd, respectively (Table 2.2.3).

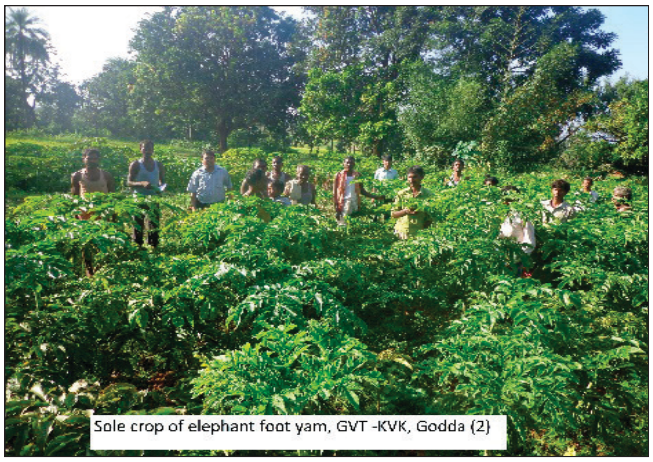
Table 2.2.3: Assessment of Elephant foot yam based multilayer vegetable cropping system

Intervention	Yield (kg ha^{-1})	Cost of cultivation (₹ ha^{-1})	Net return (₹ ha^{-1})	B C Ratio
Elephant foot yam (Gajendra) + bitter gourd (US – 6214)	35800 (EFY) 15000 (Bitter gourd)	166400	496900	3.99: 1
Farmers Practice (Sole Elephant foot yam	36000	146500	339500	3.32: 1
Farmers Practice (Sole Bitter gourd)	15640	55480	132200	2.38:1

Scope for upscaling

This technology has been found very beneficial to the marginal farmers of the district, especially for the upland areas. This technology was upscaled. After seeing the success of this model NABARD has also sanctioned a project on the same topic in two villages Pipra and Chilra of Pathargamma block. Various NGOs like PRADAN and SPGRS also adopted the technology for their operational area. Even NGO World Vision operating in the Jamui district of Bihar sent its farmers to the KVK, Godda and adopted the technology.


Sole crop of elephant foot yam, GVT -KVK, Godda


Sole crop of elephant foot yam, GVT -KVK, Godda (2)


Elephant foot yam + bitter gourd, GVT -KVK, Godda

Demonstration of elephant foot yam at KVK, Godda

Seed production – Paddy (Var.: Sahbhagi)

Climate vulnerability: Moisture stress

Background

Seed is the basic requirement for successful crop production. Quality seed plays pivotal role for healthy crops and higher productivity. Availability of quality seed of climate resilient cultivars is crucial for realising productivity. Paddy is the major crop of the district. Therefore, progressive farmers of the NICRA village Bhelwa were motivated for seed production of paddy and a training programme was organised on "Seed production Technology of paddy" for creating awareness among the farming community. Details on seed production technique like importance of seed, types of seeds, seed treatment, rouging, control of pest and diseases registration of seed plot, processing of seeds and marketing of certified seed etc were demonstrated. After that foundation seed of paddy var. Sahbhagi (drought tolerant variety, duration 110 days) was provided by the GVT – KVK, Godda for production of certified seed. All the norms of seed production were followed by the farmers.

Resilient technology

The seed production of paddy Var.: Sahbhagi was done. A seed rate of @ 40 Kg ha^{-1} was used. One or two seedlings were transplanted per hill at a spacing of 20 x 20 cm. Other agronomic practices were also followed to raise a healthy crop. Rogueing was done to remove the unwanted plants to maintain purity. Registration was also done as seed producer in the Jharkhand State Seed Certification Agency facilitated by KVK, Godda.

Performance and impact of technology

Beej gram, Bhelwa (Seed Village Bhelwa) was constituted with 60 farmers during the year 2016-17. Each farmer has grown the seed of paddy (Variety: Sahbhagi). 50 ha area of 60 farmers in Bhelwa village was registered with the Jharkhand State Seed Certification Agency (JSSCA). Seeds were processed at seed processing machine of KVK, Godda. Processed seed were tested at Seed Testing Laboratory, Ranchi. The total seed production was around 1700 q. After keeping for own purpose, 70 q of seed was procured by the Govt. of Jharkhand through @ ₹ 1600 q^{-1} as raw seed. After the success of seed production in Bhelwa, village nearby villages like Draupad, Dande, etc. has taken up seed production. During the year 2017-18 again 50 ha area of Bhelwa was registered under seed production of paddy var. Sahbhagi in JSSCA. The B C ratio of the paddy seed production was 1.81 (Table 2.2.4).

Table 2.2.4: Assessment of yield and economics of paddy var. Sahbhagi

Intervention	Yield (kg ha^{-1})	Cost of cultivation (₹ ha^{-1})	Net return (₹ ha^{-1})	B C Ratio	Area spread (ha)	No of farmers adopted technologies
Seed production of paddy var.: Sahbhagi	3800	33500	27300	1.81:1	415	925
Farmers practice Paddy local variety	3350	30300	9900	1.33:1	--	--

Scope for upscaling

Presently 5 FPOs of the district and various NGOs were engaged in the seed production.

Seed Production of Paddy (Var.: Sahbhagi) Bhelwa village of Godda

Short duration and drought-tolerant rice varieties for sustainable rice production

Climate vulnerability: Heat and moisture stress

Background

Farmers of NICRA villages were predominantly growing rice as monoculture in East Singhbhum district. The district was impacted by drought due to late onset and early cessation of monsoon, irregular & uneven distribution of rainfall and frequent dry spells. The farmers of the selected villages generally grow long-duration cultivars of more than 140-155 days. However, due to weather aberrations, farmers were forced to transplant rice between August and September which lowered rice productivity. This also delayed the timely sowing of succeeding *rabi* crops on the same field. Hence, short duration stress tolerant varieties of rice are required.

Resilient technology

Short duration and stress-tolerant varieties of rice were demonstrated by direct sowing and transplanting methods, as these varieties were capable of sustaining yield in all farming situations i.e. upland, midland and low land. However, direct-seeded rice yield is lower as compared to transplanted rice with resilient varieties but provides sustainable yield. Therefore, this is the best option in the drought situation over the long-duration varieties as these varieties can withstand two weeks of dry spells. Thus, to sustain rice yield, Sahabhagi Dhaan, Anjali, Naveen, Swarn Shreya, Gondra Bidhan and NICRA Tripura of 90-120 days duration of rice varieties were demonstrated in NICRA villages.

Performance and impact of technology

The average yield of Sahabhagi Dhan in the farmers field was 4380 kg ha^{-1} which was 54.77 % higher than the local long-duration varieties and was found to sustain a stress period of more than two weeks. The number of tillers, flowering and grain filling were not influenced by drought as compared to the local long-duration rice varieties. On average, the short-duration varieties like Anjali (39.6 q ha^{-1}), Naveen (41.4 q ha^{-1}), Swarn Shreya (43.6 q ha^{-1}), Gondra Bidhan (42.6 q ha^{-1}) and NICRA Tripura (44.5 q ha^{-1}) have 68 % higher yields as compared to local check variety (28.3 q ha^{-1}). During drought years, on an average short duration varieties recorded 52.4% yield increment and a B C ratio of 3.24 over the local check (Table 2.2.5). A total of 79.5 ha area and 222 farmers benefitted under drought tolerant and short-duration rice varieties in NICRA villages.

Table 2.2.5: Impact of drought tolerant and short duration varieties technology in terms of yield and economics

Intervention	Yield (kg ha^{-1})	Cost of cultivation (₹ ha^{-1})	Gross returns (₹ ha^{-1})	Net return (₹ ha^{-1})	B C ratio
Farmers Variety (Balibojna)	2830	30000	50940	20940	1.69
Sahabhagi Dhaan	4380	29000	78840	49840	2.71
Swarn Shreya	4360	29000	78480	49480	2.70
Gondra Bidhan-1	4260	29000	76680	47680	2.64
Tripura	4450	29000	80100	51100	2.76
Anjali	3960	29000	71280	42280	2.45
Naveen	4140	29000	74520	45520	2.56

Scope for upscaling

The seeds of the improved short duration drought tolerant varieties were unavailable. Hence, the seed availability can be improved by seed production through seed bank. Convergence can be made with the district line department and NGO's for broader dissemination of climate-resilient varieties in the whole district.

Drought tolerant and short duration paddy varieties technology in the NICRA villages of East Singhbhum district

Aerobic rice helps farmers cope with drought

Climate vulnerability: Drought

Background

The transplantation of rice varieties was delayed due to the delay in monsoon. Moreover, the right age seedlings also may not be available due to delayed transplanting. Hence aerobic rice cultivation is a method to cope with drought situations.

Resilient technology

Small plots of 10×10 feet length and width were made. Improved short duration (90 days) and drought tolerant variety, Anjali was directly seeded @ 100 kg ha^{-1} in line (R-R 25cm) with N_{40} P_{30} K_2O kg ha^{-1} fertilizer application.

Performance and impact of technology

The small plot helped to increase field moisture retention capacity during 10-15 days drought spell. In direct seeding, the improved variety Anjali was harvested one month earlier and increased yield by 30% and an additional net returns of ₹ 14,000 ha^{-1} was recorded (Table 2.2.6). After harvesting of paddy, with residual soil moisture a *rabi* crop can be cultivated. This practice increased cropping intensity.

Table 2.2.6: Impact of paddy var. Anjali under aerobic conditions

Practice	Moisture retention capacity	Duration of crop		Yield (kg ha^{-1})	Gross return (₹ ha^{-1})	Cost of cultivation (₹)	Net return (₹ ha^{-1})	B C ratio
		Date of sowing	Date of harvesting					
Transplanting (Farmers practice)	8 (50%)	23.07.2013	02.11.2013	2600	28,600	21600	30400	2.40
Direct seeding rice	16 (100%)	03.07.2012	08.10.2013	3400	37,400	23600	44400	2.88

Scope for upscaling

This practice became popular not only in NICRA village, but also in surrounding villages of NICRA and this practice is covered in 150 ha of land in the area and 33% of additional income was generated through this practice. This can be further up scaled through convergence method.

Paddy var. Anjali at Mardanpur village of Chatra district

Drought tolerant upland rice variety (Sahbhagi dhan)

Climate vulnerability: Drought

Background

Rice is the major *kharif* crop grown in Koderma district, Jharkhand, It is most water-demanding crop and productivity is frequently affected by drought and is vulnerable to monsoon-dependent agriculture in Jharkhand which may affect 50-70% production of rice. Drought is a major abiotic factor that affects rice production in rainfed regions. Sahbhagi dhan is one of the most popular drought tolerant and short duration (110-115 days) variety of rice for upland conditions and tolerates 10-15 days drought mitigation period.

Resilient technology

Sahbhagi dhan is one of the most popular drought tolerant and short duration (110-115 days) variety of rice for upland conditions and tolerates 10-15 days drought mitigation period. Demonstration of drought tolerance rice variety, Sahbhagi dhan, has the yield potential of 4.5 t ha^{-1} in rainfed upland conditions.

Performance and impact of technology

The Sahbhagi dhan rice variety recorded 69% more yield over local variety (Table 2.2.7). The higher yield in this variety was due to its drought tolerance. Moreover, this variety matures 20 to 30 days earlier than the local variety. This helps in cultivation of second crop by the utilizing the residual moisture.

Table 2.2.7: Economics of drought tolerant upland rice variety (Sahbhagi dhan)

Technology demonstrated	Yield (kg ha^{-1})	B C ratio
Paddy (Var. Sahbhagi dhan)	2957	2.52
Local variety	2068	1.82

Scope for upscaling

There is also a need to converge with the district line department and NGO's for broader dissemination of climate-resilient varieties in the whole district.


Demonstration of drought-tolerant upland rice variety (Sahbhagi dhan) in Koderma

Location specific intercropping - Groundnut + red gram

Climate vulnerability: Moisture stress/ Heat wave

Background

In Gumla district, due to erratic rainfall in the last few years, drought occurs due to which major crops are damaged. Growing of two complementary crops (Intercropping system) ensures optimal use of resources and maximizing yields. Careful selection of crops that have mutually beneficial relationships, such as nitrogen-fixing legumes enriching the soil for other plants, farmers can enhance soil fertility and reduce the need for chemical inputs, moisture conservation and biodiversity preservation. Besides this intercropping creates natural pest control systems, reducing the reliance on pesticides. Hence, growing of location specific intercropping helps farmers adapt to changing climate patterns. Krishi Vigyan Kendra, Gumla created an awareness program, training, and demonstration in farmers fields.

Resilient technology

Intercropping of groundnut and redgram was done in the Jargatoli village of Gumla district in a 23.4 ha area involving 51 farmers. The farmers practice was red gram sole cropping.

Performance and impact of technology

Intercropping of groundnut in redgram resulted in 12.8 % higher yields as compared to the sole crop (Table 2.2.8) due to optimal resource use and mutual benefits between the selected crops.

Table 2.2.8: Impact of intercropping on yield and economics

Technology demonstrated	No. of farmers	Area (ha)	Yield (kg ha^{-1})	Gross return (₹ ha^{-1})	Net return (₹ ha^{-1})	B C ratio
Redgram + Groundnut	51	23.4	1603	27379	34281	2.29
Farmers practice-Redgram sole crop			1421	28215	31095	2.10

Redgram + Groundnut intercropping at Jargatoli village of Gumla district

Intercropping - Maize + redgram for optimizied resource use

Climate vulnerability: Moisture stress/ Heat wave

Resilient technology

Intercropping of maize and red gram was done in the Gunia village of Gumla district in 6.2 ha area involving 23 farmers.

Performance and impact of technology

Intercropping of maize + red gram recorded 64.01% higher yield over the sole maize crop. Maize + red gram recorded BC ratio of 2.23 (Table 2.2.9) due to optimal resource use and mutual benefits between the selected crops.

Table 2.2.9: Impact of intercropping on the yield and economics of maize

Technology demonstrated	Yield (kg ha^{-1})	Gross return (₹ ha^{-1})	Net return (₹ ha^{-1})	B C ratio
Maize + Redgram	3632	18363	22517	2.23
Farmers practice- sole maize	2251	15450	9873	1.64

Scope for upscaling

Demonstrations of intercropping can be conducted by KVK's in the farmer fields through FLD programs. The technology can be spread to the entire district through convergence with state departmental activities, central programs and ATMA.

Maize + Redgram intercropping at Gunia village of Gumla district

Groundnut + maize intercropping system

Climate vulnerability: Moisture stress/ Heat wave

Resilient technology

Intercropping of groundnut and maize was done in the Gunia village of Gumla district in 0.4 ha area involving 3 farmers.

Performance and impact of technology

Intercropping of groundnut + maize recorded 52.38 % higher yield over the sole groundnut crop. Groundnut + maize recorded BC ratio of 2.67 due to optimal resource use and mutual benefits between the selected crops (Table 2.2.10).

Table 2.2.10: Impact of intercropping on the yield and economics of maize

Technology demonstrated	Yield (kg ha^{-1})	Gross return (₹ ha^{-1})	Net return (₹ ha^{-1})	B C ratio
Groundnut + Maize	1920	21500	36100	2.67
Farmers practice- sole maize	1260	19450	18350	1.94

Scope for upscaling

Demonstrations of intercropping can be conducted by KVK's in the farmer fields through FLD programs. The technology can be spread to the entire district through convergence with state departmental activities, central programs and ATMA.

Paddy + red gram intercropping system

Climate vulnerability: Moisture stress/ Heat wave

Resilient technology

Intercropping of paddy and red gram was done in the Jargatoli village of Gumla district in 8 ha area involving 22 farmers.

Performance and impact of technology

Intercropping of paddy + red gram recorded 54.24 % higher yield over the sole paddy crop. Paddy + red gram recorded BC ratio of 2.35 due to optimal resource use and mutual benefits between the selected crops (Table 2.2.11).

Table 2.2.11: Impact of intercropping on the yield and economics of maize

Technology demonstrated	Yield (kg ha^{-1})	Gross return (₹ ha^{-1})	Net return (₹ ha^{-1})	B C ratio
Paddy + red gram	3526	12000	16208	2.35
Farmers practice- sole paddy	2286	1100	7288	1.60

Scope for upscaling

Demonstrations of intercropping can be conducted by KVK's in the farmer fields through FLD programs. The technology can be spread to the entire district through convergence with state departmental activities, central programs and ATMA.

Paddy + red gram at Jargatoli village of Gumla district

Community nurseries for delayed monsoon

Climate vulnerability: Moisture stress/ Heat wave

Background

The NICRA cluster and adjoining villages experiences deficient and delayed onset of rainfall in July and the first fortnight of August leads to delayed transplanting of seedlings. Due to delayed transplanting 40-45 days old seedlings were transplanted. Transplanting of aged seedlings causes low tillering and poor crop yields. To address this, KVK encouraged farmers of the village to grow community nurseries on staggered dates. This enabled farmers to access seedlings as and when needed with the progress of monsoon. Community nurseries empower farmers to adapt to the challenges posed by delayed monsoons, fostering climate resilience and food security within local agricultural systems. In addition, community nurseries provide a platform for knowledge exchange, enable farmers to learn about sustainable agricultural practices, water conservation techniques, and climate-resilient crop varieties.

Resilient technology

Community nurseries serve as essential hubs for cultivating rice. During periods of delayed or erratic monsoons, farmers can source resilient seedlings from these nurseries, ensuring that they have access to crops adapted to changing climate patterns. These seedlings often have traits like early maturity, heat tolerance, and water efficiency, making them better suited to withstand prolonged dry spells.

Performance and impact of technology

Community nurseries were grown in Gunia village, in 15 ha for 39 farmers. Farmers benefitted with an additional yield of 510 kg ha^{-1} (18.55%) compared to the farmers who transplanted overaged seedlings (Table 2.2.12).

Table 2.2.12: Impact of Community nurseries on yield and economics

Technology demonstrated	Yield (kg ha^{-1})	Gross return (₹ ha^{-1})	Net return (₹ ha^{-1})	B C ratio
Community nursery of paddy (var. *Sahbhagi Dhan*)	3260	27180	15200	1.56
Transplanting of over aged seedlings : Farmers practice	2750	26780	8970	1.31

Scope for upscaling

Initiative community nursery raising has also left a wide impact through successful coverage of paddy in the district and also state by seeing the impact of community nursery, state government has replicated this model in 43 blocks across the state with an investment of 43 lakhs in 2013.

Community nurseries at Gunia village of Gumla district

Sahbhagi Dhan : A drought tolerant paddy variety

Climate vulnerability: Moisture stress/ Heat wave

Background

In Gumla moisture stress is common due to ill distribution of rainfall. This patterns leading to unpredictable rainfall and prolonged droughts has increased with climate change. Traditional crop varieties often cause significant yield losses. Hence drought-tolerant crop varieties hold immense significance in ensuring yield improvement, particularly in the face of climate change-induced water scarcity. Drought-resistant varieties are specifically engineered or bred to withstand water stress, allowing them to thrive in arid and semi-arid regions where water resources are limited. These varieties not only bolster agricultural productivity in water-scarce areas but also reduce farmers' vulnerability to climate-related risks, safeguarding livelihoods.

Resilient technology

Sahbhagi Dhan is a short-duration drought tolerant paddy variety.

Performance and impact of technology

Sahbhagi Dhan, short duration drought paddy variety was demonstrated in 21.6 ha area involving 55 farmers in the Gumla district. This variety recorded 17.55% higher yield over farmers variety *lalat*. The net returns and B C ratio of varieties *Sahbhagi Dhan and lalat* were ₹ 15200, 1.64 and ₹ 10925, 1.42, respectively (Table 2.2.13).

Table 2.2.13: Impact of drought tolerant paddy variety on yield and economics

Technology demonstrated	Yield (kg ha^{-1})	Gross return (₹ ha^{-1})	Net return (₹ ha^{-1})	B C ratio
Sahbhagi Dhan Drought tolerant variety	3460	29180	15200	1.64
Lalat : Farmers practice	2850	25612	10925	1.42

Drought tolerant Sahbhagi Dhan variety demonstration at Gumla

Birsa Arhar 1 :A drought tolerant red gram variety

Climate vulnerability: Moisture stress/ Heat wave

Background

In Gumla moisture stress is common due to ill distribution of rainfall. This patterns leading to unpredictable rainfall and prolonged droughts has increased with climate change. Traditional crop varieties often cause significant yield losses. Hence, drought-tolerant crop varieties hold immense significance in ensuring yield improvement, particularly in the face of climate change-induced water scarcity. Drought-resistant varieties are specifically engineered or bred to withstand water stress, allowing them to thrive in arid and semi-arid regions where water resources are limited. These varieties not only bolster agricultural productivity in water-scarce areas but also reduce farmers' vulnerability to climate-related risks, safeguarding livelihoods.

Resilient technology

Birsa Arhar1 is a drought tolerant red gram variety. Demonstrations were conducted in 1.25 ha area involving 2 farmers in the NICRA village of Gumla district.

Performance and impact of technology

Drought tolerant variety Birsa Arhar1 was superior compared to the traditional farmers variety Asha in terms of yield and economics. The yield of variety Birsa Arhar1 recorded 30.53% higher yield over the the farmer's variety (var. Asha). The net returns and BC ratio of the drought-tolerant variety were ₹ 36475 and 2.56, respectively (Table 2.2.14).

Table 2.2.14: Impact of drought tolerant red gram variety on yield and economics

Technology demonstrated	Yield (kg ha^{-1})	Gross return (₹ ha^{-1})	Net return (₹ ha^{-1})	B C ratio
Birsa Arhar1 Drought tolerant Red gram	1710	23375	36475	2.56
Asha Farmers practice	1310	21000	24850	2.18

Ground nut variety ITG- TG-51 : A drought tolerant

Climate vulnerability: Moisture stress/ Heat wave

Background

In Gumla moisture stress is common due to ill distribution of rainfall. This patterns leading to unpredictable rainfall and prolonged droughts has increased with climate change. Traditional crop varieties often cause significant yield losses. Hence, drought-tolerant crop varieties hold immense significance in ensuring yield improvement, particularly in the face of climate change-induced water scarcity. Drought-resistant varieties are specifically engineered or bred to withstand water stress, allowing them to thrive in arid and semi-arid regions where water resources are limited. These varieties not only bolster agricultural productivity in water-scarce areas but also reduce farmers' vulnerability to climate-related risks, safeguarding livelihoods.

Resilient technology

Drought tolerant groundnut variety, ITG- TG-51 was demonstrated in the NICRA village of Gumla district.

Performance and impact of technology

Drought tolerant groundnut variety, ITG- TG-51 recorded 44.5 % higher yield over farmers variety K-6. The net returns and B C ratio of varieties ITG- TG-51 *and* K-6 were ₹ 29670, 2.79 and ₹ 17550, 2.21, respectively (Table 2.2.15).

Table 2.2.15: Impact of drought tolerant ground nut variety on yield and economics

Technology demonstrated	Yield (kg ha^{-1})	Gross return (₹ ha^{-1})	Net return (₹ ha^{-1})	B C ratio
ITG- TG-51: Drought tolerant	1539	16500	29670	2.79
K-6 : Farmers practice	1065	14400	17550	2.21

Drought tolerant groundnut at Gunia village of Gumla

PU-31 : A drought tolerant black gram variety

Climate vulnerability: Moisture stress/ Heat wave

Background

In Gumla moisture stress is common due to ill distribution of rainfall. This patterns leading to unpredictable rainfall and prolonged droughts has increased with climate change. Traditional crop varieties often cause significant yield losses. Hence, drought-tolerant crop varieties hold immense significance in ensuring yield improvement, particularly in the face of climate change-induced water scarcity. Drought-resistant varieties are specifically engineered or bred to withstand water stress, allowing them to thrive in arid and semi-arid regions where water resources are limited. These varieties not only bolster agricultural productivity in water-scarce areas but also reduce farmers' vulnerability to climate-related risks, safeguarding livelihoods.

Resilient technology

PU-31 a drought tolerant black gram variety was demonstrated in 1.72 ha area with 4 farmers in the NICRA village of Gumla district.

Performance and impact of technology

A drought tolerant variety PU-31 was superior to the farmer's local variety in yield and economics. The PU-31 variety recorded 47.64 % higher than the local variety. The net returns and BC ratio of the drought-tolerant variety were ₹ 16737 and 1.7, respectively (Table 2.2.16).

Table 2.2.16 : Impact of drought tolerant black gram variety on yield and economics

Technology demonstrated	No. of farmers	Area (ha)	Yield (kg ha^{-1})	Gross return (₹ ha^{-1})	Net return (₹ ha^{-1})	B C ratio	% yield increase
Drought tolerant Black gram (var. *var. PU-31*)	4	1.72	7530	23925	16737	1.70	47.64
Farmers practice Black gram (*var. Local*)			5100	21000	27540	1.31	

Scope for upscaling

Drought tolerant varieties can be up scaled by conducting demonstrations of these varieties by KVKs in the farmer fields through FLD programs. The drought tolerant varieties can be spread to the entire district through convergence with state departmental activities, central programs and ATMA.

PU-31 A black gram at Gunia village of Gumla district

GPU-28: A drought tolerant finger millet variety

Climate vulnerability: Moisture stress/ Heat wave

Background

In Gumla moisture stress is common due to ill distribution of rainfall. This patterns leading to unpredictable rainfall and prolonged droughts has increased with climate change. Traditional crop varieties often cause significant yield losses. Hence, drought-tolerant crop varieties hold immense significance in ensuring yield improvement, particularly in the face of climate change-induced water scarcity. Drought-resistant varieties are specifically engineered or bred to withstand water stress, allowing them to thrive in arid and semi-arid regions where water resources are limited. These varieties not only bolster agricultural productivity in water-scarce areas but also reduce farmers' vulnerability to climate-related risks, safeguarding livelihoods.

Resilient technology

GPU-28 a drought tolerant finger millet variety was demonstrated in 33 ha area with 164 farmers in the NICRA village Gunia of Gumla district.

Performance and impact of technology

A drought tolerant variety GPU-28 was superior to the farmer's local variety in yield and economics. The GPU-28 variety recorded 35.60 % higher than the local variety. The net returns and BC ratio of the drought-tolerant variety were ₹ 11357 and 1.85, respectively (Table 2.2.17).

Table 2.2.17: Impact of drought tolerant finger millet variety on yield and economics

Technology demonstrated	No. of farmers	Area (ha)	Yield (kg ha^{-1})	Gross return (₹ ha^{-1})	Net return (₹ ha^{-1})	B C ratio	% yield increase
Drought-tolerant Finger millet (*var. GPU-28*)	164	33	1770	13282	11357	1.85	35
Farmers practice Finger millet (*var. Local*)			1330	12799	6090	1.47	

Scope for upscaling

Drought tolerant varieties can be up scaled by conducting demonstrations by KVK's in the farmer fields through FLD programs. The drought tolerant varieties can be spread to the entire district through convergence with state departmental activities, central programs and ATMA.

GPU-28 finger millet at Gunia village of Gumla district

Drought tolerant niger variety: Birsa Niger- 1

Climate vulnerability: Moisture stress/ Heat wave

Background

In Gumla moisture stress is common due to ill distribution of rainfall. This patterns leading to unpredictable rainfall and prolonged droughts has increased with climate change. Traditional crop varieties often cause significant yield losses. Hence, drought-tolerant crop varieties hold immense significance in ensuring yield improvement, particularly in the face of climate change-induced water scarcity. Drought-resistant varieties are specifically engineered or bred to withstand water stress, allowing them to thrive in arid and semi-arid regions where water resources are limited. These varieties not only bolster agricultural productivity in water-scarce areas but also reduce farmers' vulnerability to climate-related risks, safeguarding livelihoods.

Resilient technology

Birsa Niger-1 is a drought tolerant niger variety, demonstrated in 2 ha area with 8 farmers in the Gunia village of Gumla district.

Performance and impact of technology

A drought tolerant variety Birsa Niger-1 was superior to the farmer's local variety in yield and economics. The Birsa Niger-1 variety recorded 63.96% higher yield than the local variety. The net returns and B C ratio of the drought-tolerant variety were ₹ 3373 and 1.55, respectively (Table 2.2.18).

Table 2.2.18: Impact of drought tolerant niger variety on yield and economics

Technology demonstrated	No. of farmers	Area (ha)	Yield (kg ha^{-1})	Gross return (₹ ha^{-1})	Net return (₹ ha^{-1})	B C ratio	% yield increase
Drought-tolerant Niger (*var.* Birsa Niger- 1)	8	2	352	6780	3373	1.55	64
Farmers practice Niger *(var. Local)*			225	5075	1528	1.30	

Scope for upscaling

Drought tolerant varieties can be up scaled by conducting demonstrations by KVK's in the farmer fields through FLD programs. The drought tolerant varieties can be spread to the entire district through convergence with state departmental activities, central programs and ATMA.


Drought tolerant Birsa Niger- 1 at Gunia village of Gumla district

2.3 Promising Livestock Production Technologies

Azolla as a livestock green fodder

Climate vulnerability: Heat and moisture stress

Background

India has the largest livestock population and has high milk production in the world. But, average milk production still needs to be improved, this may be due to low nutrition, and insufficient availability of good quality feeds and fodder. Now a days major problem of the livestock farmers of Godda is the availability of quality fodder. Quality fodder supply remains a significant challenge for effective livestock management during lean periods or extreme weather events.

Resilient technology

Azolla, an aquatic floating fern has emerged as promising fodder alternative for livestock nutrition in the midst of green fodder crisis. It is a good source of protein with almost all essential amino acid required for animal nutrition. Furthermore, it also provides macronutrients like calcium, magnesium, potassium and vitamins like vitamin A and B_{12}. Due to ease of cultivation, high productivity and good nutritive value, it is used as a beneficial fodder supplement.

Performance and impact of technology

Demonstration of Azolla as cattle feed was conducted in the Bhelwa village by KVK, Godda among 150 cattle rearers. Feeding of paddy straw + green grass + azolla (500 g day^{-1}) to cows increased the milk yield by 12.38 %. Higher net returns (₹ 7050 cow^{-1}) and B C ratio (1.18:1) were reported (Table 2.3.1) by NICRA practice compared to the farmer's practice (Paddy straw + green grass).

Table 2.3.1: Assessment of Azolla as an animal fodder

Intervention	Milk yield (Lit cow^{-1})	Cost of production per cow	Net return (₹ cow^{-1})	B C ratio	No of farmers adopted
Paddy straw + green grass + Azolla (500 g day^{-1}) as animal fodder	1180	40150	7050	1.18:1	150
Farmers practice (Paddy straw + green grass as animal fodder)	1050	39420	2580	1.07:1	

Scope for upscaling

Presently about 150 farmers of the NICRA and surrounding villages are adopting azolla as animal feed. This technology cab be upscaled through animal husbandry departments and local livestock owners.

Azolla unit at Bhelwa village of Godda district

Heat stress tolerant pig breed- boosts farmers income

Climate vulnerability: Heat and moisture stress

Background

Unusual climate changes & their variabilities such as rising temperature, lowering of relative humidity %, irregular monsoon, and erratic & uneven distribution of rainfall lead to heat stress, occurrence of disease and higher mortality % in small ruminants. In East Singhbhum district, 28% population are engaged in pig farming in their habitat. In the NICRA-adopted village, 99% of farm families were tribal but due to weather aberration, the pig farming component was not reliable, sustainable and profitable. In NICRA villages, there were challenges to mitigate climatic vulnerability such as drought, heat wave/storm and disease infestation. The reduction in body weight, and sub-optimal behaviors reduced the immunity competence and a higher thermal heat Index (92%) also lowered farm production and profitability.

Resilient technology

Therefore, to mitigate the above-said problems, the Jharshuk breed of pig was demonstrated in the NICRA-adopted villages. The breed is very much suited to Jharkhand state as their body weight increased up to 90-100 kg, 10-12 piglets born at once, tolerant to heat stress and diseases might be due to inherent characteristics of the desi pig breed.

Performance and impact of technology

During the project period total of 62 Jharshuk pigs were demonstrated to 31 farm families in East Singhbhum district. Through capacity building programs, beneficiaries were trained in different management aspects of pig farming and 18 training programmes were organized with 576 farmers. The body weight gained by demonstrated pigs was more than 80 kg while, local breeds had 45 kg in a year. The number of piglets in the local breed in the first furrowing was 2-3, whereas in Jharsuk breed, it was 8 to 9. There was no disease occurrence in demonstrated Jharsuk pigs. The feed conversion ratio in the demonstrated breed was 4:1 compared to 7:1 in local breed (Table 2.3.2). A total of 2 breeding farms started in NICRA village, in collaboration with the district animal husbandry department.

Table 2.3.2: Performance of heat tolerance in Jharsuk breed of pig

Interventions	Body weight in 1st year (kg)	Number of piglets in 1st year	Gross returns (₹)	Net return (₹ day^{-1})	B C ratio
Local breed Farmers practice	45	3	9000.00	5000.00	2.25
Jharshuk pig	80	9	25200.00	20400.00	5.25

Scope for upscaling

The Jharshuk breed of pig can be widely up-scaled by district animal husbandry departments and central & state government schemes on livestock missions. Entrepreneurship in pig farming can also be developed in convergence with government schemes in the East Singhbhum district.

Heat stress tolerant Jharshuk pig at East Singhbhum

Introduction of improved breed of pig (T&D) under drought situation

Climate vulnerability: Drought

Background

T & D breed has been introduced for sustainable livelihood for the landless and marginal farm women during drought-like situations. The breed is heat and cold-resistant and can be reared under free range system.

Resilient technology

Introduction of an improved T & D breed of pig under the NICRA project at KVK Chatra. It is a crossbreed (Tamwarth X Desi) from Birsa Agricultural University, Ranchi producing two farrowing in a year. The body growth is fast as compared to the local breed under the same feeding management and provides more piglets, compared to the desi breed in one farrowing.

Performance and impact of technology

Improved breed piglets (T & D) attain 70 kg body weight after 9 months, whereas farmers desi breed gain merely only 45 kg body weight. It is a cold and heat resistant and requires less water compared to the local breeds. Number of farrowing is more compared to the desi breed (2 in a year) (Table 2.3.3). Disease infestations reported less compared to desi breed.

Table 2.3.3: Economics of improved breed of pig (T&D) under drought situation

Technology demonstrated	No. of furrowings	No. of piglets in one furrowing	Weight of pig @ maturity stage (kg)	Gross return	Net return	B C ratio
T&D breed (Tamwarth X Desi)	2	9	70	13500	9000	3.00
Desi breed (farmers practice)	1	5	45	6750	3750	2.25

Scope for up scaling

In the NICRA village, 17 farm families adopted this breed and are earning 1 lakh rupees annually through this enterprise. During the drought period, rural women (Landless) generally depend on government schemes for employment and income. During this period, heat and cold wave tolerant breed (T & D) of pig can be easily reared in the farmer's field situation which can provide an additional income of ₹ 22500 after rearing of one male and one female piglet (T & D).

T & D breed in farmer's situation at KVK, Chatra

Jharsuk: A good livelihood option for scheduled castes, scheduled tribes and other weaker section

Climate vulnerability: Moisture stress/ Heat wave

Background

Pig farming is a profitable business because of its short gestation period and multiple furrowing. It is mainly practiced by SC, ST and other farmers of weaker section their livelihood. Most of the farmers in the district rear local non- descript pigs in their backyard and are free range feeding habitual with traditional management practices (feeding, breeding and health care), also used outdoor pig paddock which are not able to protect against environmental extremes which results in small litter size, lower growth rate, low production and high mortality due to non – vaccination and improper management.

Resilient technology

Krishi Vigyan Kendra, Garhwa introduced an improved breed of pig 'Jharsuk' in Sangbaria and Tenar NICRA villages. A total of 3 farmers in each village were given 2 females and 1 male piglet of about 10 kg body weight, vaccinated with FMD and swine fever diseases. Scientific interventions in the form of training and capacity building for improved housing, feeding, breeding and health care management practices were provided. Regular follow-up of the program was done by KVK scientists as and when required.

Performance and impact of technology

Jharsuk, an improved breed of pig was developed by the crossing of Tamworth male, a British breed with a desi female pig of Jharkhand by Birsa Agricultural University, Ranchi Jharkhand, characterized by early maturity, prolific growth, gives 10 – 14 piglets at one farrowing with two furrowings each year, faster growth, good resistant power etc. Even low-cost housing and feed management can give good returns. The variety can gain approximately 80 kg body weight at the slaughter age of 8-10 months. The Jharsuk breed, with black lustrous skin, faster growth, lower maintenance cost, better feed conversion rate and reproductive performance, higher survivability, disease resistance and ecological adaptability, gives farmers higher economic returns. An introduction of Jharsuk drastically increased with a 53.8% and 73.4% increase in net return in Tenar and Sangbaria villages, respectively (Table 2.3.4).

Table 2.3.4: Impact of 'Jharsuk' an improved pig breed on desi pig in Sangbaria village of Garhwa district

Intervention	Village	Production year^{-1}		Selling price of meat (₹)		Gross return (₹)	Cost of cultivation (₹)	Net return (₹)	B C Ratio
		Body wt.(kg)	Piglets (No)	₹ kg^{-1}	₹ piglet^{-1}				
Jharsuk, (Improved breed)	Tenar	75	14	250	5000	65000	25000	40000	1.60
Farmers Practice		35	6	250	4000	32750	8000	26000	3.25
Jharsuk, (Improved breed)	Sangbaria	70	10	250	5000	67500	22000	45500	2.06
Farmers Practice		40	6	250	4000	34000	8000	25500	3.18

Intervention of 'Jharsuk'- an improved breed of pig in Sangbaria village of Garhwa District

Introduction of improved breed of pig (Jharsook)

Climate vulnerability: Moisture stress/ Heat wave

Background

The adoption of improved breeds of pigs, specifically those bred for traits like rapid growth and disease resistance (Jharsook), significantly enhances the productivity and income of farmers. These genetically superior pigs have higher reproductive rates, grow faster, and often require less feed to reach market weight. Their enhanced resistance to diseases reduces mortality rates, ensuring a higher survival rate among piglets.

Resilient technology

Introduction of an improved breed of pig, Jharsook in the NICRA village, with improved breeding, farmers can efficiently raise a larger number of pigs within a shorter period, leading to increased pork production. Moreover, the superior quality of meat and reduced production costs contribute to higher market value and profit margins for farmers.

Performance and impact of technology

Under livestock management module Jharsook breed of pig is being widely popularized through development of breed unit of piggery at farmer's door, and adopted farmer has succeeded in earning of ₹ 1 lakh to 3 lakh year^{-1} during the last five years. By seeing the impact of piggery for livelihood in a sustainable way, animal husbandry department of Gumla has developed the unit in 15 villages with input support. All 15 units are being linked with NICRA intervention "Breed Unit" for supplying improved piglets. Details of diffusion of piglet are given below (Table 2.3.5) which has significant impact for livelihood support in the district and how this intervention is being scaled up. Other intervention is breed replacement with improved breed Jharsook in pig has been extended in 15 Villages and 45 farm family is directly benefitted with their intervention.

Table 2.3.5: Extension of Jharsook breeds in another village from the model farm unit

Year	No. of village	No. of farmers	No. of piglets taken from breeding unit	No. of total piglets at farmers point
2011-12	01	02	09	36
2012-13	03	05	11	56
2013-14	04	07	18	112
2014-15	06	09	22	132
2015-16	09	13	30	146
2016-17	11	16	35	155
2017-18	10	14	47	201

Scope for upscaling

Gumla district is predominantly tribal district, so the farmers are more inclined towards pig farming but due to breed in this area, good production was not achieved. After conducting NICRA technology on pig farming, 2100 farmers in Gumla district are getting more income from ₹ 1 lakh to 1.5 lakhs annually and now the Jharsook breed of pig is around 70% in Gumla district.

Jharsook breed of pig in the NICRA village of Gumla district

Introduction of preventive vaccination in livestock

Climate vulnerability: Moisture stress/ Heat wave

Background

Vaccination programs create a shield of immunity within herds, effectively curbing the spread of these diseases. By minimizing the incidence and severity of PPR and FMD, these vaccinations save countless animal lives, ensuring the health and well-being of ruminant livestock. Additionally, by preventing outbreaks, these vaccinations safeguard the economic stability of farmers who rely on these animals for their livelihoods. Ultimately, these efforts play a crucial role in maintaining the health of livestock populations, preserving agricultural economies, and ensuring food security.

Resilient technology

Introduction of preventive vaccination to the livestock under NICRA project. PPR (Peste des Petits Ruminants) and FMD (Foot-and-Mouth Disease) vaccinations are instrumental in significantly reducing mortality rates among ruminant animals. These diseases, highly contagious and often fatal, pose a severe threat to livestock populations.

Performance and impact of technology

The implementation of Peste des Petits Ruminants (PPR) vaccination in goats and Foot-and-Mouth Disease (FMD) vaccination in cattle has had a transformative impact on livestock health and agricultural economies. PPR vaccination in goats has significantly reduced the incidence of this highly contagious viral disease, ensuring healthier goat populations (Table 2.3.6). This has not only safeguarded the livelihoods of countless farmers who rely on goats for meat, milk, and other products but also contributed to the overall food security in various regions. Similarly, the widespread vaccination against Foot-and-Mouth Disease in cattle has curtailed the devastating effects of this disease, which not only affects the health of the animals but also disrupts the entire livestock industry. By controlling FMD, farmers have experienced reduced livestock losses, increased productivity, and a more stable income.

Table 2.3.6: Details of preventive vaccination

Technology demonstrated	No. of farmers	No.
Vaccination camp against FMD Cattle	173	938 No
Vaccination HS, BQ	315	1231 No
Vaccination for PPR in goat	367	1137 No
Animal health camp	100	440 No
De-worming	223	1289 No
Vaccination in pig	07	48 No
Total	**1185**	**5120**

Scope for upscaling

These vaccinations have a broader positive impact on public health by preventing the transmission of diseases from animals to humans, ensuring the safety of the food supply chain. The vaccination is promoted by creating awareness among livestock owners and through the animal husbandry department.

Vaccination to the livestock in the NICRA village of Gumla district

UMMB (Urea Mineral Molasses Block) for ruminants supplementation

Climate vulnerability: Moisture stress

Background

Nutritional imbalance was reported among all breeds of goats and dairy animals due to lower content of minerals and vitamin among all feedstuffs. For elimination of such problem requires supplementations of some basic essential minerals and vitamins to improve the growth rate of goat kids, production performance of dairy animals, check the intake of unhygienic materials like plastic, cloths, paper and waste materials at surrounding area of livestock. It reduces heat or cold stress, improves reproductive efficiency and enhances the immunity of the livestock.

Resilient technology

UMMB is provided up to 50 g day^{-1} to goat kids and 500 g day^{-1} to dairy animals for improving overall animal health, immunity and productivity during stress periods.

Performance and impact of technology

A demonstration involving 50 farmers with 87 animals was carried out in NICRA village Garhi by providing UMMB for supplementation in animal feed. An increase in body weight by 25% and 25 % litres day^{-1} milk yield was observed with the cows being supplemented with UMMB over farmer's practice. Supplementation of feed with UMMB to goats enhanced the net returns and BC ratio by 91.52% and 22.54%, respectively over farmers practice. Similarly, it also increased net return and BC ratio by 42.86% and 3.90 %, respectively in case of cows (Table 2.3.7). This intervention is being adopted by the farmers of NICRA village and adjoining NICRA villages.

Table 2.3.7: Performance of UMMB supplementations to goat and cow

Intervention	Year	Indicate year normal or stress	Milk/Meat Yield/Year	Gross cost (₹ year^{-1})	Gross return (₹ year^{-1})	Net return (₹ year^{-1})	B C ratio	No. of farmers adapted technologies
Goat								
UMMB	2022-23	Normal	15 kg	3832.5	6667	2834.50	1.74	120
Farmer practice			12 kg	3460.0	4940	1480.00	1.42	
Cattle – Milk day^{-1}								
UMMB	2022-23	Normal	5 litres day^{-1}	150	200	50	1.33	85
Farmer practice			4 litres day^{-1}	125	160	35	1.28	

Scope for upscaling

This UMMB is being upscaled widely through the animal husbandry department and by local livestock owners.

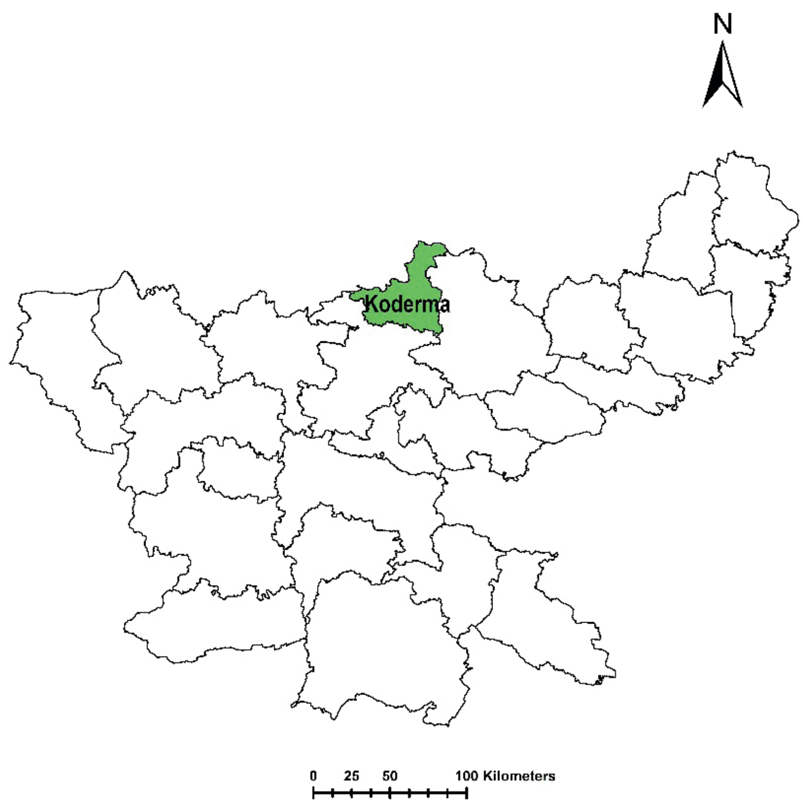
Supply of UMMB to the goats and dairy animals in Garhi village of Godda district

3. Climate Resilient Technologies for risk prone districts of Jharkhand

Climate Resilient Technologies for risk prone districts of Jharkhand

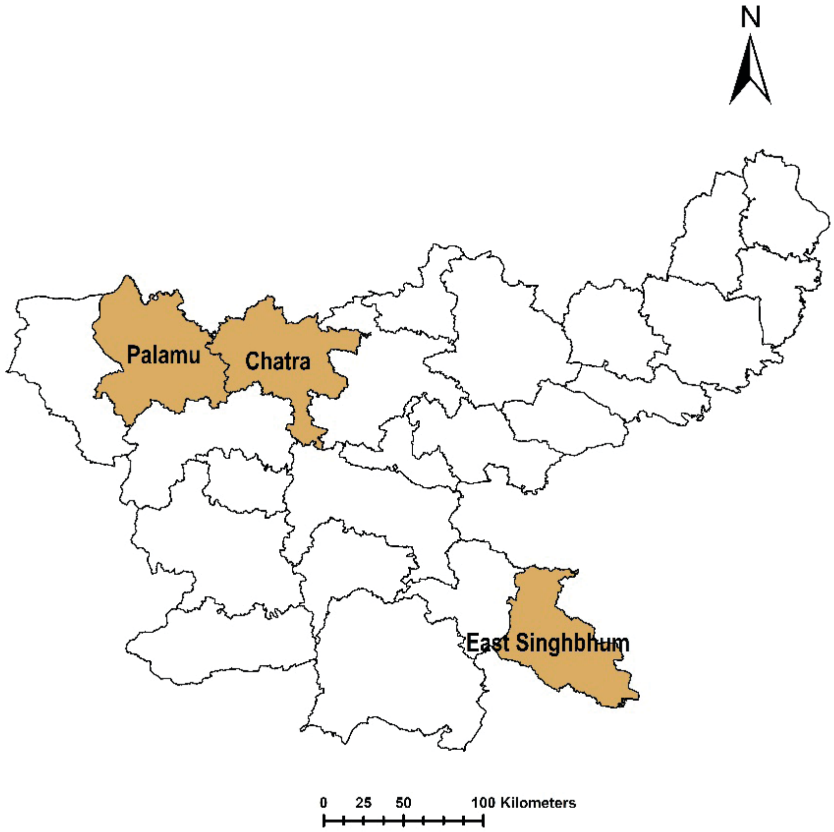
Districts of Jharkhand can be broadly categorized into low risk, medium risk and high risk, based on climatic change and variability. Based on the on-farm experimentation being taken up as part of the Technology Demonstration Component of NICRA and also other studies, technologies that can impart resilience to climate change and variability for various risk-prone districts of Jharkhand are indicated. The specific technologies for each of the farming situations in these districts depend on the predominant production systems, resource endowments and the production objectives of the farmer. Promising resilient technologies for each of the risk-prone categories for different districts of Jharkhand are as follows.

Promising climate resilient technologies for low-risk prone districts of Jharkhand



1. Nadikund / Water harvesting structure
2. Drought tolerant upland rice variety (Sahbhagi dhan)

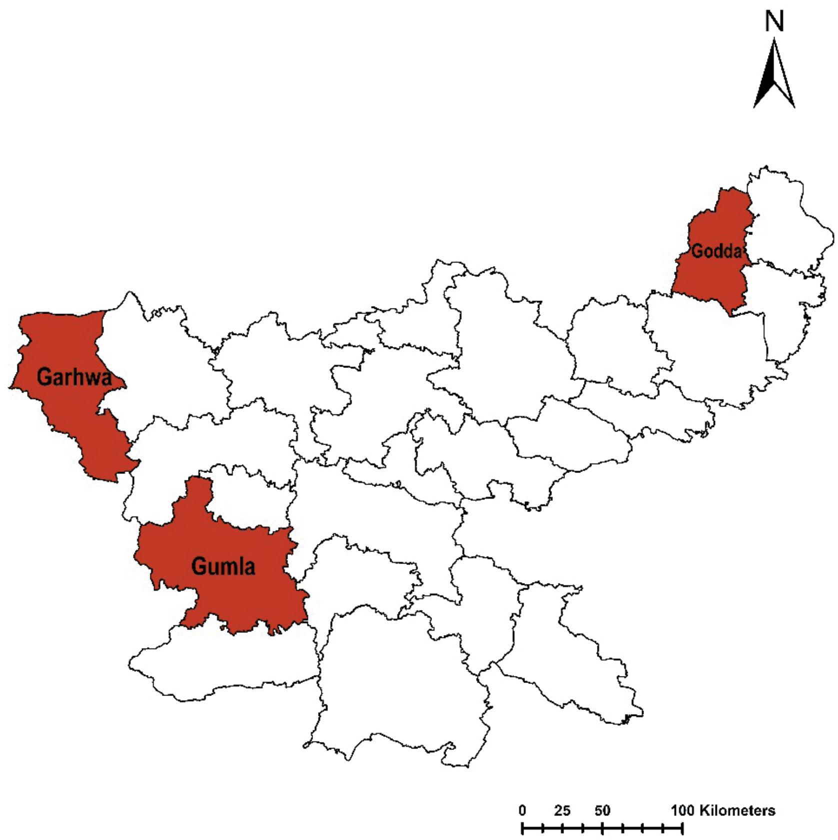
Promising climate resilient technologies for medium-risk prone districts of Jharkhand



1. Crop residue mulching in ginger and turmeric for climate resilience
2. Aerobic rice to cope with drought
3. Renovation / desilting of ponds for water harvesting
4. Introduction of improved breed of pig (T&D) under drought situation
5. Short duration and drought-tolerant rice varieties for sustainable rice production
6. Rennovation of farm ponds for rainwater harvesting
7. Heat stress tolerant pig breed

Promising climate resilient technologies for high-risk prone districts of Jharkhand

1. Introduction of preventive vaccination in livestock
2. Introduction of Improved breed of Pig (Jharsuk)
3. Azolla as a livestock green fodder
4. Field bunding for artificial groundwater recharge
5. Jharsuk: A good livelihood option for scheduled castes, scheduled tribes and other weaker sections



6. Green manuring for *In-situ* moisture conservation
7. UMMB (Urea Mineral Molasses Block) for ruminants supplementation
8. Seed production – Paddy (Var.: Sahbhagi)
9. Elephant foot yam based multilayer vegetable cropping system (MLVCS)
10. Community farm pond – A boon for the village Bhelwa
11. Boron and Sulphur: An effective nutrition to minimize moisture stress and improves yield of black gram
12. Boron and Sulphur nutrition and management of wilt and pod borers/fly/sucking bugs built pigeonpea climate resilient with yield improvement
13. DSR with var. IR64 Drt-1: Mitigation of drought in rainfed medium lands
14. Zero tillage: Alleviating heat and moisture stress in *rabi* crops
15. Bora bandh (Sandbag check dam)
16. Location specific intercropping - Groundnut + redgram
17. Intercropping - Maize + redgram for optimized resource use
18. Community nurseries for delayed monsoon
19. Sahbhagi Dhan: A drought tolerant paddy variety

20. Birsa Arhar 1: A drought tolerant redgram variety
21. Groundnut variety ITG-TG-51: A drought tolerant
22. PU-31: A drought tolerant blackgram variety
23. GPU-28: A drought tolerant finger millet variety
24. Drought tolerant niger variety: Birsa Niger-1
25. Groundnut + maize intercropping system
26. Paddy + red gram intercropping system

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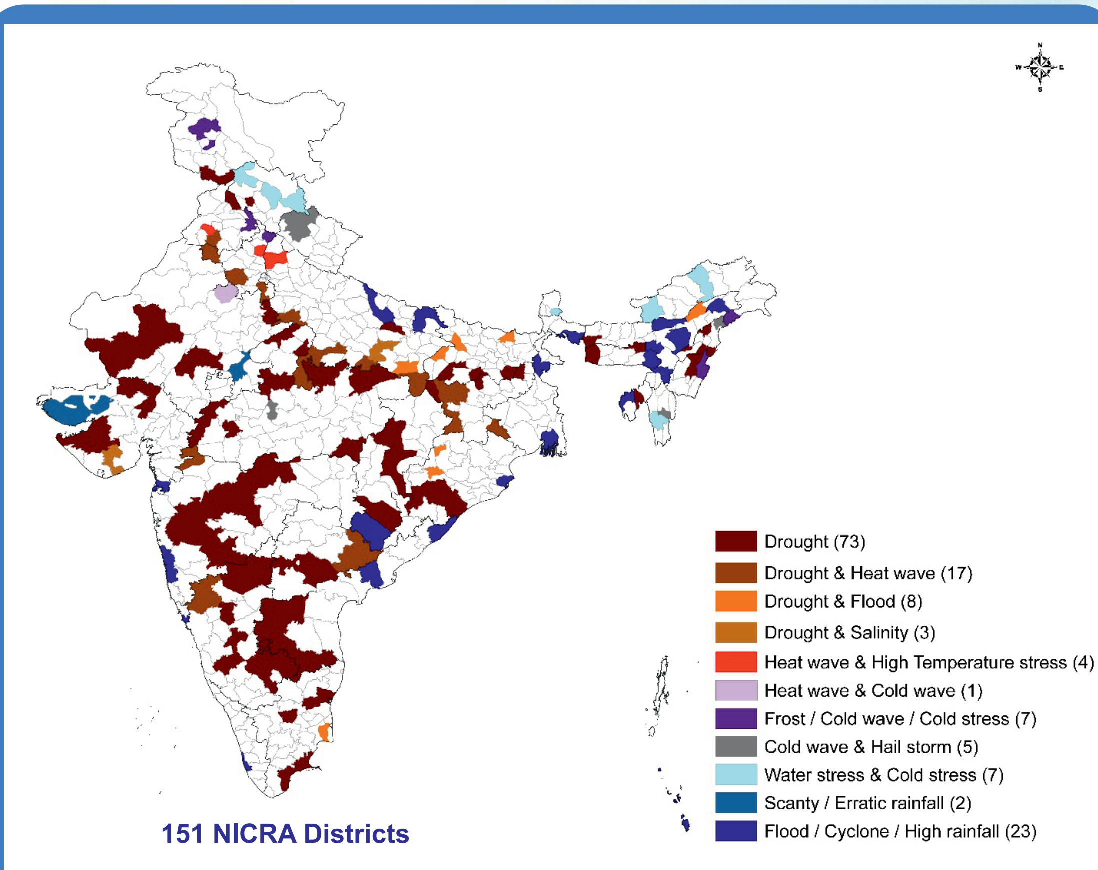

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