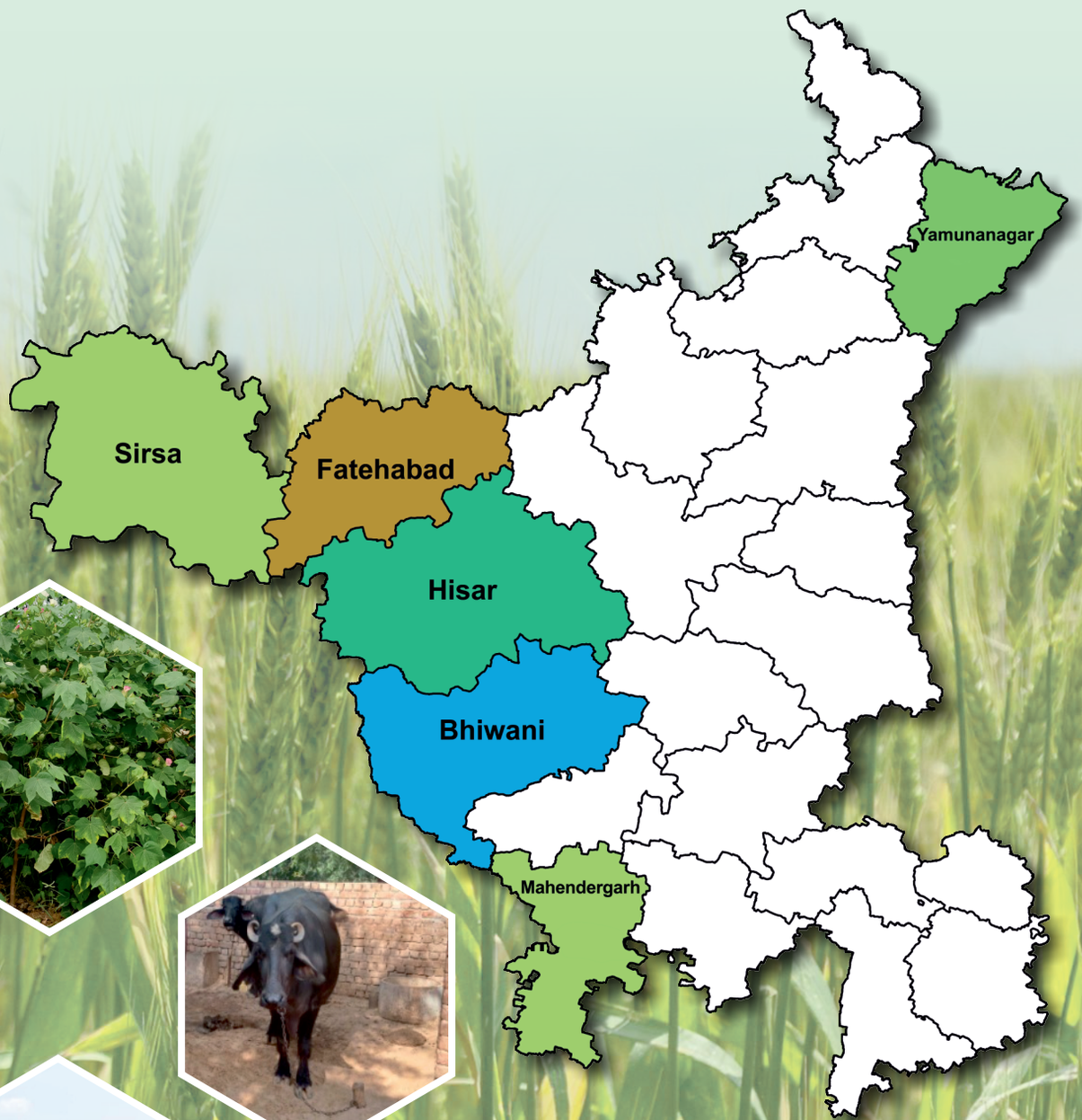
Promising Climate Resilient Technologies for

HARYANA





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

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V K Singh, G Pratibha, J V N S Prasad, A K Indoria, P K Pankaj, M Prabhakar, T V Prasad, J P Mishra, P P Rohilla, Rajbir Singh, U S Gautam and S K Chaudhari

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Back Cover: Climate resilient technology interventions and 151 risk prone districts

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FOREWORD

In the face of unprecedented global challenges posed by climate change, the adoption of climate-resilient technologies is essentially required not only to sustain the production systems but also to safeguard the livelihoods of current and future generations. Recognizing the critical need to strengthen the agricultural sector, the National Innovations in Climate Resilient Agriculture (NICRA) project of ICAR has emerged as a beacon of hope and innovation to Indian agriculture.

Haryana, with its rich agricultural heritage, stands at the forefront of this transformation. The publication titled "Promising Climate Resilient Technologies for Haryana" is a comprehensive compilation of field-tested, scientifically validated interventions tailored to the state's unique climate challenges such as drought, moisture stress, and soil salinity. It reflects Haryana's strong commitment to innovation and adaptation in the face of climate variability.

I extend my sincere appreciation to the contributors of this document and hope that it will be considered worthy by the policymakers, researchers, practitioners, farmers and other stakeholders.

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(M. L. Jat)

Dated the 4th July, 2025
New Delhi

PREFACE

Haryana has emerged as a beacon of resilience and innovation, standing at the forefront of combating the challenges posed by climate change for sustainable development. State experiencing extreme events such as droughts, moisture stress and salinity events frequently influencing the productivity and livelihoods. The Technology Demonstration Component (TDC) of National Innovations in Climate Resilient Agriculture (NICRA) aims at identifying the promise of climate-resilient technologies lies not only in their capacity to address immediate challenges but also in their potential to foster long-term sustainability. Participatory on-farm demonstrations were taken up in six districts, Bhiwani, Fatehabad, Hisar, Mahendergarh, Sirsa and Yamunanagar of the state for addressing drought, moisture stress and salinity. Various technologies pertaining to natural resource management, crops and cropping systems and livestock were demonstrated with active participation of farmers. The performance of these practices during the normal and stress years was assessed. The resilience and the perception of the farmers were recorded. Village institutions such as seed banks, fodder banks, custom hiring centres, village climate risk management committees were established in the NICRA villages. The proven resilient practices were scaled up in convergence with various ongoing developmental programmes of the states.

As we witness the unprecedented impacts of climate change globally, it becomes domineering for regions to adopt forward-thinking strategies that not only mitigate the risks but also make the way for a more sustainable future. These resilient technologies could minimize the impact of variable weather and stabilize the productivity. Technologies which were found to be promising are compiled along with the economics during the stress year. Compiling the promising technologies in the form of publication serves as guide for all the stakeholders for scaling up climate resilient technologies as part of various developmental programmes operational in the state. The upscaling domains for each of the technology was indicated and the possible development programs which can be leveraged for upscaling the technologies are identified.

We extend our appreciation to gratefully acknowledge the constant guidance and support from Dr. Mangi Lal Jat, Secretary (DARE) & Director General (ICAR), members of the High-Level Monitoring Committee, Zonal Monitoring Committee Chairmen and members, Directors of Extension of the State Agricultural and Veterinary Universities, officials of Development Departments and KVKs of the state. We gratefully acknowledge the valuable contribution of farmers, VCRMC members and other stakeholders of the project.

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CONTENTS

S.No.	Particulars		Page No.
1	**Introduction**		3
	1.1	Climate change in Haryana state	5
	1.2	Challenges to Haryana in the context of climate change	5
	1.3	Overview of the agro-ecosystems and predominant production systems in the selected districts under NICRA for technology demonstration	6
	1.3.1	Bhiwani	6
	1.3.2	Fatehabad	8
	1.3.3	Hisar	10
	1.3.4	Mahendergarh	12
	1.3.5	Sirsa	14
	1.3.6	Yamunanagar	16
2	**Promising Climate Resilient Technologies**		19
	2.1	Promising Natural Resource Management Technologies	20
	2.2	Promising Crop Production Technologies	35
	2.3	Promising Animal/ Livestock Technologies	61
3	**Climate Resilient Technologies for risk prone districts of Haryana and approaches for upscaling**		75
4	**Literature cited**		81

LIST OF ACRONYMS

ATMA	Agricultural Technology Management Agency
BCR	Benefit Cost Ratio
CFLDs	Cluster Front Line Demonstrations
CGWB	Central Ground Water Board
CHC	Custom Hiring Centres
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

1. Introduction

The State of Haryana is situated in the northern part of India and is bounded by Punjab and Himachal Pradesh to the north, and by Rajasthan to the west and south. The river Yamuna defines its eastern border with Uttarakhand and Uttar Pradesh. Haryana surround Delhi on three sides, forming the northern, western and southern borders of Delhi (Fig.1). Geographically, Haryana lies between 27°37′ to 30°35′ North latitude and 74°28′ to 77°36′ East longitude. The altitude of Haryana varies between 200 m to 1200 m above sea level. The total geographical area of the state is 4.42 m ha which is 1.4% of the total geographical area of the country. Out of total area, 84.6% is under cultivation and 96.5% is net sown area, and 90.9% is area under irrigation. There are two agro-climatic zones in the state. The north western part is suitable for rice, wheat, vegetable and temperate fruits and the south western part is suitable for high quality agricultural produce, tropical fruits, exotic vegetables, herbal and medicinal plants. Major land use in Haryana is agriculture (85%), forest (2.4%), fallow (7.2%) and waste land (5%) (Fig. 2). Haryana is self-sufficient in food production and the second largest contributor to India's central pool of food grains. The irrigated area constitutes 84% of the cultivated area in the state. The cropping intensity of the state is 181% with total food grains production of over 13 m tones. The dominant cropping systems are: rice-wheat, cotton-wheat and bajra-wheat. Agriculture contributes 17% of the state's GDP and employs 65% of the total workforce.

The natural resource base of agriculture, which provides sustainable production, is shrinking further the lands are degrading and is affecting production capacity. About 62% area of the state is under poor quality water. There are problems of declining as well as rising water tables, soil salinity/alkalinity, declining soil health and stagnating crop productivity. Efficiency-mediated improvement in productivity is the most viable option to raise production.

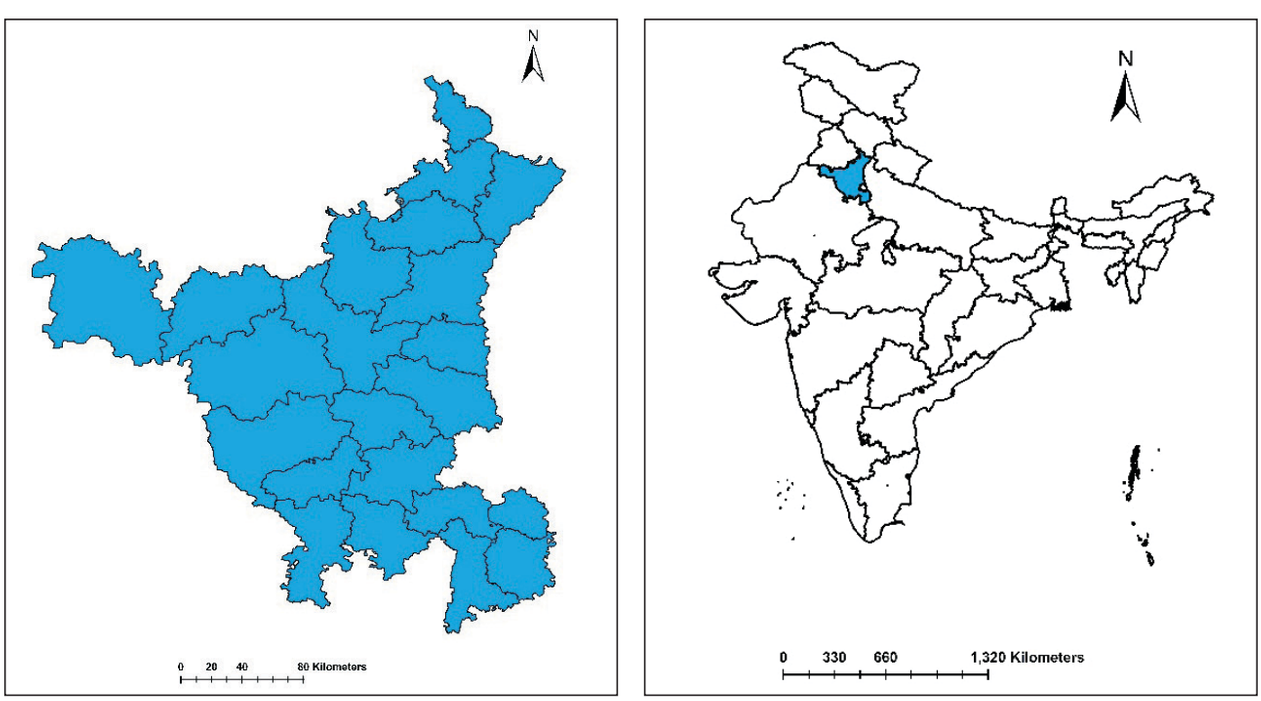


Fig.1 Location map of Haryana

Climate

The climate of Haryana is very hot in summer and cold in winters. December and January are the coldest months, in the winter months the average temperatures are in the range 3 ^{0}C to 9 ^{0}C. Whereas May and June were the hottest months and the temperature reaches up to 50 ^{0}C. In the summer months temperatures range between 35^{0}C to 48^{0}C. Rainfall is varied, about 80% of the rainfall occurs in the monsoon season during the months of July and September, Shivalik Hills region being the wettest and the Aravali Hills region being the driest.

Haryana has limited rainfall and ranges from 300 mm in the Southwest to 1,100 mm in the Northeast of the state. The state lies in the basins of the Indus and the Yamuna rivers and receives water from Sutlej and Yamuna rivers and its share from the surplus water of rivers Ravi and Beas, as per various inter-state agreements. The Southwest monsoon contributes around 82% of annual rainfall. Highest rainfall is usually received during July and August months which contributes about 60% of annual rainfall.

Major soils

Soils of Haryana falls 58% under Inceptisols, 29% under Entisols, 9% under Aridisols and 4% under Alfisols.

Cropping pattern

Agriculture contributes 17% of the state's GDP and employs 65% of the total workforce. The net sown area is 84% of the total geographic area as compared to the national average of 46%, the gross cropped area is 65 lakh ha with a cropping intensity of 180%. The main crops in Haryana are wheat, rice, sugarcane, cotton, oilseeds, gram, barley, pearl millet, green gram etc. There are two main seasons in Haryana: *rabi and kharif*. The major *kharif* crops of Haryana are rice, jowar, bajra, maize, cotton, green gram and sugarcane. The major *rabi* crops are wheat, gram, rapeseed and mustard. About 86% of the area of the state is arable, and of that 96% is cultivated and about 84% of the area is irrigated, through tube wells and an extensive system of canals.

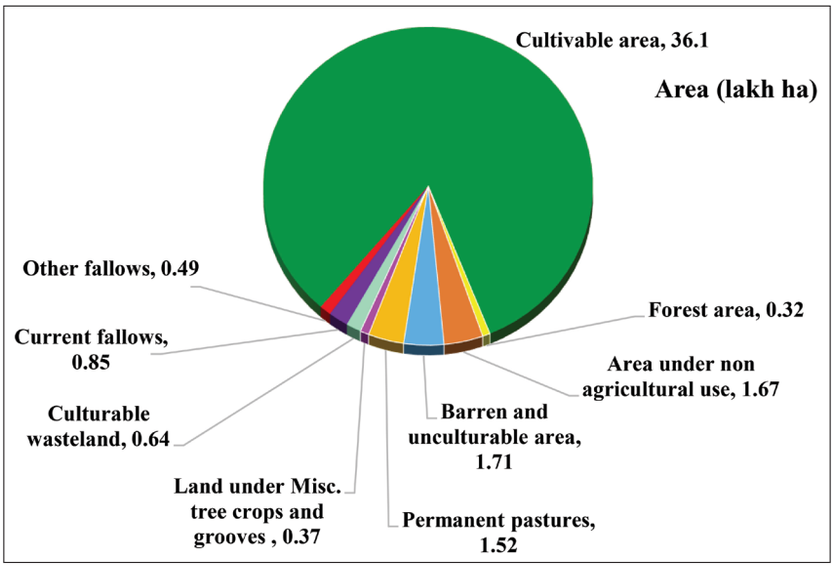


Fig.2 Land use patter of Haryana

Horticulture crops cover 4.9% of the gross cropped area, with major fruit crops like mango, guava and citrus, vegetables like potatoes, cauliflower, cucurbits, carrots, tomatoes, radish and onions, and major flower crops like marigold, rose, tuberose and gladiolus cultivation are done.

1.1 Climate change in Haryana

The projected climate change in 2050's and in 2080's over Haryana using IPCC SRES A1B scenario1 (PRECIS2 regional climate model output) have been studied. Mean maximum temperature is projected to increase by 1.3^0 C and mean minimum temperature by 2.1^0 C towards mid-century. The increase in mean maximum temperature is projected to be 4.2^0 C and mean minimum temperature 4.7^0 C towards end of the century respectively. Mean annual rainfall is projected to decrease marginally by about 3% by midcentury and increase by about 17% by the end of century (State Action Plan on Climate Change, Haryana). Haryana emits nearly 2% of Green House Gases (GHGs) and represents about 3% of national fossil fuel consumption. Agriculture sector contributes 82% of methane and nitrous oxide emissions of the state. Animals and rice cultivation contributes 14% of methane followed by crop residues burning which contributes 6% of emissions. Application of synthetic nitrogen fertilizer contributes 62% of nitrous oxide emission (State Action Plan on Climate Change, Haryana).

1.2 Challenges to agriculture in the context of climate change

Climate change on agriculture project that wheat crop yields may decrease by 20% or more due to high temperature. The increase in temperature would be 28^0-32^0 C. Unpredictable moisture deficiencies during crop growth may be major constraint for lower crop productivity. Indian mustard production may adversely be affected due to drought and salinity stress. Agriculture is the major livelihood of the state population which is largely impacted by the climate change. Due to weather variability, shift in cropping season, temperature variations and rainfall pattern alterations affects the different aspects of crop production. Climate change may also cause delayed germination, poor crop growth and flowering. Heat stress due to environmental conditions may cause decline in milk productivity in dairy animals. In order to adapt agriculture to increasing effects of climate change there is a need to transform traditional agricultural practices to climate resilient agricultural practices. Climate resilient agricultural practices include all the possible methods which are required to make agriculture more resilient to climate change. Intensifying crops and cropping systems, natural resource management practices and also livestock maintenance. Department of Agriculture and Department of Animal Husbandry and Fisheries have jointly proposed the vulnerability reduction measures. Molecular breeding for heat stress tolerance varieties, development of water efficient aerobic rice, drought and salinity stress tolerant crop varieties. Inclusion of fruits and vegetables in horticulture crops, natural resource management technologies like in situ soil moisture conservation practices for enhancing soil moisture and soil quality.

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

Haryana is extremely hot in summer with a temperature of around 45°C and mild in winter. The hottest months are May and June and the coldest December and January. Climate is arid to semi-arid with average rainfall of 354.5 mm. Around 29% of rainfall is received during July to September, and the remaining rainfall is received during December to February. Agriculture is the key economic sector of the state. Major source of irrigation is ground water (57% of the area is cultivated through ground water), followed by canals (43% of area is cultivated through canal sources). Underground water found in the state is mainly brackish. There are two agro-climatic zones in the state. The north western part is suitable for rice, wheat, vegetable and temperate fruits and the south western part is suitable for high quality agricultural produce including tropical fruits, exotic vegetables and herbal and medicinal plants.

The overview of the agroecosystems and predominant production systems under NICRA villages was given below

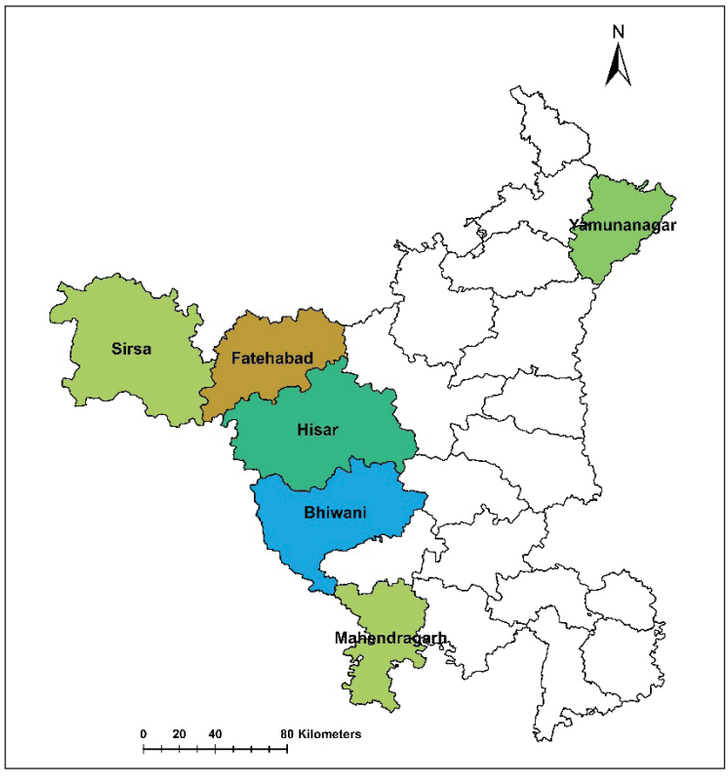


Fig.3 Districts of Haryana involved in TDC-NICRA programme

Overview of the districts

1.3.1 Bhiwani

Bhiwani district is located between 28º 46′ N latitude and 76º 08′ E longitude with an altitude of 237 m above MSL. The district is categorized into Western plain hot arid ecosystem with desert soils (ICAR), Trans Gangetic plain region (Planning Commission) and Western agroclimatic zone of Haryana (NARP). The Bhiwani district is bordered by Hisar district on its North, some area of

Jhunjhunu and Churu districts of Rajasthan on its West, Mahendergarh and Jhunjhunu districts on its South and Rohtak district in the East (Fig.4). The geographical area of the district is 3.28 lakh ha, out of which cultivable area and forest area is 2.94 lakh ha and 0.016 lakh ha, respectively and different land use pattern of the districts are indicated in Fig.7. The source of irrigation in the district are canals, bore wells and other sources. Bajra, rapeseed mustard, wheat, gram and cotton are the major field crops. Other horticulture crops like citrus, ber, guava and vegetables like carrot, cauliflower, tomato are the major crops grown in the district (Table 1.1). Indigenous cattle, buffaloes, goat, sheep farming is widely adopted. The average annual rainfall of the district is 410.8 mm and of this 340.0 mm of the rainfall is received during Southwest monsoon (Fig.5). The predominant soils in the district are sandy loam, loamy sand and sandy soils. (Fig.6)

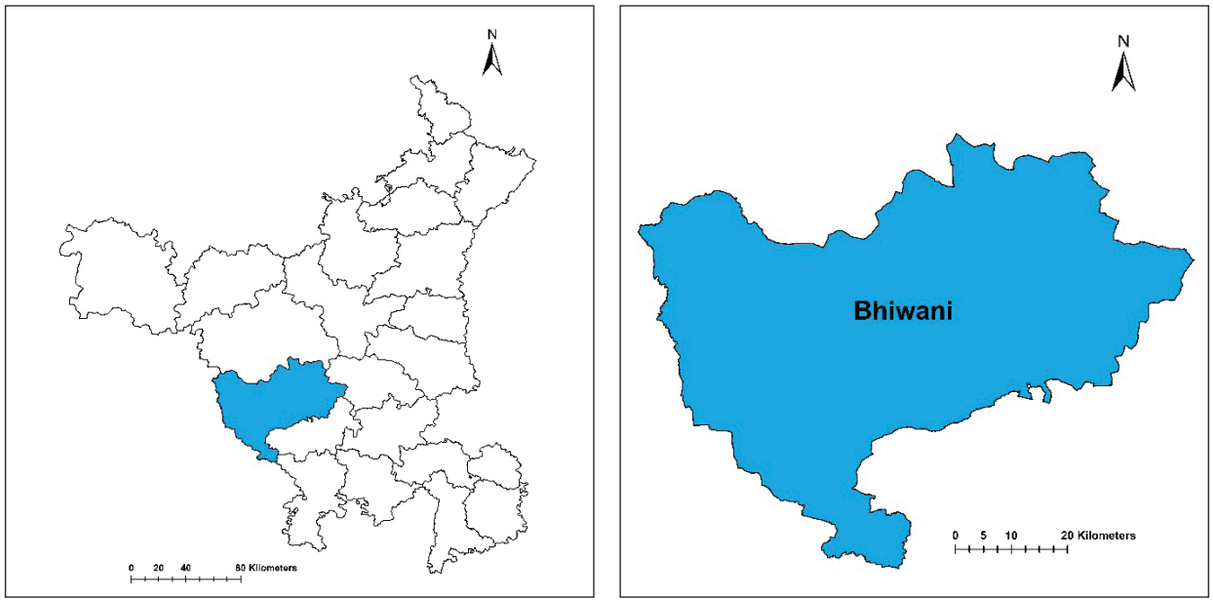


Fig.4 Location map of Bhiwani

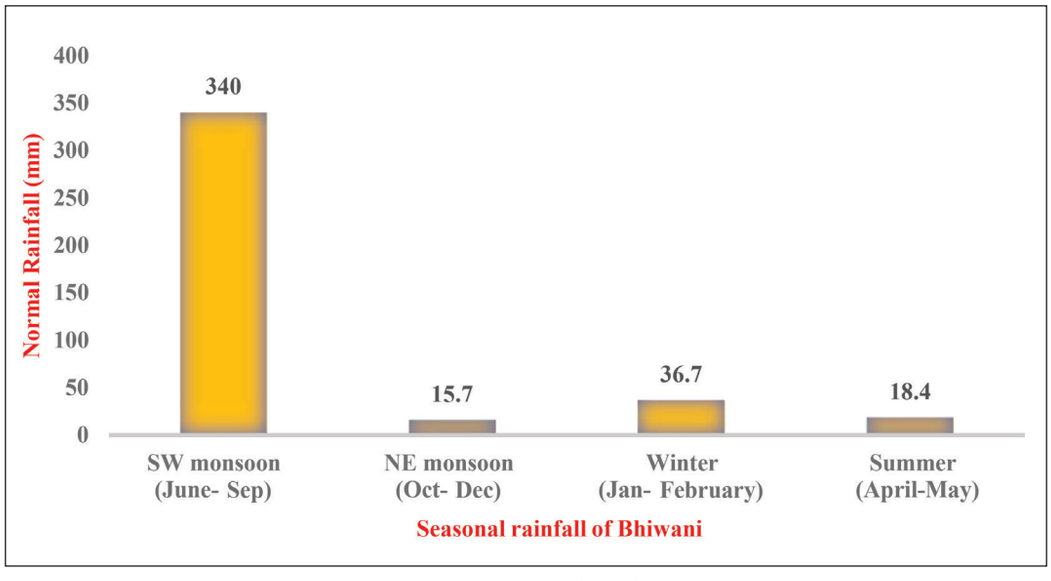


Fig.5 Season wise rainfall of Bhiwani

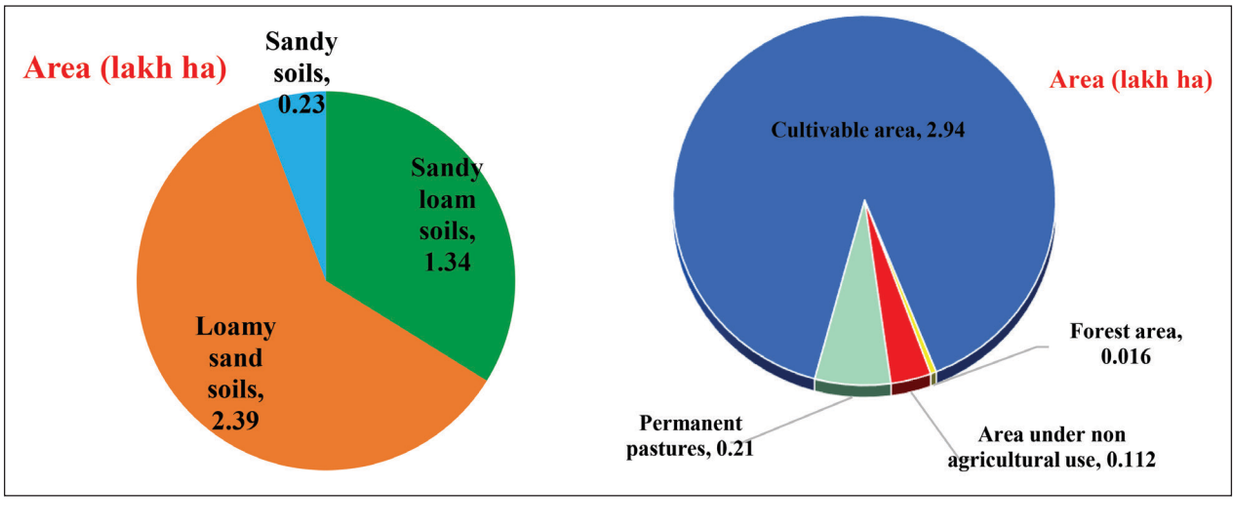


Fig.6 Major soil classification of Bhiwani *Fig.7 Land use pattern of Bhiwani*

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

Major crops	Area (ha)			Production (t)			Productivity (t ha^{-1})	
	Kharif	*Rabi*	Total	*Kharif*	*Rabi*	Total	*Kharif*	*Rabi*
Bajra	63406	-	63406	111470	-	111470	1.76	-
Barley	-	13		-	40	40		3.08
Cotton	82054	-		113000	-	113000	1.38	-
Gram	-	16583		-	16401	16401	-	0.99
Groundnut	194	-		194	-	194	1	-
Guar seeds	-	-	19193	-	-	17274	0.9	
Sugarcane	-	-	2962	-	-	194040	65.5	
Moth bean	135	-		16.9	-	16.9	0.13	-
Rapeseed & mustard	-	169596		-	297810	297810	-	1.76
Rice	22290			46790	-	46790	2.1	-
Wheat	--	86914		-	371210	371210	-	4.27

1.3.2 Fatehabad

Fatehabad district is located between 29º 52′ N latitude and 75º 45′ E longitude with an altitude of 234 m above MSL. The district is categorized into Rajasthan Bagar, North Gujarat plain and South Western Punjab plain, hot typic arid eco-subregion (ICAR), Trans Gangetic plain region (Planning Commission) and Western agroclimatic zone of Haryana (NARP). The district is surrounded by Punjab state in the North, Jind district in the East, Sirsa district in the West, Hisar district and Rajasthan state in the South (Fig.8). The geographical area of the district is 2.48 lakh ha, out of which cultivable area and forest area is 2.18 lakh ha and 0.002 lakh ha respectively. The different land use pattern of the districts are indicated in Fig.10. The gross cropped area of the district is 4.38 lakh ha out of which 2.18 lakh ha is net sown area and 2.20 lakh ha area is sown more than once. The source of irrigation in the district are canals and bore wells. Wheat, cotton, rice, rapeseed mustard and bajra are the major field

crops. Other horticulture crops like citrus, ber, guava and vegetables like carrot, cauliflower, radish are the major crops grown in the district (Table 1.2). Indigenous cattle, buffaloes, goat, sheep farming is widely adopted. The average annual rainfall of the district is 346.6 mm of which 271 mm is received during Southwest monsoon (Fig.9). The predominant soils in the district are sandy loam soils. (Fig.11)

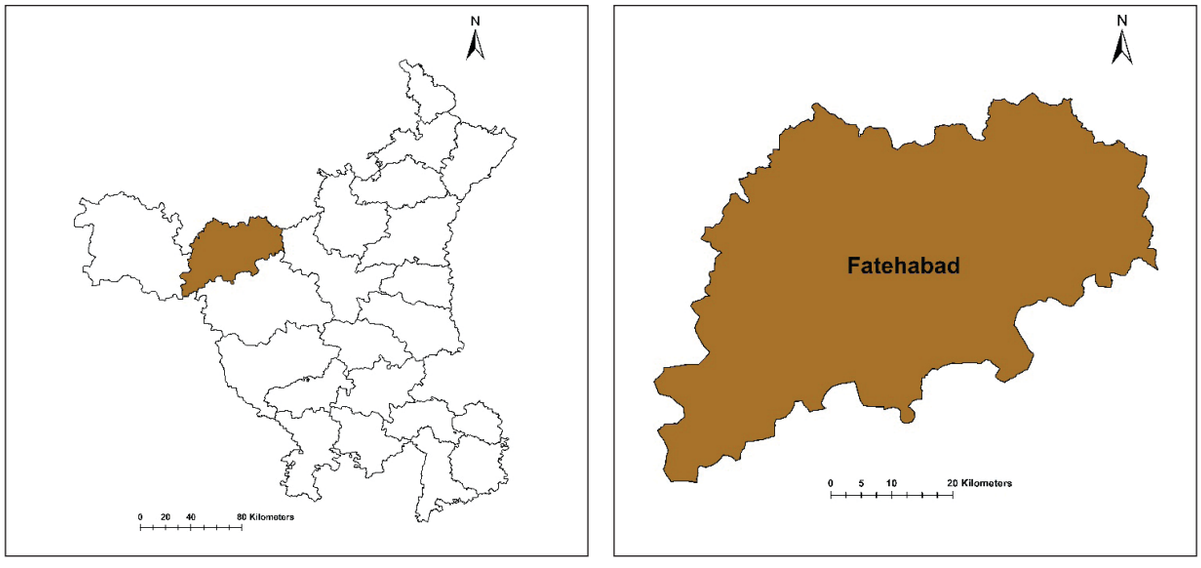


Fig.8 Location map of Fatehabad

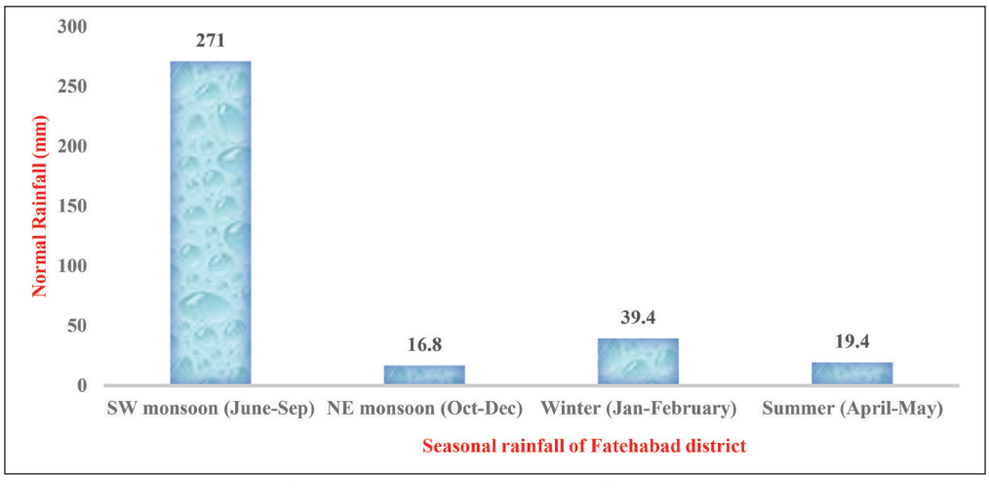


Fig.9 Rainfall distribution in Fatehabad

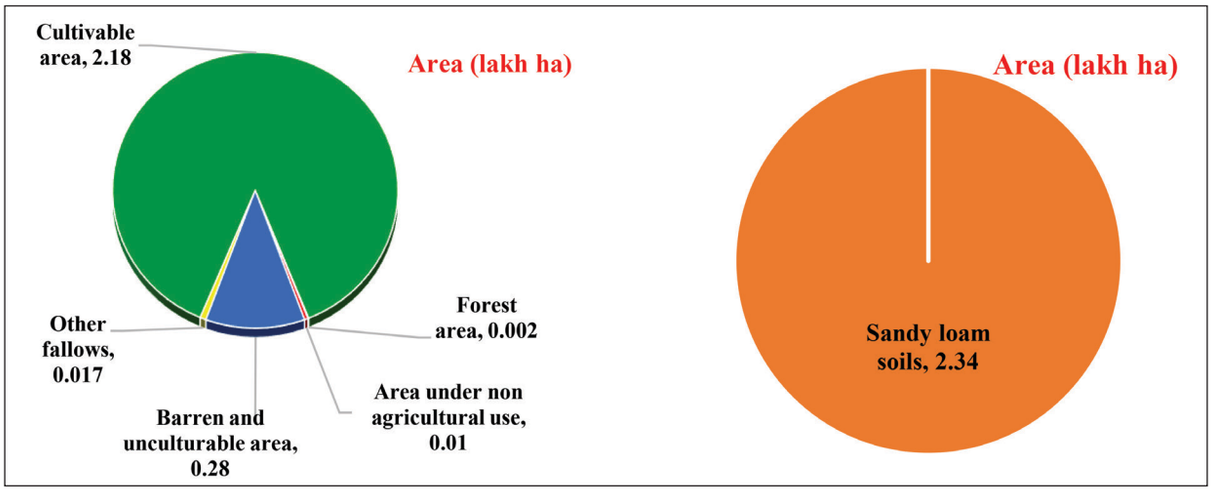


Fig.10 Land use system of Fatehabad

Fig.11 Major soils of Fatehabad

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

Major crops	Area (ha)			Production (t)			Productivity (t ha^{-1})	
	Kharif	*Rabi*	Total	*Kharif*	*Rabi*	Total	*Kharif*	*Rabi*
Bajra	2463	-	2463	5620	-	5620	2.28	-
Barley	-	129	129	-	370	370	-	2.87
Castor	157	-	157	119	-	119	0.76	-
Cotton	63353	-	63353	224700	-	224700	3.55	-
Gram	-	731	731	-	1205	1205	-	1.65
Groundnut	5729	-	5729	6307	-	6307	1.1	-
Guar seed	-	-	9260	-	-	8834	0.95	
Green gram	527	-	527	315	-	315	0.6	-
Peas & beans	-	229	229	-	343	343	-	1.5
Onion	-	-	190	-	-	4037	21.2	
Potato	-	-	1210	-	-	17545	14.5	
Rapeseed & mustard	-	23710	23710	-	42915	42915	-	1.81
Rice	129196	-	129196	524150	-	524150	4.06	-
Sesamum	36	-	36	28.8	-	28.8	0.8	-
Sugarcane	-	-	1196	-	--	92120	77.02	
Wheat	-	184207	184207	-	859330	859330	-	4.67

1.3.3 Hisar

Hisar district is located between 29º 05′ N latitude and 75º 45′ E longitude with an altitude of 234 m above MSL. The district is categorized into Rajasthan Bagar, North Gujarat plain and South Western Punjab plain, hot typic arid eco-subregion (ICAR), Trans Gangetic plain region (Planning Commission) and Western agroclimatic zone of Haryana (NARP). The Hisar district is surrounded by Fatehabad district in North, Bhiwani district in South, Jind and Rohtak districts in East and Rajasthan state in West (Fig.12). The geographical area of the district is 4.04 lakh ha, out of which cultivable area is 3.35 lakh ha and forest area is 0.0073 lakh ha (Fig.14). The gross cropped area of the district is 6.55 lakh ha out of which 3.34 lakh ha is net sown area and 3.20 lakh ha area is sown more than once. The area under rainfed and irrigated situations is 0.99 lakh ha and 5.08 lakh ha. The source of irrigation in the district are canals and bore wells/tube wells. Wheat, cotton, rapeseed mustard and bajra are the major field crops. Other horticulture crops like citrus, ber, guava and vegetables like cluster bean, carrot, cauliflower, chilies are the major crops grown in the district (Table 1.3). Indigenous cattle, buffaloes, goat, sheep farming are widely adopted. The average annual rainfall of the district is 455.1 mm and of which 77% is received during Southwest monsoon (Fig. 13). The predominant soils in the district are sandy loam soils. (Fig.15)

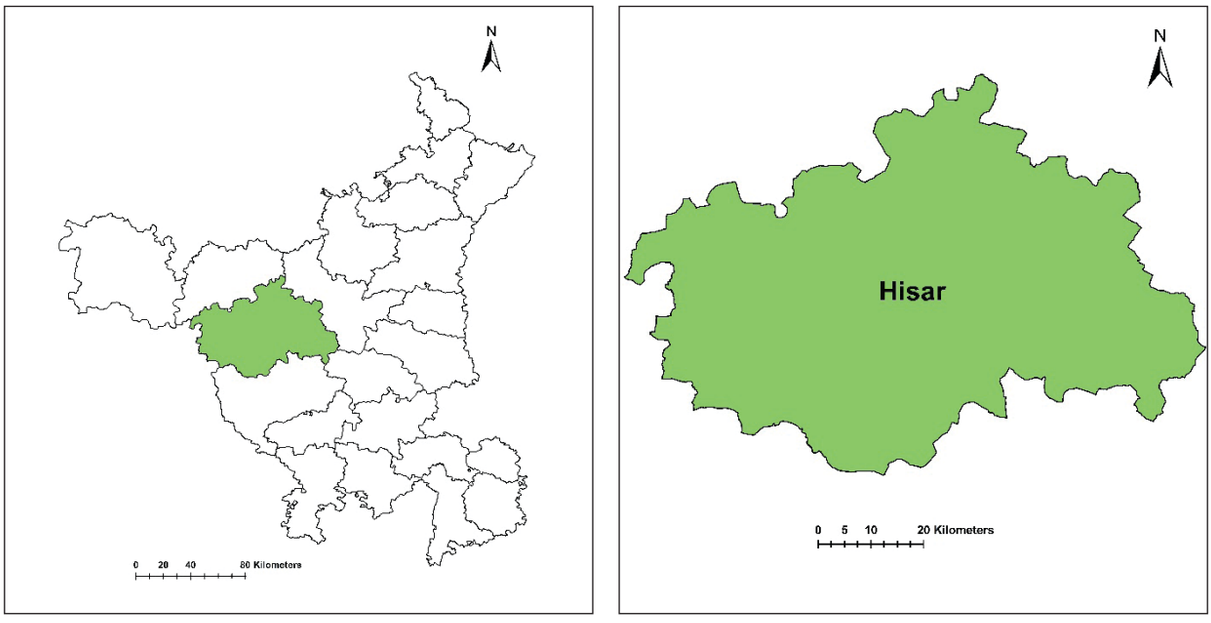


Fig.12 Location map of Hisar

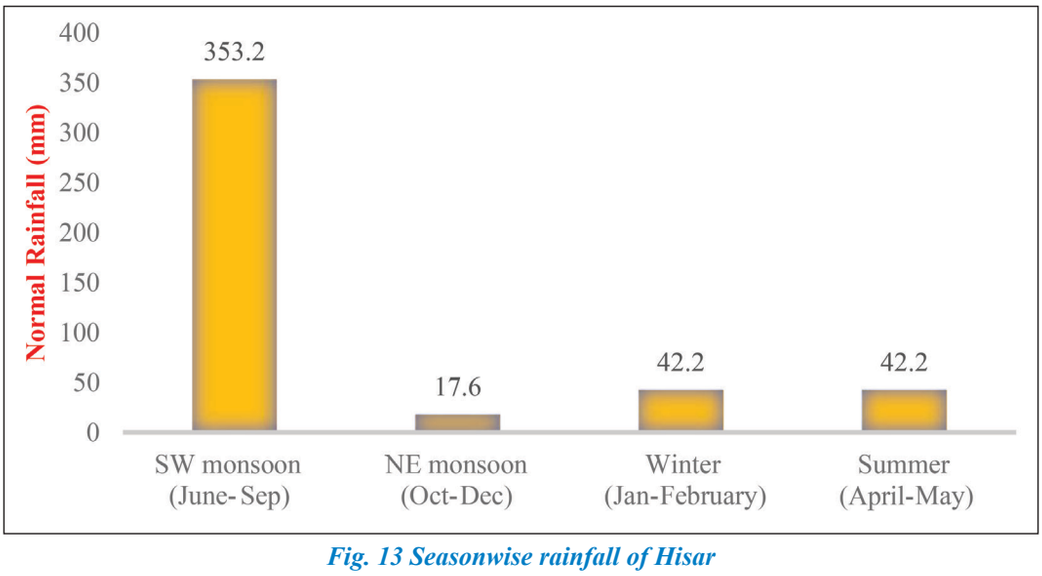


Fig. 13 Seasonwise rainfall of Hisar

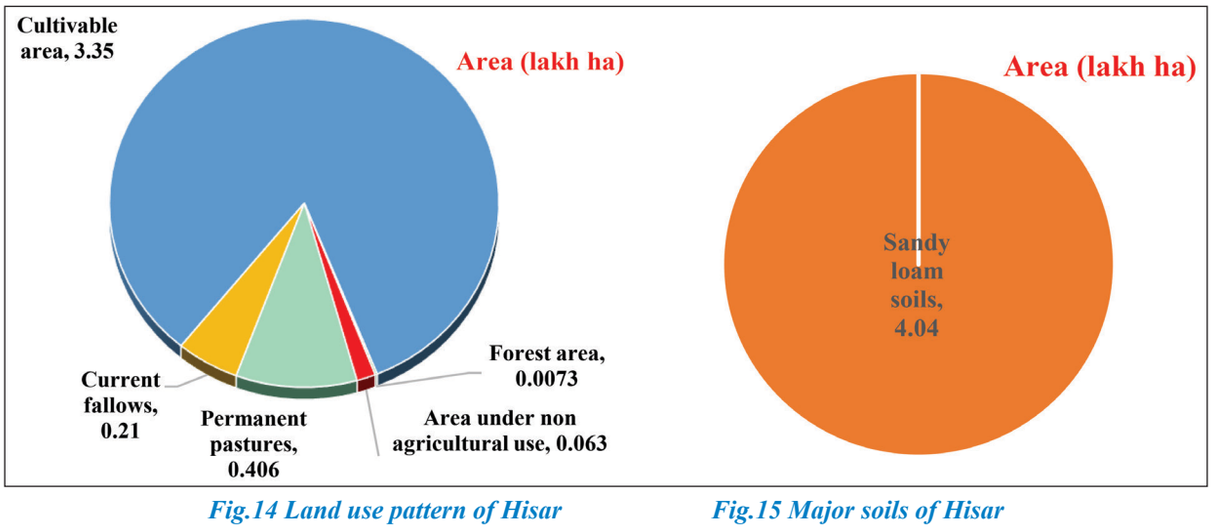


Fig.14 Land use pattern of Hisar

Fig.15 Major soils of Hisar

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

Major crops	Area (ha)			Production (t)			Productivity (t ha^{-1})	
	Kharif	*Rabi*	Total	*Kharif*	*Rabi*	Total	*Kharif*	*Rabi*
Bajra	29012	-	29012	70730	-	70730	2.44	-
Barley	-	791	791	-	2680	2680	-	3.39
Castor	367	-	367	227.5	-	227.5	0.62	-
Cotton	127688	-	127688	284600	-	284600	2.23	-
Gram	-	11.35	11.35	-	15228	15228	-	1.38
Groundnut	2614	-	2614	2825.7	-	2825.7	1.08	-
Guar seed	-	-	21420	-	-	21420	1.0	
Green gram	24263	-	24263	16984	-	16984	0.7	-
Rapeseed & mustard	-	107032	107032	-	205715	205715	-	1.92
Rice	82952	-	82952	239070	-	239070	2.88	-
Sesamum	100	-	100	80		80	0.8	-
Sugarcane	-	-	1989	-	166180	166180	83.5	
Wheat	-	206860	206860	-	960660	960660	-	4.64

1.3.4 Mahendergarh

Mahendergarh district is located between 29º 28′ N latitude and 76º 15′ E longitude with an altitude of 295 m above MSL. Western plain, Kachchh and part of Kathiawar peninsula, hot arid eco-region (ICAR), Trans Gangetic plain region (Planning Commission) and Western agroclimatic zone of Haryana (NARP). Mahendergarh district is situated at the extreme end of the south-west end of Haryana state. Its west-south borders and a large part of the eastern boundary, the Rajasthan region and the rest of the eastern boundary, along with the districts of Haryana, Rewari and northern part of Bhiwani district (Fig.16). The geographical area of the district is 1.94 lakh ha, out of which cultivable area and forest area is 1.52 lakh ha and 0.02 lakh ha respectively and different land use pattern of the districts are indicated in Fig.18. The gross cropped area of the district is 2.85 lakh ha out of which 1.52 lakh ha is net sown area and 1.33 lakh ha area is sown more than once. The area under rainfed and irrigated is 0.38 lakh ha and 2.47 lakh ha respectively. The source of irrigation in the district are canals and bore wells/tube wells. Wheat, cotton, rapeseed mustard, gram and bajra are the major field crops. Other horticulture crops like citrus, ber, guava are the major crops grown in the district (Table 1.4). Indigenous cattle, buffaloes, goat, sheep farming are widely adopted. The average annual rainfall of the district is 430.7 mm. Around 367.4 mm is received during Southwest monsoon (Fig.17). The predominant soils in the district are sandy loam and loamy sand soils. (Fig.19)

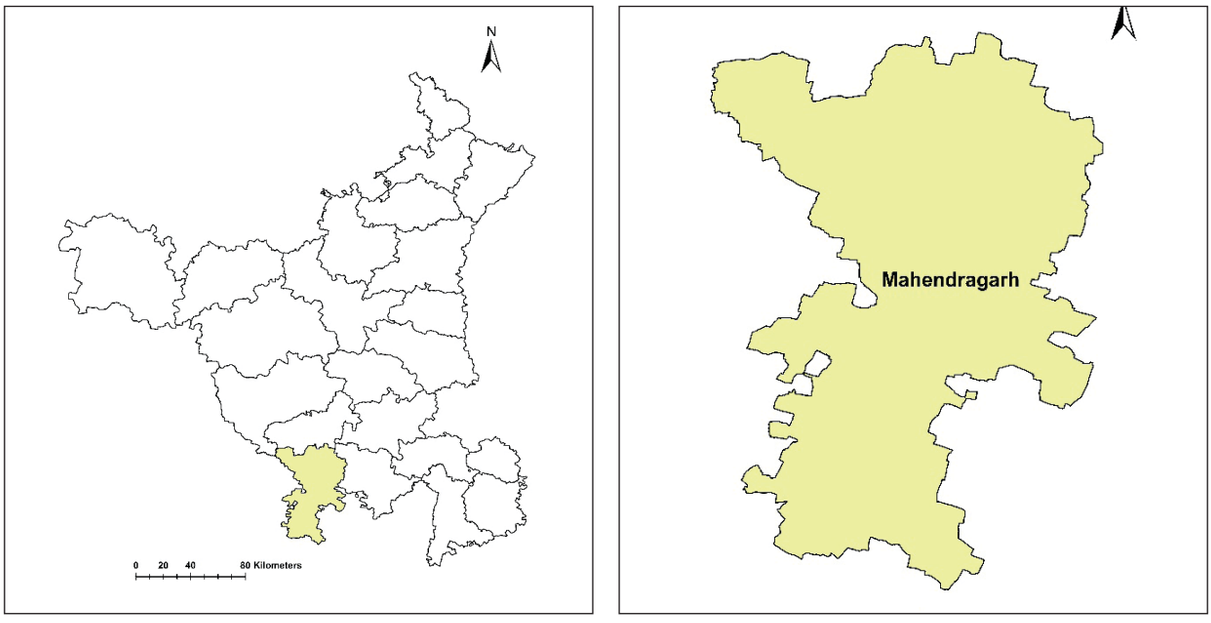


Fig.16 Location map of Mahendergarh

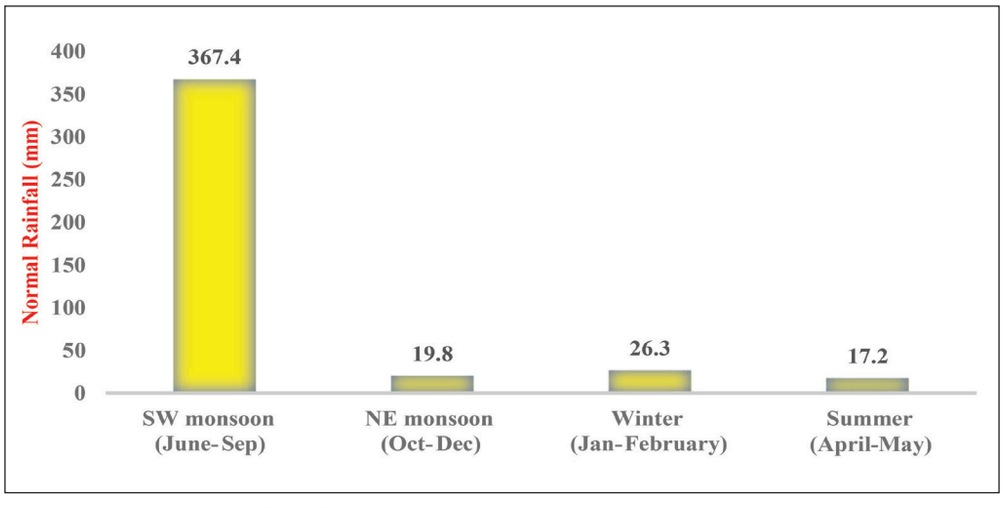


Fig.17 Season wise rainfall of Mahendergarh

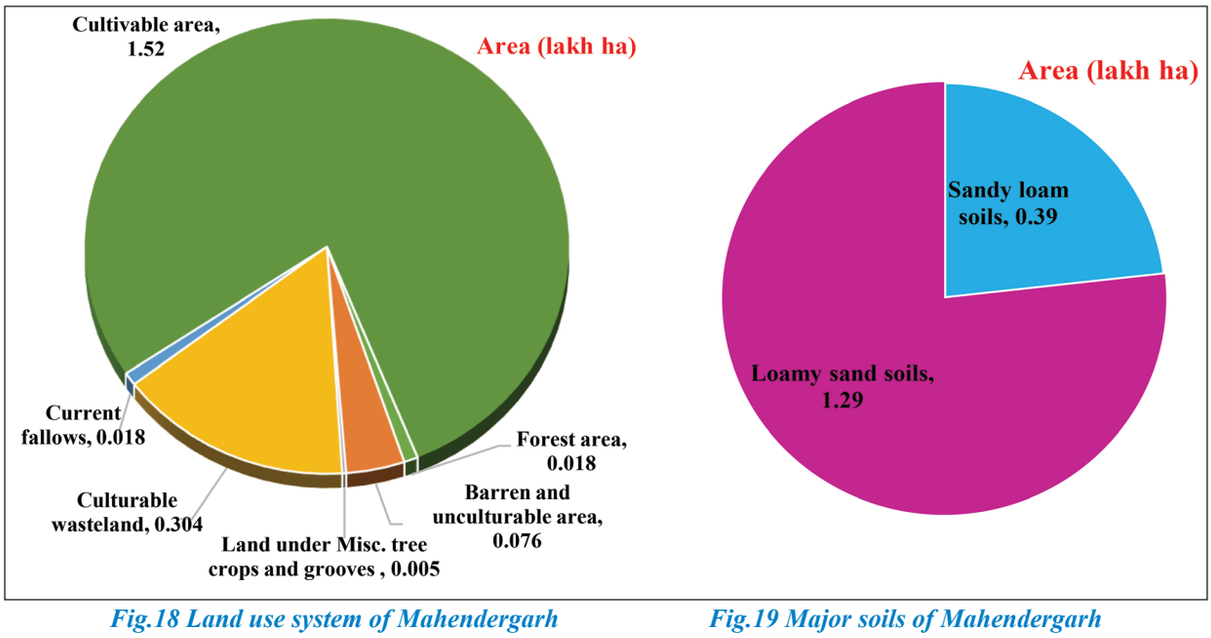


Fig.18 Land use system of Mahendergarh

Fig.19 Major soils of Mahendergarh

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

Major crops	Area (ha)			Production (t)			Productivity (t ha^{-1})	
	Kharif	*Rabi*	Total	*Kharif*	*Rabi*	Total	*Kharif*	*Rabi*
Bajra	108387	-	108387	303700	-	303700	2.8	-
Barley	-	144	144	-	500	500	-	3.47
Cotton	16884	-	16884	35200	-	35200	2.08	-
Gram	-	5667	5667	-	7044	7044	-	1.24
Groundnut	254	-	254	127	-	127	0.5	-
Guar seed	-	-	5000	-	-	4330	0.87	
Green gram	4731	-	4731	2379.7	-	2379.7	0.5	-
Peas & beans	-	1527	1527	-	2137.8	2137.8	-	1.4
Rapeseed & mustard	-	112504	112504	-	229170	229170	-	2.04
Wheat	-	25905	25905	-	120380	120380	-	4.65

1.3.5 Sirsa

Sirsa district is located between 29º 31′ N latitude and 75º 01′ E longitude with an altitude of 224 m above MSL. Western plain, Kachchh and part of Kathiawar peninsula, hot arid eco-region (ICAR), Trans Gangetic plain region (Planning Commission) and Western agroclimatic zone of Haryana (NARP). Sirsa district is in the western part of Haryana State. It is bounded by the state of Punjab on the north and east, state of Rajasthan on the south and east by the district Fatehabad (Fig.20). The geographical area of the district is 4.27 lakh ha, out of which cultivable area and forest area are 4.04 lakh ha and 0.056 lakh ha respectively. The different land use pattern of the districts are indicated in Fig.22. The gross cropped area of the district is 7.64 lakh ha. In this 3.93 lakh ha is net sown area and 3.70 lakh ha area is sown more than once. The area under rainfed and irrigated situations is 0.52 lakh ha and 7.12 lakh ha, respectively. The source of irrigation in the district are canals and bore wells/tube wells. Wheat, cotton, rapeseed mustard, gram and rice are the major field crops. Other horticulture crops like citrus, ber, guava, vegetables like radish and potato are the major crops grown in the district (Table 1.5). Indigenous cattle, buffaloes, goat, sheep farming is widely adopted. The average annual rainfall of the district is 391.1 mm. 76 % of the total rainfall is received during southwest monsoon (Fig.21). The predominant soils in the district are sandy loam and loamy sand soils. (Fig.23)

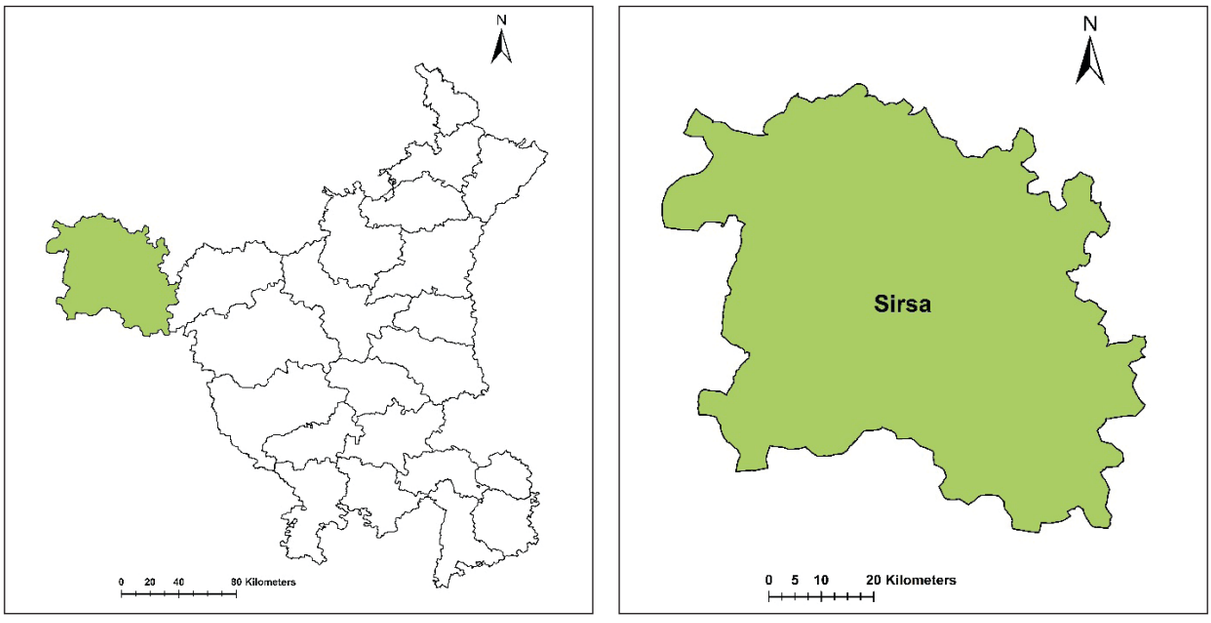


Fig.20 Location map of Sirsa

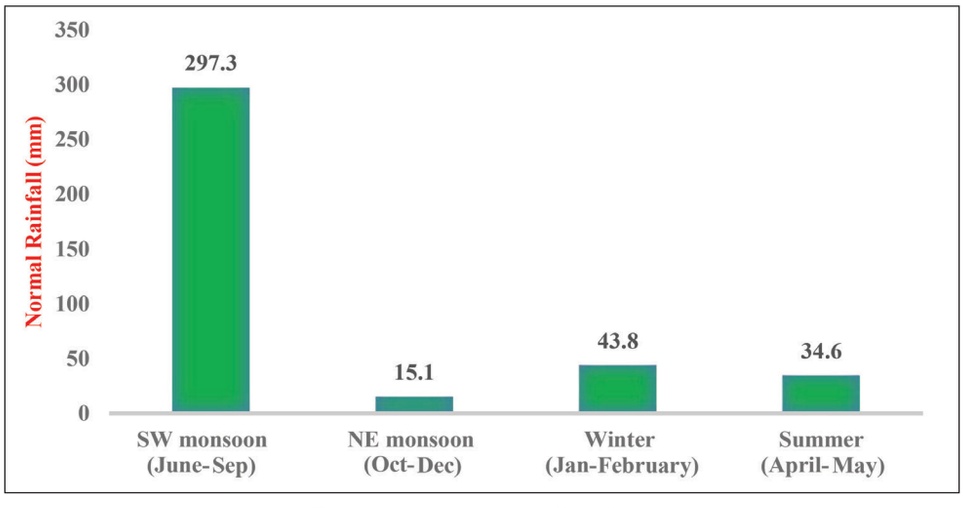


Fig.21 Seasonal rainfall of Sirsa

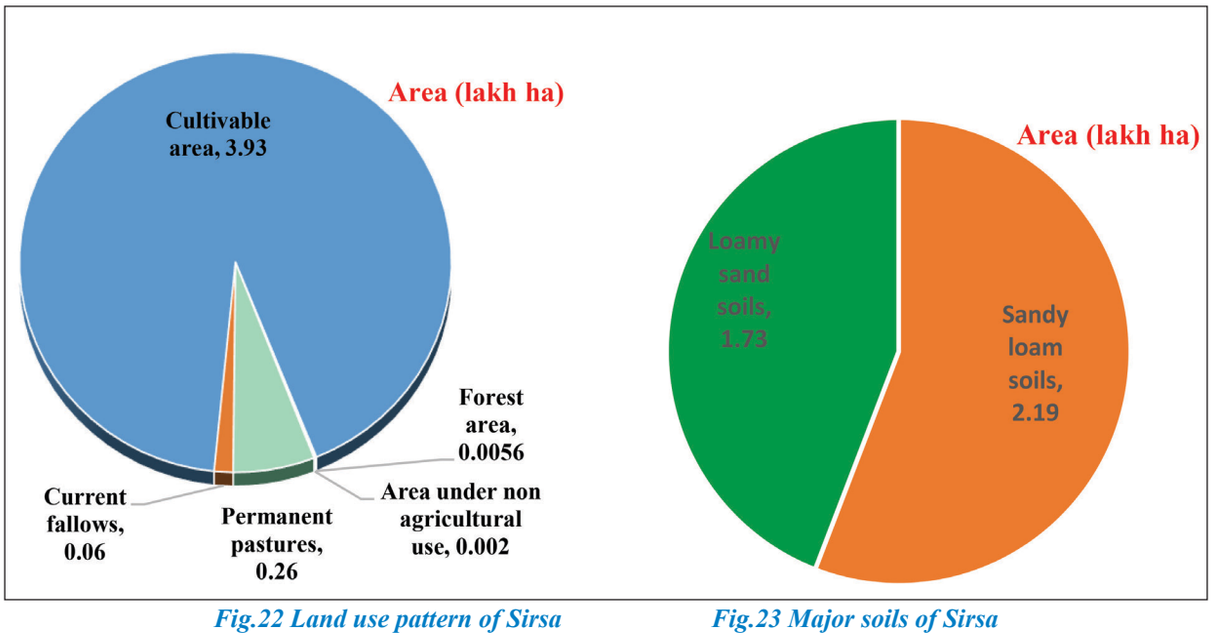


Fig.22 Land use pattern of Sirsa

Fig.23 Major soils of Sirsa

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

Major crops	Area (ha)			Production (t)			Productivity (t ha^{-1})	
	Kharif	*Rabi*	Total	*Kharif*	*Rabi*	Total	*Kharif*	*Rabi*
Bajra	6247		6247	17720	-	17720	2.84	-
Barley		529	529	-	1940	1940	-	3.67
Cotton	187543		187543	447800	-	447800	2.39	-
Gram		3315	3315	-	4462	4462	-	1.35
Groundnut	5059		5059	6065	-	6065	1.2	-
Guar seed			53212	-	-	42570	0.8	
Green gram	1885		1885	1129	-	1129	0.6	-
Peas & beans		245	245	-	245	245	-	1
Potato			640	-	-	8320	13	
Rapeseed & mustard		103861	103861	-	203359	203359	-	1.96
Rice	105541		105541	371930	-	371930	3.52	-
Sesamum	167		167	133.6	-	133.6	0.8	-
Wheat		257738	257738	-	1106470	1106470	-	4.29

1.3.6 Yamunanagar

Yamunanagar district is located between 30º 17′ N latitude and 77º 17′ E longitude with an altitude of 307 m above MSL. Northern Plain, Hot Subhumid (Dry) Eco-Region (ICAR), Trans Gangetic plain region (Planning Commission) and Eastern agroclimatic zone of Haryana (NARP). Yamunanagar district is situated on Northeastern tip of Haryana. It is bounded by Himachal Pradesh on North and Uttar Pradesh on Eastern side (Fig.24). Land is plain with Siwalik hills on northern side, some high cliffs can also be found on northern side. The geographical area of the district is 1.72 lakh ha, out of which cultivable area and forest area are 1.28 lakh ha and 0.14 lakh ha respectively (Fig.26). The gross cropped area of the district is 2.22 lakh ha out of which 1.13 lakh ha is net sown area and 1.08 lakh ha area is sown more than once. The area under rainfed and irrigated is 0.15 lakh ha and 2.07 lakh ha, respectively. The source of irrigation in the district are canals and bore wells. The major field crops were wheat, rice and sugarcane. Other horticulture crops like mango, guava, chikku and vegetables like cauliflower, radish and onion are the major crops grown in the district (Table 1.6). Indigenous cattle, buffaloes, goat, sheep farming is widely adopted. The average annual rainfall of the district is 952.2 mm of the total rainfall is received during Southwest monsoon (Fig.25). The predominant soils in the district are sandy loam and loamy sand soils. (Fig.27)

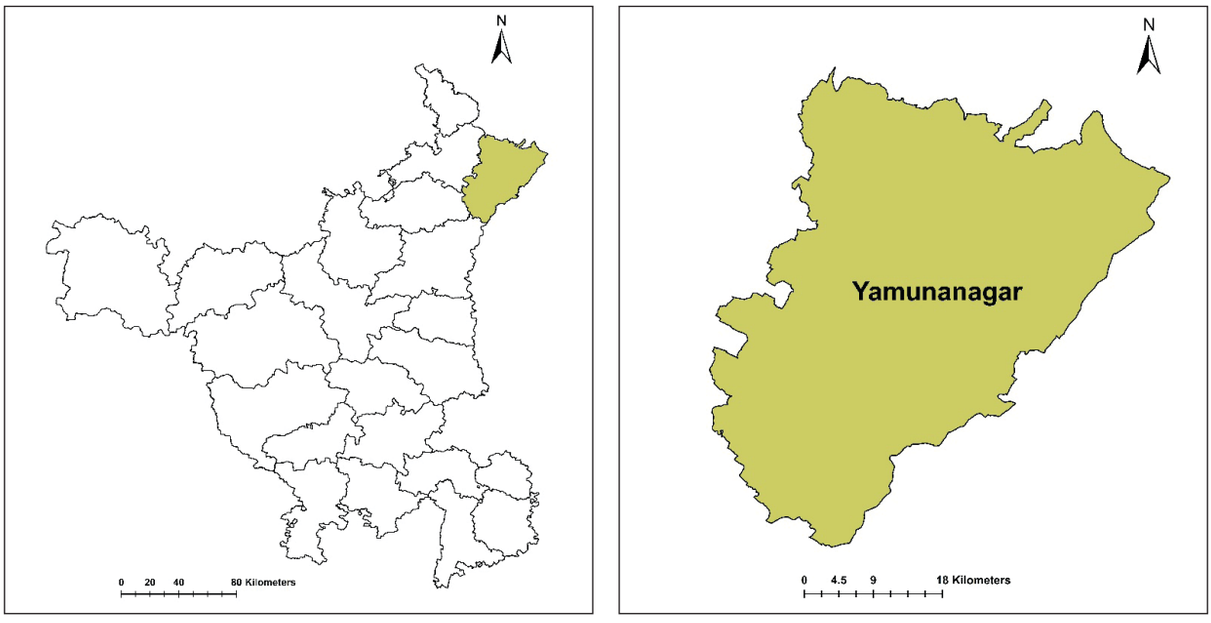


Fig.24 Location map of Yamunanagar

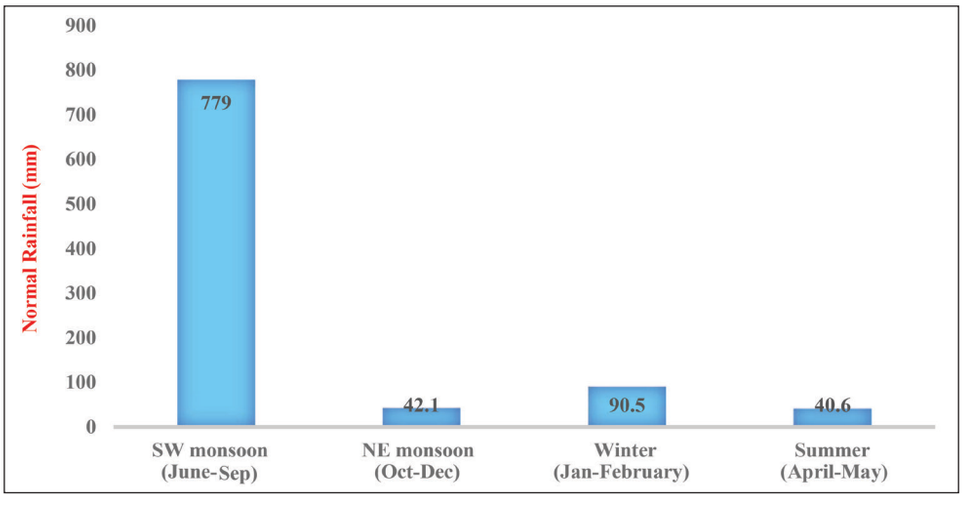


Fig.25 Season wise rainfall of Yamunanagar

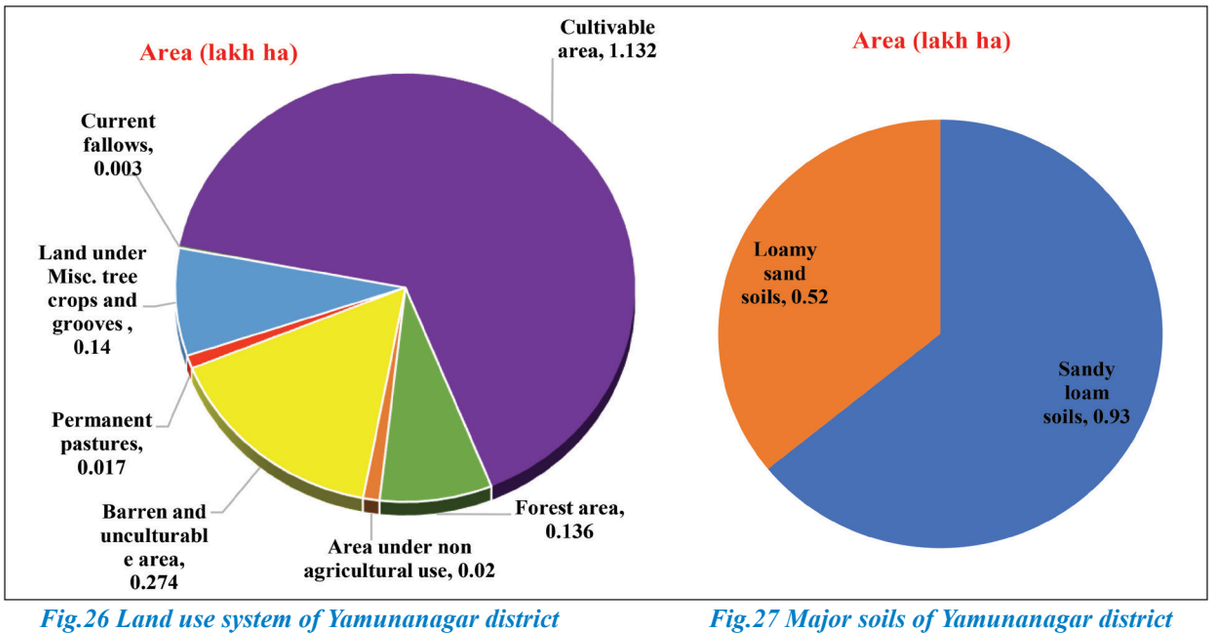


Fig.26 Land use system of Yamunanagar district

Fig.27 Major soils of Yamunanagar district

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

Major crops	Area (ha)			Production (t)			Productivity (t ha^{-1})	
	Kharif	*Rabi*	Total	*Kharif*	*Rabi*	Total	*Kharif*	*Rabi*
Bajra	183	-	183	420	-	420	2.3	-
Maize	1267	-	1267	5670	-	5670	4.48	-
Masoor	-	145	145	-	145	145	-	1
Onion	-	-	254	-	-	6295	-	24.7
Potato	-	-	1309	-	-	24871	19	
Rapeseed & mustard	-	5346	5346	-	6752	6752	-	1.26
Rice	88625	-	88625	394740	-	394740	4.45	-
Sugarcane	-	-	20190	-	-	1689260	83.6	
Sunflower	310		310	374.4	-	374.4	1.21	-
Wheat	-	94499	94499	426190	-	426190	-	4.51

2 Promising Climate Resilient Technologies

2.1 Promising Natural Resource Management Technologies

Laser land levelling for improved WUE and resource conservation

Laser land levelling at Hisar

Climate vulnerability: Drought and heat wave

Background

Water and soil are key factors for crop production. The agricultural land is undulating due to which the top fertile soil is severely eroded along with water and this led to water scarcity and poor soil fertility. Hence to address these challenges and increase the crop productivity, development of innovative and effective methods of soil and water conservation is the need of the hour.

Rice and wheat are the major cereal crops in Haryana, contributing to the approximately 80% to the production of food grains. The water requirement of rice-wheat system varies from 1382 mm to 1838 mm, where more than 80% water is required for paddy cultivation. The excessive groundwater usage and inappropriate management practices have raised a threat to the cultivation of these crops

Resilient technology

Laser land levelling is a solution for improving water use efficiency by reducing soil and water loss in the undulated lands. Laser land levelling with laser land leveller is a more advanced technique for levelling the land surface and smoothening the ground surface. Laser land leveller is a machine equipped with a laser guided drag bucket, it is much more effective and quicker in ensuring a flat table top like surface. Laser land levelling is a good agronomic crop-management and water-saving technology as it uses scarce groundwater optimally by ensuring even coverage. This method helps to increase the crop productivity, profitability and water use efficiency. Laser land leveller also helps to minimize run-off, water-logging and ensures equal distribution of water on field as compared to conventional practice

Performance and impact of technology

In NICRA villages (Bhodia Bhishoiyan and Sadalpur) KVK Hisar has demonstrated laser land levelling technology. The efforts of KVK helped in increasing significant progress in adoption of laser land levelling by farmers. The laser land levelling increased the cotton yield by 10.9% over control and resulted in net profit of ₹ 52540 ha^{-1} with B: C ratio of 1.9. Whereas traditional method of land levelling (farmers practice) realized a net profit of ₹ 42590 ha^{-1} with a B: C ratio of 1.77 (Table 2.1.1). The area under land levelling increased significantly in NICRA and adjoining villages in Hisar district.

Table 2.1.1: Impact of Laser land levelling on yield of seed cotton under rainfed condition

Intervention	Yield (kg ha^{-1})	Cost of cultivation (₹ ha^{-1})	Net returns (₹ ha^{-1})	B:C
Laser land levelling	1320	55700	52540	1.9
Conventional leveling	1190	54990	42590	1.7

Laser land levelling at Yamunanagar

Performance and impact of technology

In Yamunanagar district levelling, smoothing and shaping the field surface for preparation of proper seed bed in paddy was demonstrated. Effective land levelling reduced the crop failure and increased the yield and quality due to uniform water distributions in the root zone. Water saving to the tune 20 to 38.3% was recorded in laser levelled fields as compared to conventional method of levelling of fields. Laser land levelling helped to save ₹ 2860 ha^{-1} (Table 2.1.2).

Table 2.1.2: Impact of laser land levelling on paddy yield and economics

Name of intervention	Yield* (kg ha^{-1})	Cost of cultivation (₹ ha^{-1})	Gross returns (₹ ha^{-1})	Net return (₹ ha^{-1})	B:C	Remarks
Laser Land Leveling	4870	34600	107140	72540	3.09	Normal year
Conventional leveling	4690	33500	103180	69680	3.08	
Laser Land Leveling	4640	34600	102080	67480	2.95	Stress year
Conventional leveling	4460	33500	98120	64620	2.92	

***Average of 10 FLDs**





Laser land levelling at Bhodia Bhishoiyan and Sadalpur villages of Hisar district



Laser land levelling at Radauri village, Yamunanagar district

Laser land levelling in paddy -wheat system

Climate vulnerability: Drought and heat wave

Performance and impact of technology

The laser land levelling technology was demonstrated in the rice-wheat cropping system at Rupana Village of Sirsa District in Haryana. Laser land levelers were provided through custom hiring centers. The rice yields in the laser levelled fields were 7.1%, 9.5% and 9.1% higher in year 2020-21, 2021-22, 2022-23, respectively over farmers practice (Table 2.1.3). Furthermore, this technology helped in better water management, improved WUE, net returns, saving in time and energy in terms of pumping hours, reduced weed population and also reduced the cost. Approximately 86% of the farmers have successfully adopted the laser land levelling and practiced it regularly once in every two or three years.

Table 2.1.3: Performance of laser land levelling technology at Rupana village, Sirsa district

Year of trial	Yield (kg ha^{-1})		% increase in yield	Economics of demonstration (₹ ha^{-1})				Economics of FP (₹ ha^{-1})			
	Demo	FP*		Cost of cultivation	Gross returns	Net returns	B:C	Cost of cultivation	Gross returns	Net returns	B:C
2020-21	4500	4200	7.14	38500	103500	65000	2.69	36600	96600	60000	2.64
2021-22	4600	4200	9.52	39500	107640	68140	2.72	38000	98280	60280	2.59
2022-23	4800	4400	9.09	40250	153600	113350	3.82	38500	140800	102300	3.66

*FP: Farmers practice

Scope for upscaling

The technology can be scaled up by with the help of custom hiring centers established at village level under different projects or programs of state and union government.

- The laser land leveler was made available to farmers through custom hiring centers established under NICRA. Hence 90% of the farmers in nearby villages adopted this technology.
- **Horizontal spread:** Realizing the benefits of laser levelled fields in improving productivity along with saving of precious farm resources, area under laser land levelling has increased to 35000 ha in Yamunanagar.
- **Vertical spread:** Laser Land levelling was advocated by KVK Yamunanagar in the district and now 150 laser land levelers have been purchased by the farmers in Yamunanagar district.



Laser land leveller



Laser land levelled field



Control

Performance of laser land levelling in Paddy at Rupana village Sirsa district

Climate smart irrigation : Drip irrigation in cotton

Drip irrigation at Yamunanagar

Climate vulnerability: Drought and heat wave

Background

Water scarcity is one of the major problems for cultivation of crops. Cotton is one of the most important, commercial and fibre *kharif* crop grown under both rainfed and irrigated conditions. It needs 2 to 10 irrigations after cessation of monsoon under different soil and agroclimatic conditions and the consumptive use varies from 650 to 1000 mm in different states. The farmers use sprinkler system of irrigation for irrigating cotton crop. Though sprinkler system of irrigation is itself an efficient method but spread of water is not uniform. Hence a better irrigation application efficiency method than sprinkler method of irrigation is needed.

Resilient technology

Drip method of irrigation is known for improving uniform water application, crop stands, yields and stabilizing nutrient water interactions in irrigated and rainfed environments. Drip and micro sprinkler method of irrigation is a promising resilient technology to have better water use efficiency with the available water resources. Hence these technologies were demonstrated in cotton crop on farmer's field of NICRA villages, Yamunanagar during *kharif* 2023.

Performance and impact of technology

Observations recorded on performance of cotton crop raised with three different irrigation systems viz. drip, micro sprinkler and sprinkler system reveals that number of bolls per plant (35.6 bolls/plant) were highest in drip irrigation system. Flower and boll drop were also minimum in drip irrigated crop. In addition, sudden wilting which is one of the main problems noticed in sprinkler irrigated cotton growing areas was also minimum in drip irrigated crop. Seed cotton yield in drip irrigated crop was 43% and 50% higher than micro sprinkler and sprinkler irrigated crop (Table 2.1.4). The water use efficiency (WUE) in drip was 2.0 kg m^{-3} where as in micro sprinkler and sprinkler system the WUE was 0.7 and 0.38 kg m^{-3} respectively.

Table 2.1.4: Performance of cotton crop under different irrigation methods

Intervention	Yield (kg ha^{-1})	Cost of cultivation (₹ ha^{-1})	Net returns (₹ ha^{-1})	WUE (kg m^{-3})	B:C
Drip irrigation system	2620	75093	97827	2.00	2.30
Micro sprinkler irrigation system	1830	75093	45687	0.70	1.60
Sprinkler irrigation system	1750	75093	40407	0.38	1.53



Drip and micro sprinkler irrigation system in cotton at Yamunanagar district

Drip irrigation in cotton at Sirsa

Climate vulnerability: Salinity and heat wave

Performance and impact of technology

The study was conducted in Rupana village of Sirsa district. The observations indicated that the cotton yield in drip irrigation system increased by 7.31% (Table 2.1.5). The response of farmers and yield data indicated that approximately 68% farmers have successfully adopted drip irrigation and were practicing it regularly since last 2-3 years. The farmers also reported time and energy saving in terms of pumping hours, reduced weed infestation and cost saving.

Table 2.1.5: Performance of Drip irrigation in cotton in Rupana village of Sirsa district

Yield (kg ha^{-1})		% increase in yield	Economics of demonstration (₹ ha^{-1})				Economics of FP (₹ ha^{-1})			
Demo	FP*		Cost of cultivation	Gross returns	Net returns	B:C	Cost of cultivation	Gross returns	Net returns	B:C
2200	2050	7.31	36000	132000	96000	3.66	38000	127100	89100	3.34

*FP: Farmers practice

Scope for upscaling

This technology can be upscaled by providing subsidies to irrigation system components through state and central government schemes.



Drip irrigation in cotton at Rupana village of Sirsa district

Furrow Irrigated Raised Bed (FIRB) : A climate smart and resource efficient technology

Climate vulnerability: Frost and salinity

Background

In cotton-wheat cropping system farmers in Bhiwani district irrigate the crops through flood irrigation method, in which the entire field is irrigated through flood irrigation and flows across the soil surface. In this traditional method the major disadvantage is higher water requirement and lower WUE. This method also has substantial risks of water logging to the crops and soil salinization. Whereas the availability of water is limited and the cost of extraction of groundwater, storage and delivery is high. Hence there is a need for development of an efficient irrigation method.

Resilient technology

Furrow Irrigated Raised Bed (FIRB) is one of the most advanced agricultural technologies that play a significant role in reducing the irrigation water requirement. This system of raised bed planting of crops may be particularly advantageous in areas where groundwater levels are receding and herbicide-resistant weeds are a major problem. Moreover, formation of raised bed and furrows in sandy loamy or clayey textured soil is feasible, which are commonly found across Bhiwani. The raised bed and furrow can be easily formed with locally available tools and can be maintained over several growing seasons. In this method beds of 40-130 cm width, 10-20 cm height and furrows of 20-50 cm wide are made. Seeds were sown on top of the beds and the crop is irrigated through the furrows, which ensures the crops to be irrigated uniformly and soils maintain ideal moisture conditions. After wheat the bed-furrow system is suitable for rotating crops like rice, cotton or legumes. This technology substantially decrease the cost of production and the pressure on resources in dryland areas. Furthermore, infiltration of rainwater is higher in the furrows this results in reduction in soil erosion and irrigation water needs. In this technique optimal soil moisture can be maintained and nutrient availability throughout the season, ensuring higher grain yields and returns on investments are realized.

Performance and impact of technology

Furrow irrigated raised bed method is suitable where flooding is traditionally practiced and where freshwater resources are limited. Soil in the furrows is placed on top of the raised bed with a handheld hoe or tractor-mounted plough and then levelled with a harrow. Weeds growing in the furrows were removed manually or mechanically, and those in between the crop are controlled by spraying herbicide on the bed. FIRB method was demonstrated in 8 ha area, an improved wheat variety HD 3086 was sown. The furrow irrigated raised bed recorded 24%,16%, 24%, 32% and 6% higher yield, cost of cultivation, GMR, NMR and B:C ratio respectively.

Similarly, in Cotton, FIRB method with improved varieties recorded higher yields, cost of cultivation, GMR, NMR and B:C ratio of 27%,15%, 20%, 57%, and 10% respectively (Table 2.1.6).

Table 2.1.6: Impact of furrow irrigated raised bed on yield and economics of wheat and cotton crops at Lohani and Dhareru villages, Bhiwani district

Intervention	Yield (kg ha^{-1})	Cost of cultivation (₹ ha^{-1})	Gross returns (₹ ha^{-1})	Net returns (₹ ha^{-1})	B:C
a) FIRB method (Wheat)	2030	20105	43254	23149	2.15
Farmer's practice: Flatbed	1640	17290	34839	17549	2.02
b) FIRB method (Cotton)	1520	79500	127680	50180	1.60
Farmer's practice: Flatbed	1200	68900	100800	31900	1.46

Scope for upscaling

The technology can be spread through convergence with state department by creating awareness programmes, group meetings *etc*.



FIRB system in cotton at Dhareru village, Bhiwani district

FIRB system in Wheat at Lohani village, Bhiwani district

Zero tillage in wheat : A climate resilient strategy for heat stress and drought mitigation

Background

Haryana is an important wheat growing state in the country. It produces 10.5 Mt of wheat with a productivity of 4.21 t ha^{-1}. Many farmers grow late-maturing, fine-grained basmati varieties of rice, this leads to late sowing of wheat. Delayed sowing of wheat leads to heat stress and drought to the crop which led to low yields in Sirsa and Mahendragarh districts.

Resilient technology

To avoid delay in planting and reduce the cost of production, Zero till sowing a resource conservation technology was recommended in wheat. This technology is an important alternative to save scarce resources and enhance the net farm income. Apart from this there is better germination, vigour, due to availability of soil moisture for a longer period, reduces lodging and matures early this helps in remitigation of terminal heat stress

Zero tillage in wheat in Sirsa district

Climate vulnerability: Salinity and drought

Performance and impact of technology

The study was conducted in village Rupana of Sirsa district from 2022-2023. The wheat yields in zero tillage increased by 2.1%, Zero tillage recorded 12 % lower cost of cultivation, 7 and 14 % higher net returns and B:C ratio respectively (Table 2.1.7). The lower cost of cultivation is due to reduced tillage operations and number of irrigations. Besides this the farmers also reported saving of time and energy. This higher yield and net returns led to adoption of the technology by 88% farmers.

Table 2.1.7: Performance of zero tillage in wheat at Rupana village, Sirsa district

Yield (kg ha^{-1})		Economics of demonstration (₹ ha^{-1})				Economics of FP (₹ ha^{-1})			
Demo	FP	Cost of cultivation	Gross returns	Net returns	B:C	Cost of cultivation	Gross returns	Net returns	B:C*
4900	4800	34000	156800	122800	4.61	38500	153600	115100	3.99

*Benefit:cost ratio

Zero till wheat sowing using Happy Seeder at Mahendragarh

Climate vulnerability: Drought and heat

Resilient technology

Demonstrations on zero tillage technology in wheat were conducted at farmers' fields of NICRA villages Happy Seeder was used for seeding the crop in demonstration plots and performance of crop was compared with crop sown by conventional tillage. Adoption of zero tillage had several advantages. The main advantage is better and early germination, better seedling growth, retention of higher soil moisture for longer period, comparatively low lodging and advancement in crop maturity by a week, this helped in reducing terminal heat stress.

Performance and impact of technology

An additional yield advantage of 13.4% was realized in zero till sown crop over conventional crop. Zero tillage recorded 21% lower cost of cultivation and 36 % higher net returns over conventional tillage (Table 2.1.8).

Table 2.1.8: Impact of Happy Seeder on wheat at Mahendergarh district

Intervention	Yield (kg ha^{-1})	Cost of cultivation (₹ ha^{-1})	Gross return	Net returns (₹ ha^{-1})	B:C
Happy Seeder	4560	27420	100320	72900	3.65
Farmers practice: Broadcasting	4020	34900	88440	53540	2.53

Scope for upscaling

The technology can be scaled up by making the equipment available through custom hiring centers. The custom hiring centres also can be established by convergence with various programmes being implemented by the state government and central government.



ZT wheat sowing at Mahendergarh district

Residue recycling with Happy Seeder : A sustainable alternative to stubble burning in rice-based cropping systems"

Climate vulnerability: Frost

Background

In India, rice is a major crop under cultivation. This crop generates a large amount of residues. In India the crop residues are burned to make the field ready for the next *rabi* crop sowing. The burning of the residues cause excessive particulate matter emissions, this causes poor air quality and also imposes health hazards and this also contributes to global warming. Hence to recycle the crop residues to the soil and sow the crop in the residues an efficient planter is required.

Resilient technology

Happy Seeder a tractor-mounted machine that cuts the residues and enables wheat sowing in standing rice stubbles is a promising technology. The wheat crop can be sown immediately after harvest of the rice crop without harvesting of rice residues. Hence this not only stops rice straw burning, but also helps to improve soil fertility by incorporation of organic matter in the soil, besides reducing fuel consumption for tillage this implement helps in timely sowing of wheat crop.

Performance and impact of technology

Realizing the benefits, farmers have shown interest towards this technology and hence almost 65% area is sown using Happy seeder machine during *rabi* season. Happy Seeder technologies has advantages over conventional tillage like reduction in number of irrigations, saving of diesel fuel (almost 13 liters $acre^{-1}$), early sowing of wheat (no pre-irrigation is required), less *Phalaris minor* population (due to stubble coverage). Besides these advantages Happy Seeder uniformly place the seeds and presses the chopped paddy straw in an inter-row area as mulch. This facilitates better germination, emergence, vigorous initial crop establishment, better weed control and higher yield. Recycling of paddy straw instead of burning can improve the soil nutrient status, and improves soil organic content and soil physical properties.

The net returns obtained from Happy Seeder sown wheat crop is 20 and 26 % in normal and stress years respectively as compared to conventional tillage (Table 2.1.9).

Table 2.1.9: Impact of happy seeder on wheat in Radauri village, Yamunanagar district

Treatments	Yield (kg ha^{-1})	Cost of cultivation (₹ ha^{-1})	Net returns (₹ ha^{-1})	B:C	Remarks
CT Broadcasted wheat	5400	36740	51172	2.39:1	Normal year (2017-18)
Happy seeder sown wheat	5600	29600	61887	3.09:1	
CT Broadcasted wheat	4900	37500	57595	2.53	Stress year (2020-21) Terminal heat stress
Happy seeder sown wheat	5400	30100	73080	3.42	

Scope for upscaling

The technology can be scaled up by making available the equipment through custom hiring centers through various programmes which were being implemented by the state government and central government.











Rice residue recycling and wheat establishment with happy seeder at Yamunanagar district

Direct Seeded Rice (DSR) for resource conservation and climate resilience

Climate vulnerability: Frost

Background

Rice is cultivated through manual transplanting under puddled conditions using large quantity of ground water. This method uses large quantity of water and hence depletes ground water. In addition puddled transplanting method releases methane and huge drudgery demanding higher cost of production.

Resilient technology

Direct Seeded Rice (DSR) is an efficient resource conserving technology in general and water in particular. After field preparation the field is laser levelled and a pre-sowing irrigation is given. Rice seeds are directly drilled to a depth of 2-3 centimetres into the prepared fields at optimum moisture level with DSR drill. Stomp 30 EC (Pre-emergence weedicide) @ 1 litre $acre^{-1}$ dissolved in 150 litres of water is sprayed after sowing on moist soil. This is a labour and water saving technology.

Performance and impact of technology

DSR requires less labour and mature faster than transplanted rice. In this method, plants are not subjected to transplanting shock. However, they have more competition from weeds, which if managed properly can not only improve yield of rice but also saves the precious water, energy and resources. The importance of DSR technology is being realized by the farmers of the Yamunanagar district and as such area under DSR has increased to 4500 acres in district.

Economics: Frontline trials clearly show economic advantages in DSR over puddled transplanting. DSR compared with conventional transplanting had a lower cost of production to the tune of ₹ 3942 ha^{-1} on an average, over conventional transplanting with out much yield difference (Table 2.2.10). In September, 2018 there was heavy rainfall, *i.e.* 179 mm in three days. This lead to flower drop and lodging in conventional sown rice, whereas in DSR due to better water permeability, less lodging and lower yield reduction was observed.

Table 2.2.10: Performance of DSR at Radauri village, Yamunanagar district

Name of intervention	Yield (kg ha^{-1})	Cost of cultivation (₹ ha^{-1})	Gross returns (₹ ha^{-1})	Net returns (₹ ha^{-1})	B:C	Remarks
Direct Seeded Rice (DSR)	6500	30420	98270	67850	3.23	Normal year 2021
Conventional sown Rice	6580	35500	99408	63908	2.08	
Direct Seeded Rice (DSR)	4870	29540	73050	43510	2.47	Stress year 2018
Conventional sown Rice	4600	35660	69000	33340	1.93	

Scope for upscaling

The importance of DSR technology is being realized by the farmers of the Yamunanagar district and as such area under DSR has increased to 4500 acres in district. After the success of the technological intervention, Haryana government has also provided 50% subsidy on DSR machine and paddy seeds.



DSR *Lodging in transplanted rice*

Performance of DSR Rice at Radaurai village in Yamunanagar district

2.2 Promising Crop Production Technologies

Promising drought tolerant pulse varieties

MH 421 : A promising drought tolerant greengram variety

Climate vulnerability: Drought and heat wave

Background

Fatehabad region receives very low rainfall, but the farmers of this region use traditional long duration varieties of pearlmillet and clusterbean, which cannot withstand the dry spells at different growth stages and hence lower yields were obtained. Pulse crops are not in practice of cultivation. Inclusion of short duration pulse crops like greengram in cropping sequence under such conditions will bring sustainability in the system. Greengram has the ability to grow in harsh climates with low rainfall and poor to medium soil conditions. In addition the short duration greengram can be grown as summer crop after wheat. This improves economic returns of the farmers. Rapid-growing, early-maturing varieties make it a valuable crop in various cropping systems.

Resilient technology

A short duration green gram variety of 60 days duration which is resistant to yellow vein mosaic virus, tolerate long dry spells and escape the moisture stress is resilient technology as compared to traditional varieties. The fodder of these green gram varieties, can be used as feed to the cattle as it is rich in nutrients. Moreover, this legume crop, can improve soil fertility by fixing atmospheric nitrogen and enhance soil productivity as it is a legume crop.

Performance and impact of technology

Short duration and drought tolerant green gram variety MH-421 recorded mean yield of 345 kg ha^{-1} which was 22% and 18% higher yield and net returns respectively than that of traditional variety (Table 2.2.1). The crop faced dry spells in July and August months during the year 2022-23, in NICRA villages of Fatehabad. MH 421 is a short duration variety hence this variety can escape terminal drought and it recorded higher yields.

Table 2.2.1: Performance of short duration greengram variety MH-421 at Bodiwali village, Fatehabad district

Intervention	Yield (kg ha^{-1})	% higher yield than non-NICRA farmers	Net returns (₹ ha^{-1})	% higher net returns than non-NICRA farmers
Green gram variety MH-421	345	22	24791	18
Farmers practice: Local variety	282		21010	

Scope for upscaling

The technology is scaled up by creating awareness through field day on green gram production technology at Bodiwali village, Fatehabad district.



Field day on greengram production technology in Bodiwali village, Fatehabad district



Short duration greengram variety MH 421 at Bodiwali village Mahendergargh district

Short duration drought tolerant green gram and clusterbean varieties

Climate vulnerability: Drought and heat wave

Performance and impact of technology

In low soil organic carbon and less water availability regions of Hisar district, demonstrations were conducted on short duration and drought tolerant varieties of green gram (MH 421) and cluster bean (HG 2-20). A 13.6% and 10.7% increase in grain yield of greengram and clusterbean respectively was recorded with maximum net returns and higher B: C ratio compared to local check (Table 2.2.2). In NICRA villages nearly, 85% farmers have adopted short duration and drought tolerant varieties and are proven boon for farmers as compared to the traditional variety.

Table 2.2.2: Response of short duration and drought tolerant greengram and clusterbean varieties on grain yield and economics

Intervention	Yield (kg ha^{-1})	Cost of cultivation (₹ ha^{-1})	Net returns (₹ ha^{-1})	B:C	% increase in yield
Short duration green gram variety (MH421)	750	22300	33368	2.5	13.6
Local Check	660	21750	29434	2.3	
Drought tolerant clusterbean variety (HG 2-20)	1240	21750	32805	2.5	10.7
Local Check	1120	21750	26458	2.2	

Scope for upscaling

Total 85 % farmers of two adjoining village have adopted these varieties for economic gain. The seed of these varieties were made available through CCS HAU Hisar and state seed organisation.



Greengram variety MH421 at Bhodia Bhishoiyan village, Hisar district







Clusterbean variety HG 2-20 at Bhodia Bhishoiyan village, Hisar district

Crop diversification with short duration green gram var. MH-421

Climate vulnerability: Drought and heat wave

Performance and impact of technology

In Gadania and Bairawas NICRA villages of Mahendragarh district, greengram variety MH 421 was introduced. It was 58-62 days duration. Average yield of the crop recorded from fields of NICRA farmers was 6400 kg ha^{-1} which was 23% higher than yield realised by non- NICRA farmers and provides an additional net returns of ₹ 3791 ha^{-1} (Table 2.2.3). Looking at the sustainability of the crop in NICRA villages, farmers are desirous of inclusion of greengram in cropping system.

Table 2.2.3: Performance of short duration greengram variety MH 421 at Gadania and Bairawas villages of Mahendergarh district

Interventions	Yield (kg ha^{-1})	Cost of cultivation (₹ ha^{-1})	Gross returns (₹ ha^{-1})	Net returns (₹ ha^{-1})	B:C
Short duration green gram variety (MH421)	6400	21972	32670	10698	1.49
Local Check	5200	20186	27093	6907	1.34

Scope for upscaling

The technology can be spread to the entire district through convergence with state department activities.



Short duration greengram variety MH 421 at Gadania village, Mahendergarh district

Short duration summer mungbean var. MH-421

Climate vulnerability: Salinity and heat wave

Performance and impact of technology

The summer mung variety MH-421 was demonstrated in NICRA village- Rupana and Nirban of Sirsa district. The improved variety produced 15% and 50% higher yield in 2021-22 and 2022-23 over local variety (SML-668) in the village (Table 2.2.4). The inclusion of mungbean in the existing cropping system enhanced annual farm income of farmers in the village. As a result of successful demonstrations of the intervention, the variety is very popular among farmers.

Table 2.2.4: Performance of short duration summer moong var. MH-421 under crop diversification at Rupana and Nirban village, Sirsa district

Yield (kg ha^{-1})		% Increase in yield	Economics of demonstration (₹ ha^{-1})				Economics of farmers practice (₹ ha^{-1})			
Demo	FP*		Cost of cultivation	Gross returns	Net returns	B:C	Cost of cultivation	Gross returns	Net returns	B:C
750	650	15	17000	37500	20500	2.20	16000	32500	16500	2.03
300	200	50	7000	20400	13400	2.91	6500	13600	7100	2.09

* Farmers practice

Scope for upscaling

As a result of successful demonstrations of the intervention, the variety is very popular among farmers. The technology can be spread to the entire districts through convergence with state department activities like field day and farmers visit programmes.







Summer mung variety MH-421 at Nirban village, Sirsa district

Pusa hydrogel and HG 2-20 drought tolerant cluster bean for soil moisture storage

Climate vulnerability: Drought and heat wave

Background

Poor soil moisture is the limiting factors for successful cultivation of crops in NICRA villages. There are instances of either complete failure of crops or very low yield is realize in rainfed dry land conditions. Hence selection of crops and the technologies for improving soil moisture is needed.

Resilient technology

PUSA hydrogel, a moisture absorbent helps in retention of soil moisture for longer period. HG 2-20 is a drought tolerant variety was demonstrated along with PUSA hydrogel application.

Performance and impact of technology

Pusa hydrogel application @ 2.5 kg ha^{-1} and cultivation of HG 2-20 recorded 20-21% higher yield and ₹ 8327 ha^{-1} additional net returns as compared to non-NICRA farmers (Table 2.2.5).

Table 2.2.5: Impact of short duration improved clusterbean variety HG 2-20 and PUSA hydrogel application

Intervention	Village 1		Village 2	
	Yield (kg ha^{-1})	Net returns (₹ ha^{-1})	Yield (kg ha^{-1})	Net returns (₹ ha^{-1})
Improved variety (HG 2-20) and Pusa hydrogel @ 2.5 kg ha^{-1}	1190	36807	1280	39590
Farmers' practice : Local variety	980	28480	1060	30805

Scope for upscaling

The technology can be spread to the nearby villages through convergence with state department activities.



Short duration cluster bean variety HG 2-20 at Bairawas village Mahendergragh district

Crop diversification with pulses a climate resilient and resource conservation technology

Crop diversification with Guar for resource conservation

Climate vulnerability: Drought and heat wave

Background

Monocropping was usually practiced in both *kharif* and *rabi* season. This monocropping ultimately decrease the fertility of soil. Hence, higher dose of fertilizers has to be applied for realising higher yield. Therefore reduction in fertilizer use is the need of the hour. Therefore, crop diversification has to be done. Crop diversification with pulses improves soil health as it fixes atmospheric nitrogen. Hence fertilizer nitrogen can be saved in crops cultivated after pulses. The soil microbes are improved. This helps in soil health improvement. Hence pulses were recommended in the crop rotation.

Resilient technology

India is the largest producer of guar and contributes 80% of total production in the world. Guar crop is cultivated mainly during *kharif* season. The crop diversification with Guar saves water and time by early harvesting. Hence crop diversification with Guar crop is a promising resilient technology.

Performance and impact of technology

The average yield of guar crop was 570 kg ha^{-1} which gave gross returns, net returns and B:C ratio of ₹ 29700, ₹ 13500 ha^{-1} and 1.83 respectively. The gross cost of the production was ₹ 16200 (Table 2.2.6).

Table 2.2.6: Yield and economic benefits by guar production at Bodiwali and Banmandori villages of Fatehabad district

Intervention	Yield (kg ha^{-1})	Cost of cultivation (₹ ha^{-1})	Gross returns (₹ ha^{-1})	Net returns (₹ ha^{-1})	B:C
Guar	570	16200	29700	13500	1.83

Scope for upscaling

This technology can be upscaled through field demonstration and field days.



Crop diversification with guar at Bodiwali and Banmandori villages, Fatehabad district



Awareness on production technology

Crop diversification with GNG-2171 chickpea

Climate vulnerability: Salinity and heat wave

Performance and impact of technology

The gram variety GNG-2171 was demonstrated in NICRA village Rupana and Nirban of Sirsa district. The improved variety produced 9% higher yield in 2019-20 and 11% higher yield in 2021-22 and 2022-23 in comparison to local variety or other popular variety in the village (Table 2.2.7). The inclusion of chickpea in the existing cropping system enhanced annual farm income of farmers in the village.

Table 2.2.7: Performance of chickpea variety GNG-2171 under crop diversification at Rupana and Nirban village, Sirsa district

Year of trial	Yield (kg ha^{-1})		% increase in yield	Economics of demonstration (₹ ha^{-1})				Economics of FP (₹ ha^{-1})			
	Demo	FP*		Cost of cultivation	Gross returns	Net returns	B:C	Cost of cultivation	Gross returns	Net returns	B:C
2019-20	2130	1950	9	24600	96000	71400	3.9	24000	88000	64000	3.6
2021-22	2000	1800	11	19500	90000	70500	4.6	19000	81000	62000	4.3
2022-23	2000	1800	11	19500	108000	88500	5.5	19000	97200	78200	5.1

*Farmers practice

Scope for upscaling

The success of this intervention, made the chickpea variety GNG-2171 very popular among the farmers. This variety can be upscaled through state agriculture departments and seed banks.



Chickpea variety GNG-2171 at Rupana and Nirban village, Sirsa district

KRL-210 salt tolerant wheat variety

Climate vulnerability: Salinity and heat wave

Background

In Sirsa District of Haryana, about 3000 ha area is salt affected. Similar conditions exist in village Rupana, where the salt affected land are left barren due to low crop yields. The soil salinity is a severe abiotic stress caused primarily due to abundance of sodium chloride, from both natural accumulations and from irrigation and crop evapotranspiration. Salinity can reduce yield with a significant metabolic affect which effects plant adaptation, growth maintenance and stress responses with a subsequent decrease in yield.

Resilient technology

In *rabi* season, the traditional wheat varieties could not withstand owing to higher salt accumulation in root zone. The salt tolerant wheat variety KRL-210 developed by CSSRI have better resilience and increased adaptability to salt affected area and offer better opportunity to harvest reasonable wheat yields. This variety helps in transforming the traditional farming into an ecologically sustainable and profitable venture.

Performance and impact of technology

The demonstrations of salt tolerant wheat variety KRL-210 with improved crop production technology were conducted in Rupana village of Sirsa district. The improved variety produced significantly higher yields (69%) when compared with local variety (Table 2.2.8). The impact of salt was less in KRL-210 variety and the technology was proven to be effective to mitigate income sustainability problems.

Table 2.2.8: Performance of salt tolerant wheat variety KRL-210 at Rupana village, Sirsa district

Particular	Yield (kg ha^{-1})	Cost of cultivation (₹ ha^{-1})	Gross returns (₹ ha^{-1})	Net returns (₹ ha^{-1})	B:C
Salt tolerant wheat variety (KRL 210)	3300	33850	64772	30922	1.92
Traditional variety	1950	33600	39790	6190	1.18

Scope for upscaling

The results enhanced the adoption of this variety in the village at large scale as well as in nearby villages where the land is affected by salt. The demonstrations created awareness among the farmers.



Salt-tolerant wheat KRL-210 at Rupana village, Sirsa district

Improved wheat variety WH 1142 is boon for limited irrigation conditions

Climate vulnerability: Drought and heat wave

Background

In Haryana about 20 % of the total geographical area is under rainfed. There is a scarcity of surface water. Groundwater is mostly brackish. In this rainfed conditions cultivation of wheat is slightly challenging due to limited availability of water. Hence a drought tolerant wheat variety is required.

Resilient technology

A wheat variety WH 1142 which is suitable for limited irrigated condition is most viable alternative for more production and productivity of wheat.

Performance and impact of technology

Total 40 demonstrations on wheat variety WH 1142 were conducted in 18 ha area which resulted in 7.5 % increase in yield with maximum net returns of ₹ 67448 and higher BC ratio of 2.8 as compared to local check (2.6) (Table 2.2.9). In the district 73 % of the farmers have adopted this variety which performed better over local variety.

Table 2.2.9: Response of improved wheat variety WH 1142 under limited irrigation condition at Hisar district

Intervention	Yield (kg ha^{-1})	Cost of cultivation (₹ ha^{-1})	Net returns (₹ ha^{-1})	B:C	% increase in yield
Improved wheat variety (WH 1142)	5120	35720	67448	2.8	7.5
Local Check	4760	35800	60114	2.6	

Scope for upscaling

Seeds of this variety made available through CCS HAU Hisar and other state seed agency.



Improved wheat variety WH 1142 at Bairawas village, Mahendergarh district

Terminal heat stress tolerant wheat variety WH 1124

Climate vulnerability: Drought and heat wave

Background

Temperatures are usually raising in the month of March. Hence terminal heat stress has become one of the major threats due to global climate change. The terminal heat stress is significantly affecting the productivity of wheat crop. The term "terminal heat stress" refers to a rise in temperature (> 30°C) after anthesis during grain development which impairs the process of grain filling in wheat. Rising temperatures shorten the vegetative and reproductive periods of the wheat crop, but the reproductive stage is more vulnerable than the vegetative.

Resilient technology

The short duration wheat variety WH 1124 which is tolerant to the terminal heat stress due to its genetic characters and also short duration could be the most viable option to cope up with the terminal heat stress. The early maturing varieties may complete their reproductive growth before the temperature rises, hence they can avoid terminal heat stress. In the adopted village of Adampur block of Hisar district, WH1124 was introduced.

Performance and impact of technology

WH 1124 a short duration variety recorded 10% and 17% higher yield and net returns respectively with a B:C ratio of 2.7 (Table 2.2.10).

Table 2.2.10: Performance of heat tolerant wheat variety WH 1124 under terminal heat stress condition

Intervention	Yield (kg ha^{-1})	Cost of cultivation (₹ ha^{-1})	Net returns (₹ ha^{-1})	B:C	% increase in yield
Heat tolerant wheat variety (WH 1124)	4720	34980	60128	2.7	10
Local Check	4280	35100	51142	2.4	

Scope for upscaling

Total 35% farmers in adjoining villages have adopted this variety to tackle the problem of terminal heat stress.

PB-1509 early duration Basmati rice

Climate vulnerability: Salinity and heat wave

Background

In Basmati growing regions of the north western India, there is a growing concern of reducing water table due to pumping of groundwater for puddling operation before transplanting and frequent irrigation of rice crop.

Resilient technology

Pusa Basmati 1509 (PB-1509) is the early maturing Basmati rice variety with 120 days duration. This variety can help saving up to 5-6 irrigations (about 33% saving of irrigation water) compared to Pusa Basmati 1121 as it is a short duration variety. Furthermore, if transplanting is done in the last week of July, ground water can be saved as by last week of July monsoon rains starts Because of shorter duration, it also economizes the cost of agri-inputs and result in higher cropping intensity leading to better economic gains to the farmers.

Performance and impact of technology

The study was conducted in village Rupana of Sirsa district. The demonstrations indicated that the yield from PB- 1509 was marginal as compared to PB-1121, besides that there was 5% higher net income and saving in the water requirement and cultivation cost (Table 2.2.11).

Table 2.2.11: Performance of direct seeded rice var. PB-1509 at Rupana village, Sirsa district

Particular	Yield (kg ha^{-1})	Cost of cultivation (₹ ha^{-1})	Gross returns (₹ ha^{-1})	Net returns (₹ ha^{-1})	B:C
Pusa Basmati 1509	4800	31200	105000	73800	3.36
Pusa Basmati 1121	4750	33500	103937	70437	3.10

*Benefit:cost ratio

Scope for upscaling

Approximately 78% farmers have successfully adopted Pusa Basmati 1509 since there was saving in time and energy in terms of pumping hours, and cost saving.



Early duration rice var. PB-1509 at Rupana village, Sirsa district

Bio-fortified pearl millet hybrid (HHB-299)

Climate vulnerability: Drought and heat wave

Background

Pearl millet, also known as bajra, is one of the main *kharif* crop in the arid and semi-arid farming regions of India. Among the different millets this crop has highest production, productivity and area in the states of Rajasthan, Uttar Pradesh, Maharashtra, Haryana and Gujarat. Pearl millet accounts for more than 90% of the total area and contributes to similar production levels. India is the largest producer of pearl millet in the world. It is examined as a "poor man's" crop and is rich in carbohydrates, protein, fat, fibre and mineral content.

Resilient technology

Generally, farmers in the arid regions grow local varieties of the saved seed, which were not potential yielders in drought situations and are of long duration of 110 days. Therefore, introduction of high yielding hybrid pearl millet is needed in NICRA villages of Fatehabad district. HHB-299 hybrid pearl millet developed by CCS HAU was introduced which has high grain and straw yields in the arid region.

Performance and impact of technology

In NICRA villages of Fatehabad district, the average annual rainfall was 40% deficit and had long dry spells of 18-22 days in the months of July and August. The pearl millet hybrid HHB-299 has achieved 2 and 4% higher yield and net income whereas, during normal rainfall year the yield increase was 40% (Table 2.2.12).

Table 2.2.12: Impact of pearl millet hybrid in arid region of Haryana

Intervention	Yield (kg ha^{-1})	Cost of cultivation (₹ ha^{-1})	Net returns (₹ ha^{-1})	B:C
Bajra (HHB-299)	2350	15000	43750	3.92
Traditional variety (Nzndi-72)	2300	15500	42000	3.71

Scope for upscaling

This technology can be upscaled through field demonstration and field days.



Pearl millet hybrid (HHB-299) at Bodiwali village, Fatehabad district

Short duration pearl millet hybrid HHB 67 for multiple stresses

Climate vulnerability: Drought and heat wave

Background

Weather aberrations *i.e.* late onset of monsoon, dry spells, high temperature, *etc*. along with improper selection of crops and varieties are key factors of low productivity. Pearl millet is main *kharif* season crop predominantly grown in the district. The productivity of the crop realized by farmers of two NICRA villages is low. Majority of farmers in NICRA villages cultivate pearl millet hybrids having long duration of 90-100 days. These hybrids can't tolerate/ escape prolonged dry spells and result in low yield. Hence selection and cultivation of short duration and drought tolerant varieties are the options for harvesting better yield and returns.

Resilient technology

Improved pearl millet hybrid HHB 67 developed by CCSHAU, Hisar is of short duration (60-62 days) and can escape dry spells without affecting crop yield levels. Demonstrations were, therefore conducted on cultivation of pearl millet hybrid HHB 67 at farmers fields in NICRA villages during *kharif* 2022 and 2023.

Performance and impact of technology

HHB 67 improved hybrid recorded 20% higher yield than average yield of local hybrids (1500 kg ha^{-1}) grown by non-NICRA farmers (Table 2.2.13). The improved hybrid HHB 67 realised an additional net returns of ₹ 4376 ha^{-1}. This lower yields in traditional hybrids was due to the dry spell of 10 days experienced in the month of September. These dry spells affected performance of traditional hybrids grown by non-NICRA farmers as these hybrids are of longer duration and can't tolerate moisture stress for longer time.

Table 2.2.13: Impact of short duration and drought tolerant pearl millet hybrid HHB 67 at Mahendergarh district

Interventions	Yield (kg ha^{-1})	% increase in yield over local	Cost of cultivation (₹ ha^{-1})	Gross returns (₹ ha^{-1})	Net returns (₹ ha^{-1})	B:C
Short duration pearl millet (HHB 67)	1800	20	30552	57227	26675	1.87
Farmers' practice: Local variety	1500	-	27988	50287	22299	1.80

Scope for upscaling

The technology can be spread to the nearby villages in district through convergence with state department activities.







Short duration pearl millet hybrid HHB-67 at Mahendergarh district

Groundnut variety GJG 19 for higher crop productivity and returns

Climate vulnerability: Drought and heat wave

Background

The annual rainfall of Mahendergarh is around 430 mm apart from low rainfall the distribution of rainfall is also uneven. Hence to realize higher crop productivity and income with groundnut improved management practices are need of the hour. Water resources though available in limited amount can be utilized for raising more profitable crops with need-based irrigations.

Resilient technology

Cultivation of improved varieties of groundnut with improved practices can be the best option for increasing farm income under irrigated conditions.

Performance and impact of technology

Groundnut variety GJG-19 was raised successfully at Gadania village. Two supplement irrigations were applied. Crop diversification with groundnut in place of pearl millet is profitable. The average yield of improved variety of groundnut was 23% and 32% higher yield and net returns respectively over local varieties was obtained (Table 2.2.14).

Table 2.2.14: Performance of groundnut at Gadania village, Mahendergarh district

Interventions	Yield (kg ha^{-1})	Cost of cultivation (₹ ha^{-1})	Gross returns (₹ ha^{-1})	Net returns (₹ ha^{-1})	B:C
Improved groundnut variety (GNG-19)	2430	41081	142863	101782	3.48
Local check	1970	38946	115953	77007	2.98

Scope for upscaling

The technology can be spread to the nearby villages in district through convergence with state department activities.



Groundnut variety GJG 19 at Gadania village, Mahendergarh district

RH-725 mustard variety for rainfed/limited irrigation condition

Climate vulnerability: Drought and heat wave

Background

Mustard has maximum cropped area in the district as well as in NICRA villages in *rabi* season. Productivity of the crop is very low in NICRA villages. Due to frost as well as moisture stress, cultivation of traditional varieties which are susceptible to frost and drought is one of the factors for low productivity. Most of the farmers grow crop varieties of private sector having more water requirement.

Resilient technology

Selection and cultivation of varieties suitable for rainfed/ limited irrigation water conditions will be helpful in increasing crop productivity. Demonstrations were, therefore, conducted at farmers fields of NICRA villages on mustard variety RH-725 which is recommended for cultivation under rainfed conditions.

Performance and impact of technology

The yield and net returns of RH 725 was 16 and 17 % higher than average yield and net returns of local varieties (Table 2.2.15). The higher yield in RH 725 than the traditional varieties is because this variety was tolerant to frost as well as moisture stress whereas the traditional varieties were susceptible.

Table 2.2.15: Performance of mustard variety RH 725 at Gadania village

Interventions	Yield (kg ha^{-1})	Cost of cultivation (₹ ha^{-1})	Gross returns (₹ ha^{-1})	Net returns (₹ ha^{-1})	B:C
Improved mustard variety (RH-725)	1300	30666	70920	40255	2.31
Local check	1120	27332	61669	34336	2.26

Scope for upscaling

The technology can be spread to the nearby villages in district through convergence with state department activities.



Mustard variety RH 725 at Gadania village, Mahendergarh district

Performance of frost tolerant variety of mustard RH-725

Climate vulnerability: Salinity, frost and heat wave

Background

The temperatures in December-January are low some times they reach sub -zero temperatures hence *rabi* face cold stress in general and mustard in particular. It affects crop yield adversely. The extent of damage to plants and flower may rise up to 1/4 th of the total crop stands under adverse situations.

Resilient technology

The improved varieties of mustard such as RH-725 showed very good results in terms of tolerating low temperatures and frost. The robust growth of plants of this variety helps in protecting the flowers and pods from direct contact of frost, thereby ensuring a good yield. The cheaper prices of seed, good yield and tolerance to adverse climatic conditions makes it a better option for the farmers of Sirsa district in Haryana.

Performance and impact of technology

The seed of mustard variety RH-725 produced at the CCS HAU Hisar university, was distributed for demonstration in Rupana village of Sirsa district. The improved variety produced 10.6% higher yield in 2021-22 and 6.6 % higher yield in 2022-23 when compared to local variety in the village (Table 2.2.16). Moreover, the impact of frost was less in RH-725 variety. The results enhanced the adoption of this variety in the village at large scale including the nearby village. This year the demand of RH-725 was increased.

Table 2.2.16: Performance of improved mustard variety RH-725 at Rupana village, Sirsa district

Year of trial	Yield (kg ha^{-1})		% increase in yield	Economics of demonstration (₹ ha^{-1})				Economics of FP (₹ ha^{-1})			
	Demo	FP*		Cost of cultivation	Gross returns	Net returns	B:C	Cost of cultivation	Gross returns	Net returns	B:C
2021-22	2800	2500	12	28000	118720	90720	4.24	28000	104160	76160	3.72
2022-23	2400	2250	6.6	19500	151200	131700	7.75	19000	141750	122750	7.46

*FP: Farmers practice

Scope for upscaling

The technology can be spread to the entire districts through convergence with state department activities, central programmes, NFSM and CFLD (Cluster Front Line Demonstrations-oilseeds).



Frost tolerant variety of mustard RH-725 at Rupana village, Sirsa district

Climate resilient mustard variety RH-725

Climate vulnerability: Drought and heat wave

Background

The changing climate is a major impediment in sustaining agricultural productivity especially to small and marginal farming communities of Bhiwani district, where the event of loss of even a single crop can lead to starvation or malnutrition of the family. Apart from other stresses frost is a major stress in Rajasthan

Resilient technology

The need for stress tolerant varieties has become very important in the present context of climate change apart from various adaptation and mitigation strategies to feed the ever-increasing population in the country. Improved RH-725 mustard variety was introduced in NICRA villages of Bhiwani district.

Performance and impact of technology

RH-725 is a high yielding frost resistant variety. This improved variety recorded 21 and 23 % higher yield and net returns respectively (Table 2.2.17).

Table 2.2.17: Performance of mustard variety RH-725 at Lohani and Dahreru villages, Bhiwani district

Intervention	Yield (kg ha^{-1})	Cost of cultivation (₹ ha^{-1})	Gross returns (₹ ha^{-1})	Net returns (₹ ha^{-1})	B:C
Flood tolerant mustard variety (RH-725)	790	12462	38661	26199	3.1
Farmer's practice : Local Check	650	10794	32017	21223	2.97

Scope for upscaling

The technology can be spread to the all districts through convergence with state department activities like field days and awareness programmes.



Flood/salt/frost tolerant mustard variety RH-725 at Lohani village, Bhiwani district

Sesame RT -351 for crop diversification

Climate vulnerability: Drought and heat wave

Background

Sesame cultivation is one of options in *kharif* season. The crop can be successfully grown in the agro-ecology of NICRA villages and can provide better yield and returns than pearl millet crop in the *kharif* season. Growing of crops and varieties suitable for a particular farming situation can provide better yield and returns than the traditional crops.

Resilient technology

RT 351 sesame variety is tolerant to drought and suitable for agroecology of NICRA selected villages for better yield and income

Performance and impact of technology

Cultivation of sesame crop of improved variety RT-351 realized better yields and returns over farmers practice. The results of the demonstrations indicate that adoption of improved crop production practices recorded 22 and 37 % higher yield and net returns respectively than that obtained in farmer's practice (Table 2.2.18).

Table 2.2.18: Performance of improved variety of sesame RT 351

Intervention	Yield (kg ha^{-1})	Net returns (₹ ha^{-1})
Improved sesame variety (RT 351)	5500	31310
Farmers' practice : Local variety	4500	22775

Scope for upscaling

The technology can be spread to the entire district through convergence with state department activities.



Improved sesame variety RT-351 at Mahendergarh district

Drought tolerant cotton varieties

Climate vulnerability: Drought and heat wave

Background

Erratic weather patterns and temperature and humidity changes have resulted in a dramatic rise in pest and disease outbreaks in cotton, crop losses due to drought and pest damage are causing a major toll on the yield of the cotton.

Resilient technology

Cultivation of drought tolerant varieties of cotton was demonstrated. Cultivating new and improved varieties of cotton enhances the resistance of plants to a variety of stresses that could result from climate change such as water, heat stresses and the emergence of new pests.

Performance and impact of technology

Cotton varieties RCH-776, Ankur-555, US-51, Ajit-155 were selected for management of pink boll worm and sucking pests. The results showed that use of pheromone traps was effective in management of pink boll worm. This variety recorded 27% higher yield than farmers practice. An average of ₹ 79500 gross cost, ₹ 50180 of net returns and B:C of 1.60 as compared to ₹ 68900 of gross cost, ₹ 31900 of net returns and B:C ratio of 1.46 was obtained in the farmers practices (Table 2.2.19).

Table 2.2.19: Performance of improved drought tolerant cotton varieties at Lohani and Dahreru villages, Bhiwani district

Intervention	Yield (kg ha^{-1})	Cost of cultivation (₹ ha^{-1})	Gross returns (₹ ha^{-1})	Net returns (₹ ha^{-1})	B:C
Drought tolerant/ improved /Insect-pest resistant cotton varieties (RCH-776, Ankur-555, US-51, Ajit-155)	1520	79500	127680	50180	1.60
Farmer's practice : Local Check	1200	68900	100800	31900	1.46

Scope for upscaling

The technology can be spread to all the districts through convergence with state department activities, awareness programmes.



Drought tolerant improved cotton variety RCH-776 at Dahreru village, Bhiwani district

Cotton–mungbean intercropping: A climate-resilient strategy for drought and heat stress mitigation"

Climate vulnerability: Drought and heat wave

Background

The drought and heat wave are common in Bhiwani district. Cultivation of sole cropping of cotton is risky since cotton crop is exposed to drought, frost as well as pest incidence which could severely impact the crop productivity. In addition to the abbarent weather conditions the soils are poor in organic carbon. Hence to improve the crop yields and act as insurance, intercropping of crops along with cotton is need of the hour

Resilient technology

Intercropping refers to the cultivation of crops in between the widely spaced crops. It reduces the risk of total crop failure and also provides alternative means of generating income, as different crops will respond to climate scenarios in different ways. While the cold may affect one crop negatively, production in an alternate crop may increase. Mungbean variety MH-421 can be cultivated as an intercrop (2:1) in cotton.

Performance and impact of technology

Intercropping of cotton + mungbean (2:1) recorded higher yields as compared to sole crop of cotton. The net returns were 119 % higher than sole crop alone (Table 2.2.21).

Table 2.2.21: Performance of cotton + mungbean system at Lohani and Dhareru villages, Bhiwani district

Intervention	Crop	Yield (kg ha^{-1})	Cost of cultivation (₹ ha^{-1})	Gross returns (₹ ha^{-1})	Net returns (₹ ha^{-1})	B:C
Intercropping of cotton + mungbean (2:1)	Cotton	1680	82725	140680	58043	1.70
	Mung	3850	8899	20955	12056	2.35
Farmer's practice : Cotton sole cropping	Cotton	1200	68900	100800	31900	1.46

Scope for upscaling

The technology can be spread to all the districts through convergence with state department activities and central programmes.



Mungbean variety MH-421 in cotton at at Lohani village, Bhiwani district

2.3 Promising Livestock Production Technologies

Annual fodder for enhancing climate resilience in livestock

Climate vulnerability: Drought and heat wave

Background

Haryana has largest livestock population in the country. Sustainable farm animal raising is dependent on the production of sufficient quantities and quality of forages and fodder, especially in rainfed region. There is a decline in the traditional rangelands and pastures, fodder trees and shrubs, hence there is a huge scarcity of fodder for livestock in the state. Consistent supply of fodder during the entire season and in drought period is unpredictable Hence climate resilient forage species, efficient management of fodder crops to withstand adverse weather conditions, which ensures a consistent supply of feed even during dry and challenging periods needs to be popularised for sustainable livestock production under changing climate scenarios.. Moreover, fodder crops can be customized to fulfil specific nutritional requirements, thereby optimizing the health and productivity of animals.

Resilient technology

The cultivation of fodder crops enhances the resilience of livestock production by providing reliable and adaptable sources of feed. Hence, multicut berseem hybrid (Amritsar hybrid along with improved fodder management practice was introduced in NICRA adopted villages in Fatehabad district for sustainable livestock production.

Performance and impact

KVK Fatehabad introduced drought resistant improved fodder crop of berseem (Amritsar hybrid) in the NICRA villages of Banmandori and Bodiwali with the support of 20 farmers. This crop can grow well under low fertile soils, with quick growth, high biomass accumulation and dry matter content. Feeding of berseem to the animals increased milk yield by 1.0 litre day^{-1} in milching animals (Table 2.3.1).

Table 2.3.1: Impact of berseem fodder hybrid (Amritsar hybrid- Haddu) in Fatehabad District

Intervention	Yield (kg ha^{-1})	Cost of cultivation (₹ ha^{-1})	B:C
Berseem (Amritsar Hybrid-Haddu Seed)	69100	4500	1.9



Berseem seed distribution at Bodiwali village, Fatehabad district

Adoption of climate-resilient fodder crops and varieties

Climate vulnerability: Drought and heat wave

Resilient technology

The short duration and climate-resilient fodder pearl millet variety (HC 20) during *kharif* and improved variety of berseem (HB-2) and oats (HJ 8 and Kant) were taken in *rabi*.

Performance and impact of technology

The short duration fodder pear millet variety HC 20 was demonstrated This variety has more fodder production as compared to local check. In *rabi* season 12 demonstrations on improved berseem variety HB-2 were conducted which resulted in more fodder production and higher net returns of ₹ 86725 and B: C ratio (7.1) over local (6.2). Improved variety of oats (HJ 8 and Kant) were introduced which resulted in more fodder production and higher net returns of ₹ 44500 and B: C ratio (2.2) over local (1.8).

Scope for upscaling

In adjoining villages 39% of farmers adopted climate-resilient forage variety. The seed of varieties were made available by CCS HAU Hisar and other state seed agency.



Climate resilient berseem fodder variety at Fatehabad district

Sorghum and oat green fodder for enhancing livestock productivity

Climate vulnerability: Drought and heat wave

Background

The availability of year round fodder is scarce due to drought conditions. Supply fodder year round resilient technologies like sorghum+ cowpea in *kharif* and Oats in *rabi* season is solution.

Performance and impact of technology

Cultivation of fodder crops like sorghum + cowpea, in *kharif* and Oats in *rabi* and feeding to milch animals with green fodder for 8-9 months enhanced the milk productivity and gross returns. An additional gross returns of ₹ 9735- 12760 were obtained when animals were fed with green fodder (Table 2.3.2).

Table 2.3.2: Performance of green fodder sorghum and oat supplementation to buffalo in NICRA villages of Mahendergarh district

Intervention	Village 1			Village 2		
	Milk production (L^{-1} $year^{-1}$ $animal^{-1}$)	Selling price (₹ L^{-1})	Gross returns (₹ ha^{-1})	Milk production (L^{-1} $year^{-1}$ $animal^{-1}$)	Selling price (₹ L^{-1})	Gross returns (₹ ha^{-1})
NICRA Farmers	1995	55	106260	1930	55	106150
Non-NICRA Farmers	1755	55	96525	1698	55	93390

Scope for upscaling

The technology can be spread to the entire district through convergence with state department activities.



Fodder oat variety Chari Bajra at Bairawas village Mahendergarh district

Introduction of new multi-cut fodder sorghum variety MFSH-4

Climate vulnerability: Drought and heat wave

Fodder sorghum forms a specialized production system to cater to the needs of commercial dairy farms, largely confined in northern India. It is mostly preferred for its lower input and drought tolerance. Multi-cut sorghum has potential for intensive fodder production under irrigated condition. There is ready and growing market for multicut forage sorghum hybrids to support the proliferating dairy business where private sector is dominating and marketing notified varieties such as MFSH-4. It is suitable for well drained, medium to heavy soils.

Performance and impact of technology

Improved variety of multi cut sorghum variety MFSH-4 was given to 50 farmers of Lohani village. The yields of this variety was 27 % higher than local and also recorded 33 % higher net returns (Table 2.3.3).

Table 2.3.3: Performance of fodder sorghum variety MFSH-4 at Lohani village, Bhiwani district

Interventions	Fodder yield (q ha^{-1})	Gross cost (₹ day^{-1})	Gross returns (₹ day^{-1})	Net returns (₹ day^{-1})	B:C
Introduction of new fodder variety MFSH-4	610	35750	79300	43550	2.21
Farmers Practice	480	29500	62400	32900	2.1

Scope for upscaling

The technology can be spread to the entire districts through convergence with state department awareness programmes.



Multicut fodder sorghum variety MFSH-4 at Lohani village of Bhiwani district

Supplementation of mineral mixture for enhancing milk productivity

Climate vulnerability: Drought and heat wave

Background

Balanced ratio plays a pivotal role in attaining the maximum genetic potential of an animal. Feeding proper quantum of all the essential nutrients not only helps an animal to maintain its vital functions at their best, but also helps them to produce and reproduce in a proper physiological manner. The micro-nutrients, especially minerals play an indispensable role in maintaining normal metabolic and physiological functions of body.

Low productive and reproductive performance of livestock is one of the major problems in livestock production in Mahendergarh district, resulting in poor economic returns to the livestock farmers. The deficiency and/or imbalance of micro and macro nutrients are one of the important factors responsible for the low milk production efficiency. The practice of mineral supplementation to livestock is not common in NICRA villages. Problem of mineral deficiency and metabolic disorder in all categories of dairy animals has been reported due to lower content and low bioavailability of minerals in feed and fodder supply. There is need for the supplementation of area specific mineral mixture to dairy animals.

Resilient technology

Mineral mixture contains all the essential minerals in required quantities. Supplementing mineral mixture will help in improving growth rate in calves, increasing milk production, reduces heat stress, improves reproductive efficiency and reduce calving interval, increase productive life of animals and improve immunity. It can be given at the rate of 50 -100 g day^{-1} $animal^{-1}$ once in a day along with the animal feed. It will improve overall animal health, immunity and productivity during stress.

Performance and impact of technology

The use of mineral mixtures has not only helped in increasing the milk yield but also alleviated problems of anoestrus and repeat breeding to a large extent in Fatehabad district. A demonstration involving 100 animals were conducted in NICRA villages of Fatehabad, increase in milk yield per day was observed with the animals being supplemented with balanced mineral mixture to an extent of 14% over local practice. Usage of mineral mixture for animals has increased from 10% to 60% among animals in NICRA villages (Table 2.3.4). This intervention is well adopted by the farmers of NICRA villages of Fatehabad district.

Table 2.3.4: Performance of balanced mineral mixture supplementation at Fatehabad district

Interventions	Milk yield (L day^{-1})	Cost of cultivation (₹ yr^{-1})	Gross returns (₹ yr^{-1})	Net return (₹ yr^{-1})	B:C
Mineral mixture	8	61850	97300	35540	1.57
Farmers Practice	7	60343	91519	31176	1.33





Mineral mixture supplementation in Bodiwali and Banmandori villages of Fatehabad district

Mineral mixture for enhancing livestock productivity

Climate vulnerability: Drought and heat wave

Performance and impact of technology

80 demonstrations were conducted in the NICRA villages Gadania and Bairawas on intervention of improved livestock feeding through mineral mixtures. All the animals were selected at a comparable stage of lactation i.e. within first month of lactation and were maintained under similar management conditions throughout the trial. Animals were fed mineral mixture at the rate of 50-100 g animal^{-1} day^{-1} for a period of 6 months. Milk yield of these animals was recorded by the dairy farmer. The selected livestock farmers were trained on importance of mineral mixture practices in livestock before starting of demonstrations.

The demonstrated livestock were regularly monitored and periodically observed the production parameters. The milk yield of these animals was recorded for 6 months after supplementation of LUVAS- Mineral mixture. Animals fed with LUVAS mineral mixture showed higher milk production of 13.69 % (Gadania village) and 12.68 % (Bairawas village) in study period when compared to regular farmer practice without mineral mixture supplement (Table 2.3.5). Farmers reported low incidence of metabolic disorders and mastitis in their animals by regular supplementation of 50-100 gram mineral mixture. Hence, by supplementing LUVAS mineral mixture in livestock ration, economic status of the farmers is increased by enhancing productivity of the animals.

Scope for upscaling

This technology can be spread widely through the animal husbandry department, National Livestock Mission and also supplying mineral mixture on subsidy. Local entrepreneurship can also be encouraging which can further contribute to upscaling.

Table 2.3.5: Performance of balanced mineral mixture supplementation to buffalo in NICRA villages

Intervention	Village Gadania			Village Bairawas		
	Milk production (L year^{-1} animal^{-1})	Selling price (₹ L^{-1})	Gross returns (₹ animal^{-1})	Milk production (L year^{-1} animal^{-1})	Selling price (₹ L^{-1})	Gross returns (₹ animal^{-1})
NICRA Farmers	1785	55	98175	1910	55	105050
Non-NICRA Farmers	1570	55	86350	1695	55	93225











Mineral mixture distribution at Gadania and Bairawas villages of Mahendergarh district

Inclusion of mineral mixture in daily diet of livestock for improvement in health and milk yield

Climate vulnerability: Salinity and heat wave

Performance and impact of technology

The mineral mixture in daily diet of animal along with suitable health supplements increased the milk yield. The incidences of mastitis in cattle were also reduced as the overall health of animal was improved in Sirsa district. In the year 2020-21, 2021-22 and 2022-23, fifty demonstrations in each year were given to farmers of the NICRA villages *i.e.* Rupana, Ludesar and Nirban. The milk yield was found to be increased by 11%, 14% and 11% in the year 2020-21, 2021-22 and 2022-23, respectively, as compared to the local practice (Table 2.3.6). Despites the cost of mineral mixture the B:C ratio was higher in the economics of demonstration, proving the fact that inclusion of mineral mixture increases per unit income along with milk yield. The intervention is well adopted by the farmers of NICRA villages and the adjacent villages of Sirsa district.

Table 2.3.6: Impact of mineral mixture and health supplements in animal diet (2020-2023)

Year	Milk yield		% increase	Economics of demonstration (₹ ha^{-1})				Economics of Local (₹ ha^{-1})			
	Demo	Local		Cost of cultivation	Gross returns	Net returns	B:C	Cost of cultivation	Gross returns	Net returns	B:C
2020-21	3400	3050	11	33600	153000	119400	4.55	31500	137250	105750	4.35
2021-22	3600	3150	14	34500	162000	127500	4.69	33500	148000	114500	4.41
2022-23	3400	3050	11	33600	153000	119400	4.55	31500	137250	105750	4.35

Scope for upscaling

The CCS HAU Hisar is producing mineral mixture in large quantities which is being distributed at KVKs of the university. However, the availability of the technology can be enhanced widely through the animal husbandry department, National Livestock Mission and also by supplying subsidised mineral mixture.



Mineral mixture and health supplements for livestock at Rupana village of Sirsa district





Mineral mixture and health supplements for livestock at Rupana village of Sirsa district



Mineral mixture supplementation to livestock at Ludesar and Nirban villages, Sirsa district

Supplementation of area specific mineral mixture for enhancing productivity

Climate vulnerability: Frost

Background

Problem of mineral deficiency and metabolic disorder in all categories of dairy animals have been reported due to lower content and low bioavailability of minerals in feed. There is need for the supplementation of area specific mineral mixture to dairy animals.

Resilient technology

Mineral mixture contains all the essential minerals in required quantities. Supplementing mineral mixture will help in improving growth rate in calves, increasing milk production, reduces heat stress, improves reproductive efficiency and reduce calving interval, increase productive life of animals and improve immunity. It can be given at the rate of 50 - 100 g day^{-1} $animal^{-1}$once in a day along with the animal feed. It will improve overall animal health and immunity and productivity during stress.

Performance and Impact of technology

The use of mineral mixtures has not only helped in increasing the milk yield but also alleviated problems of anestrus and repeat breeding to a large extent in Yamunanagar district. In a demonstration involving 57 farmers with 117 animals, conducted in a NICRA village Radauri, increased milk yield per day was observed with the animals being supplemented with balanced mineral mixture (Table.). It has also recorded increased net returns (50%) and BC ratio (1.47%) than local practice (Table 2.3.7).

Table 2.3.7: Performance of balanced mineral mixture supplementation to cow in Yamunanagar (2017-18)

Year	Interventions	Milk yield (L day^{-1})	Cost of production (₹ day^{-1})	Gross returns (₹ day^{-1})	Net returns (₹ day^{-1})	B:C
Normal year	Mineral mixture	7.5	210	310	100	1.47
	Farmers Practice	6.0	170	220	50	1.29
Stress year	Mineral mixture	6.9	210	296	86	1.40
	Farmers Practice	5.5	170	198	28	1.16

Scope for upscaling

This can be up scaled widely through the animal husbandry department, National Livestock Mission and also by supplying them on subsidy. Local entrepreneurship can also be encouraged which can further contribute to upscaling.

Supplementation of area specific mineral mixture for enhancing productivity

Climate vulnerability: Frost

Background

There is need for the supplementation of mineral mixture to dairy animals as the problem of mineral deficiency and metabolic disorder have been reported in all categories of dairy animals due to lower content and low bioavailability of minerals in their feed.

Resilient technology

Mineral mixture contains all the essential minerals in required quantities. Supplementing mineral mixture will help in improving growth rate in calves, increasing milk production, reduces heat stress, improves reproductive efficiency and reduce calving interval, increase productive life of animals and improve immunity. It can be given at the rate of 50 - 100 g day^{-1} $animal^{-1}$ once in a day along with the animal feed.

Performance and Impact of technology

The use of mineral mixtures has helped in increasing the milk yield in villages Lohani and Dhareru, district of Bhiwani. In a demonstration involving 40 farmers with 40 animals, conducted in the NICRA villages of Bhiwani, increased milk yield per day was observed with the animals being supplemented with balanced mineral mixture to an extent of 18.75% over local practice (Table). It has also recorded increased net returns (32.3%) than local practice (Table 2.3.8). Usage of mineral mixture for animals has increased from 15-20% to 60-70% among farmers in NICRA village of Bhiwani district. This intervention is well adopted by the farmers of NICRA village of Lohani and Dhareru.

Table 2.3.8: Performance of balanced mineral mixture supplementation to cow and buffalo at Lohani and Dhareru villages of Bhiwani district

Interventions	Milk yield (L day^{-1})	Cost of cultivation (₹ day^{-1})	Gross returns (₹ day^{-1})	Net returns (₹ day^{-1})	B:C
Farmers Practice	8	29500	62400	32900	2.1
Mineral mixture	9.5	35750	79300	43550	2.21

Scope for upscaling

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



Mineral mixture supplementation to cow and buffalo at Lohani and Dhareru villages of Bhiwani district

3 Climate resilient technologies for risk prone districts of Haryana

3. Climate resilient technologies for risk prone districts of Haryana

Selected districts of Haryana can be broadly categorized in to very high risk, high risk and medium risk, based on proneness to climate change and variability. Haryana is susceptible to the adverse impacts of climate change on agriculture, including changing rainfall pattern, temperature increase and extreme weather events like heat waves, cold waves, dry spells *etc*. implementing climate resilient agriculture practices like natural resource managements technologies, crop diversification and livestock management practices can enhance the state's ability to withstand climate related challenges. Based on demonstrations which are conducted by the TDC-NICRA and other studies promising climate resilient technologies for risk prone districts of Haryana are indicated below.

Promising climate resilient technologies for very high-risk prone districts of Haryana

1.Bhiwani 2. Fatehabad 3. Mahendergarh

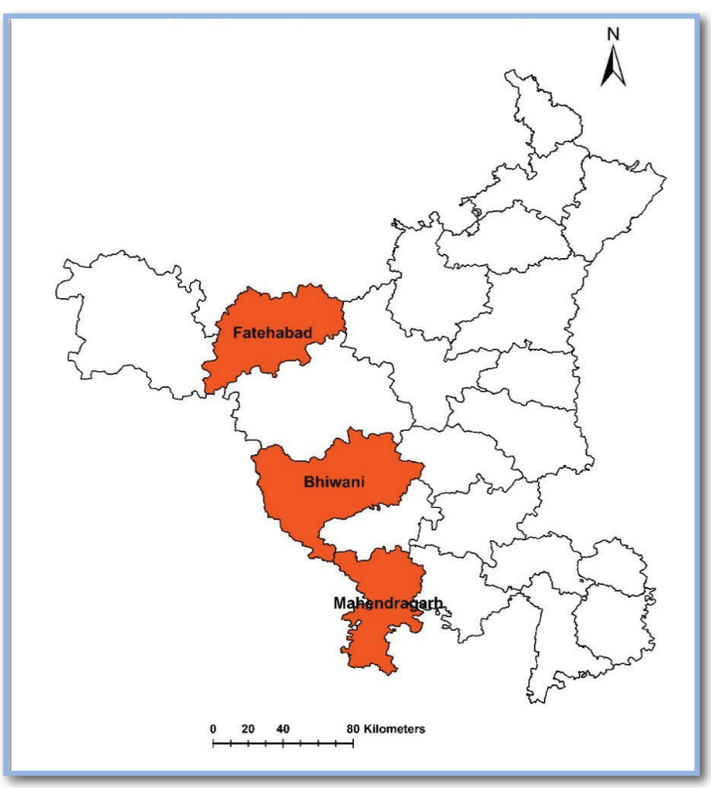


Fig.28 Very high risk prone districts of Haryana

- Furrow irrigated raised bed method of planting in wheat and cotton
- Zero till wheat sowing using Happy Seeder
- Micro irrigation in cotton
- High yielding and yellow rust tolerant wheat variety HD 3086 for disease affected areas
- Drought tolerant and pest resistant cotton varieties RCH-776, Ankur-555, US-51, Ajit-155 for erratic weather patterns
- Frost and salinity tolerant mustard variety RH-725 for abiotic stress prone areas
- Intercropping of mungbean in cotton at 2:1 row ratio as a crop diversification measure

- Introduction of short duration green gram variety MH-421 under long dry spells situation
- Guar production to conserve resources and improve soil fertility under monocropping sequence systems
- Bio fortified pearl millet hybrid HHB-299 under water deficit situation
- Short duration and drought tolerant pearl millet hybrid HHB 67
- Crop diversification with short duration green gram variety MH 421 and groundnut variety GJG 19
- Microbial seed treatment with biofertilizers
- Dairy animal supplementation with area specific mineral mixture to enhance/ sustain milk yield
- Introduction of multi cut forage sorghum hybrid MFSH-4
- Improved berseem fodder variety Amritsar hybrid production to enhance fodder availability

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

1.Hisar 2. Sirsa

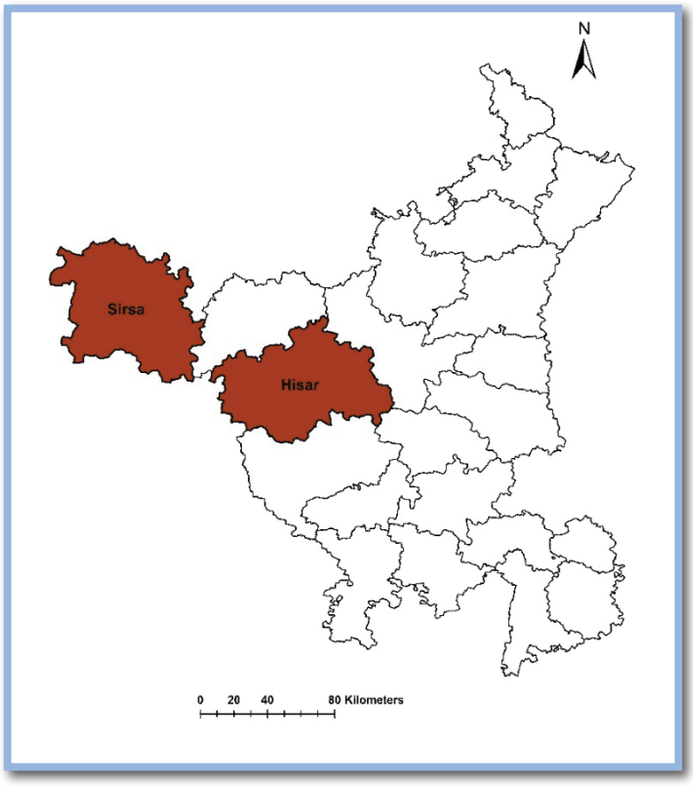


Fig.29 High risk prone districts of Haryana

- Laser land levelling in cotton for resource conservation
- Summer deep ploughing in cluster bean
- Zero tillage in wheat to avoid delay in planting and reduce the cost of production
- Use of drip irrigation in cotton
- Direct Seeded Rice (DSR) variety PB-1509 (Pusa Basmati) for higher basmati rice yields
- Cobalt chloride application in cotton for para wilt management

- Adoption of short duration and drought tolerant green gram variety MH-421 and cluster bean variety HG-2-20
- Adoption of improved wheat variety WH1142 for terminal heat stress under limited irrigation condition
- Introduction of chickpea variety GNG-2171 under crop diversification for higher income and nutritional security
- Introduction of climate resilient forage varieties of berseem (HB-2), oats (HJ 8 and Kant) and pearl millet (HC-20)
- Adoption of frost tolerant mustard variety RH-725 for frost and low temperature situation
- Salt tolerant wheat variety KRL-210 for salinity conditions
- Livestock supplementation with area specific mineral mixture to enhance milk yield
- Deworming of livestock for improvement in health and milk yield

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

1.Yamunanagar

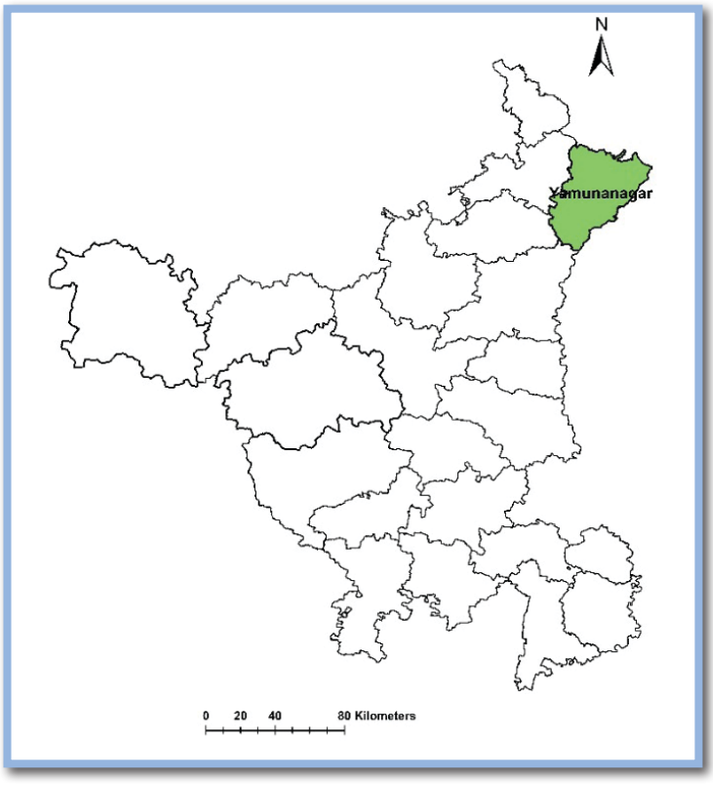


Fig.30 Medium risk prone districts of Haryana

- Crop residue management in wheat with Happy Seeder
- Laser Land Levelling in paddy for levelling, smoothing and shaping the field surface
- Direct seeding of rice to conserve resources and minimize the impact of weather aberrations
- Supplementation of livestock with area specific mineral mixture for enhancing productivity and health







Residue recycling with Happy Seeder

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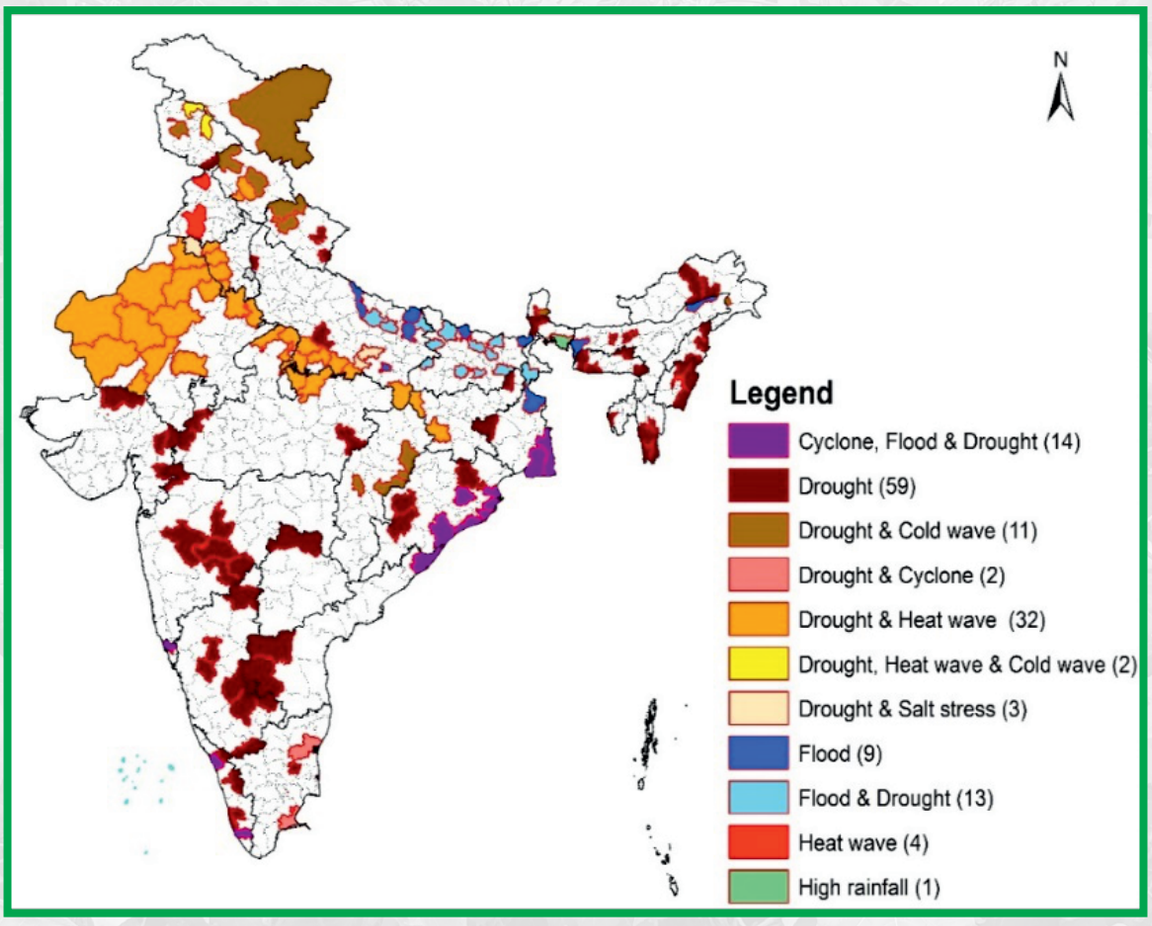
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