NICRA - TDC

Highlights 2018-19

Technology Demonstrations

Enabling communities to cope with climate variability and to enhance adaptive capacity and resilience

ICAR-Central Research Institute for Dryland Agriculture, Hyderabad
Natural Resource Management & Agricultural Extension Division
Indian Council of Agricultural Research (ICAR), New Delhi

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HIGHLIGHTS
2018-2019

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Citation: Ravindra Chary, G., Prasad, J.V.N.S., Osman, M., Ramana, D.B.V., Nagasree, K., Rejani, R., Subbarao, A.V.M., Srinivas, I., Rama Rao, C.A., Prabhakar, M., Bhaskar, S., Singh, A.K. and Alagusundaram, K. (Editors). 2019. Technology Demonstrations: Enabling communities to cope with climate variability and to enhance adaptive capacity and resilience. National Innovations in Climate Resilient Agriculture (NICRA) Project, ICAR-Central Research Institute for Dryland Agriculture, Hyderabad, Research Highlights: 121 pp.

December 2019

Copies: 500

Facilitated by:

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Published by

The Director
ICAR-Central Research Institute for Dryland Agriculture
Santoshnagar, Hyderabad-500059. Ph: 040-24530177 Fax: 040-24531802
Website: http://www.crida.in E-mail: director.crida@icar.gov.in

Front Cover: NICRA Interventions
Back Cover: Checkdam at NICRA village of Valsad, Gujarat

Printed at:
Balaji Scan Pvt. Ltd.,
Nampally, Hyderabad-1
Tel: 040-23303424/25 www.balajiscan.com; e-mail: bsplpress@gmail.com

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Foreword

Climate variability and extreme weather events are impacting agriculture and livelihoods. Identifying technologies which can minimize the impact of climate change and variability is essential for enhancing the adaptive capacities of communities. The on-farm participatory demonstrations of proven resilient practices are being taken up in 121 climatically vulnerable districts through Krishi Vigyan Kendras (KVKs) of ICAR under Technology Demonstration Component (TDC) of National Innovations in Climate Resilient Agriculture (NICRA) to enhance their adoption and resilience of farmers. During 2018, the TDC program is expanded to 121 village clusters involving 383 villages. Prioritized resource management practices were demonstrated in districts which are frequently prone to dry spells and droughts. About 50 districts adopted under NICRA have received deficient rainfall during the year 2018. Dry spells occurred during the months of August and September impacted crops severely at reproductive and maturity stages. Emphasis was on enhancing water storage potential at the village and to provide access to critical irrigation to communities and for sustainable intensification. More than 250 resilient varieties evaluated under NICRA-TDC were integrated in to the district agriculture plans in various states. Efforts were made to reach every household in the village by forging convergence with various development programs. Existing village institutions were strengthened and quantification of resilience was taken up. About 2303 training programs were taken up to build capacities of communities in the NICRA villages.

I am happy to note that under NICRA-TDC, several promising resilient practices were identified to cope with various weather aberrations of the country. I congratulate the TDC team at ICAR-CRIDA, Agricultural Technology Application Research Institutes (ATARIs) and compliment KVKs for bringing out the highlights and salient achievements during 2018-19 in this document. I hope these technologies will be integrated with the development programs for scaling out climate resilient technologies and to enhance the adaptive capacity of farmers.

(T. MOHAPATRA)

Dated the 10th December, 2019
New Delhi

Preface

The Technology Demonstration Component of NICRA aims at demonstration of climate resilient practices in a participatory mode so as to accelerate the adoption of these practices for enhancing the adaptive capacity and resilience. The programme is being operational in 121 village clusters and addressing climatic vulnerabilities like drought, heat wave, cold wave, floods and cyclones and being implemented by KVKs.

During the year 2018, deficient rainfall was observed in 50 NICRA districts. Several districts in the states of Maharashtra, Gujarat, Rajasthan, Madhya Pradesh, Jharkhand, Telangana and Andhra Pradesh received deficient rainfall during the months of August and September impacting crop growth and yields. Prolonged dry spells were observed during reproductive growth and maturity. Three cyclones, *Titli, Gaja* and *Pethai* impacted coastal Andhra Pradesh, Tamil Nadu and Odisha rice at ripening and maturity. Low temperature and cold waves were observed in the states of Himachal Pradesh and Jammu Kashmir.

Location specific, promising resilient technologies were demonstrated and efforts were made to scale the proven practices among the farming community in the NICRA villages. Climate resilient varieties for drought, flood and salinity were introduced and demonstrated. The proven varieties were integrated with the district agricultural plans so as to reach large number of farmers. Emphasis was given to demonstration and spread of proven intercropping and farming systems. Demonstration of practices for enhancing soil fertility and rational fertilizer use was taken up. Improved breeds and practices for higher livestock productivity in terms of milk, meat and eggs were demonstrated in all KVKs for additional household income. Efforts are being made to spread the proven resilient practices to all the households in the NICRA villages by leveraging convergence with the developmental programs. Mitigation co-benefits of resilient technologies were quantified. The established village institutions were utilized for the adoption and spread of climate resilient practices in the NICRA villages.

We take this opportunity to gratefully acknowledge the constant guidance and support from Dr. Trilochan Mohapatra, Secretary (DARE) & Director General (ICAR), members of the HLMC, Chairmen and members of the zonal monitoring committees. We do place on record and appreciate the valuable contribution of network partners, farmers, VCRMC members, scientists, department officials and other stakeholders.

AUTHORS

Acknowledgements

Technology Demonstration Component (TDC) of National Innovations in Climate Resilient Agriculture (NICRA) is closely associated with farmers, scientists, subject matter specialists of KVKs, ATARIs, SAUs, NGOs, ICAR institutes from various parts of the country.

We are extremely grateful to Dr. Trilochan Mohapatra, Secretary, DARE & Director General, ICAR, for his constant support and advice for the successful implementation of the project. We express our heartfelt thanks to Dr. K Alagusundaram, Deputy Director General (AE & NRM) for his continuous encouragement and guidance. We are highly grateful to Dr. A.K. Singh, Deputy Director General (Agricultural Extension) for his constant guidance and support in the implementation of the programme.

We are extremely thankful to Dr. S. Bhaskar, Assistant Director General (A AF & CC) for his constant support and guidance. We would like to thank Dr. Randhir Singh, Assistant Director General (Agricultural Extension) for his support in implementing the programme. Our sincere thanks to the Zonal Monitoring Committee (ZMC) Chairmen and members for their valuable suggestions. We are grateful to all Directors and Nodal Officers of ATARIs for their support and guidance in the implementation of the project. We would like to acknowledge the guidance and support of Director of Extension (DE) of the Agricultural Universities in the implementation of the programme.

We thank the Programme Coordinators and staff of KVK towards the implementation of the project and our deepest gratitude to the farmers who have adopted resilient practices and contributed towards their spread.

I wish to thank all Co-Principal Investigators of the project and scientists from CRIDA for their valuable suggestions during the planning and execution of the programme.

Date: 10th December, 2019

Place: Hyderabad

(G. Ravindra Chary)
Director(Acting), CRIDA

Executive Summary

The Technology Demonstration Component (TDC) of National Innovations in Climate Resilient Agriculture (NICRA) is a participatory programme involving demonstration of location-specific technologies on farmers' fields for coping with climate variability, to generate awareness and build capacity of farmers and other stakeholders on climate resilient agriculture and to evolve institutional mechanisms at village level to enable communities to respond to climate stresses in a continuous manner beyond the project period. The programme is being implemented in 121 village clusters representing climatically vulnerable districts.

During *kharif* 2018, significant variability in rainfall was observed in the project locations. Several NICRA districts received sub normal rainfall. About four NICRA districts have received large deficit rainfall of 60% and above and 46 districts received deficient rainfall between 20-59%. KVKs located in the western region and parts of north east have received deficient rainfall in the months of June and July. Several locations in the western India, central and eastern India received deficient rainfall during the months of August and September months impacting crop growth at reproductive stage and at maturity.

Various promising, location specific resource management practices were demonstrated so as to enhance their adoption and consequently the adaptive capacity of communities to climate change and variability. During 2018-19, about 244 demonstrations were taken up on in-situ measures involving 7221 farmers. Harvesting water and its efficient utilization is the key intervention for minimising the impact of variable rainfall in various agro-climatic regions of the country. Emphasis has been laid on strengthening of community water harvesting structures in the NICRA villages so as to provide access to water to as many farmers as possible. During the year 2018-19, about 116 demonstrations were taken up involving 2956 farmers on various water harvesting structures. Growing of green manure and leguminous crops, compost making helped to improve the soil fertility. About 105 demonstrations were conducted in villages on soil improvement covering 3862 farmers in various districts.

Zero tillage is demonstrated in many states, *viz.,* Punjab, Haryana, Uttar Pradesh, Bihar, Madhya Pradesh, Andhra Pradesh and in some of the north eastern states with varying residue quantities. In Punjab, nine technological options were demonstrated as alternatives to crop residue burning. New farm machinery were demonstrated for incorporation of crop residues in Punjab. About 270 demonstrations on alternatives to crop residue burning were demonstrated and 32 training programs and field visits were organized in Punjab and Haryana to minimize crop residue burning in about 24 villages thus significantly reducing the extent of burning in these villages.

Short duration, improved, drought escaping/ tolerant, flood tolerant varieties played significant role in enhancing resilience of the farmers to varying rainfall. About 177 demonstrations covering 4984 farmers on short duration and improved varieties paddy, maize, mustard, finger millet and oil seeds stabilized yields under moisture stress conditions and long dry spells. Drought escaping short duration paddy cultivars such as Abhishek, Sahabhagi, Anjali, Swarnashreya have shown distinct yield advantage in the states of Jharkhand, Odissa and Bihar. Flood tolerant varieties like Swarna sub-1, Ranjit sub-I, CR 1009 sub- 1, MTU-1061 *etc.*, helped farmers to get assured income inspite of submergence and floods in low lying areas Assam, West Bengal, Uttar Pradesh coastal regions of Andhra Pradesh and Odisha. Resilient intercropping systems were demonstrated in frequently drought prone regions of Maharashtra, Telangana, Andhra Pradesh. About 76 demonstrations were being conducted on intercropping systems involving 932 farmers. Salt tolerant varieties of paddy, wheat and mustard in salt affected regions of Uttar Pradesh, Haryana and Telangana were demonstrated. Proven varieties were integrated in the district agriculture plans in various districts and contributed towards their spread.

In case of livestock, the emphasis has been on enhancing the green fodder production and availability during lean/aberrant situations at the village and to stabilize income at the household level. Demonstrations were taken up on introduction of improved breeds, supplementation with mineral mixtures, vaccination and health camps, back yard poultry etc. About 529 demonstrations were taken up on various aspects of livestock during the year involving 20,802 farmers. About 102 demonstrations on improved shelters and mineral mixtures were demonstrated in frequently heat stress and flood prone regions of the country. Integrated Farming Systems (IFS) were demonstrated mainly in North Eastern Region for efficient resource utilization. Livestock and fisheries based farming systems became more popular in the region due to high returns and sustainable yields.

Village institutions established as part of the project, *viz.,* seed bank, fodder bank and custom hiring centers contributed towards the adoption and spread of the resilient practices. During the year, custom hiring centers for farm implements generated revenue of Rs. 61 lakhs. During the year, 2195 quintals of seed was produced from the seed banks. About 583 VCRMC meetings were held for taking decisions regarding the implementation of the programme at village level. About 1045 training programs involving 29119 farmers were taken up on improved practices, cultivars, value addition, crop residue management etc. Carbon balance studies were taken up for the states of Bihar, Jharkhand, West Bengal and A&N islands to assess the mitigation and adaptation of resilient practices. Zonal monitoring teams visited 32 KVKs during the year and made several suggestions for improving the performance of the KVKs and enhancing impact of the programme. Three day Annual Review Workshop of KVKs under Technology Demonstration Component of NICRA was held at ICAR-CRIDA, Hyderabad during 4^{th}-6^{th} June, 2019 where progress of work done during the year was reviewed and the action plan for the subsequent year for KVKs was thoroughly discussed and suggestions were made.

Contents

1. Introduction

The National Initiative on Climate Resilient Agriculture (NICRA) is a flagship project of the Indian Council of Agricultural Research (ICAR) launched in February, 2011 in the XI Plan Period to comprehensively address issues related to climate change. The National Innovations in Climate Resilient Agriculture project in the XII Plan Period (2012-17) is continuing with the following objectives:

1. To enhance the resilience of Indian agriculture covering crops, livestock and fisheries to climate variability and climate change through development and application of improved production and risk management technologies
2. To demonstrate site specific technology packages on farmers' fields for adapting to current climate risks and
3. To enhance the capacity of scientists and other stakeholders in climate resilient agricultural research and its application.

The Technology Demonstration Component (TDC) is an important component of NICRA, is a participatory approach to address climatic variability. TDC is being implemented in 121 vulnerable village clusters representing 28 states and two union territories. The specific objectives of technology demonstration component are:

- To demonstrate location-specific technologies on farmers' fields for coping with climate variability in vulnerable districts.
- To generate awareness and build capacity of farmers and other stakeholders on climate resilient agriculture.
- To evolve innovative institutional mechanisms at village level that enable communities to respond to climate stresses.

As part of the technology demonstration component, 121 climatically vulnerable districts were identified based on a scientific analysis of climate related problems. The districts selected and their climate vulnerability is depicted in Figure 1.1. Currently the programme is operational in 383 villages of 121 clusters from each of the 121 selected districts. The programme is being implemented by Krishi Vigyan Kendra (KVK) in the district (Table 1.1). Eleven Agricultural Technology Application Research Institutes (ATARIs) are involved in coordinating the project in their respective zones. Planning, coordination and monitoring of the program at the national level is the responsibility of CRIDA. The programme is being implemented through farmer participatory approach.

The predominant climatic vulnerabilities being addressed are drought, prolonged dry spell, flood, cyclone, heat wave, high temperature stress, cold wave, etc. Technology interventions are identified and implemented depending on the biophysical environment and prevalent production systems. Prioritization of interventions is based on extent of exposure of the different farming situations prevalent in the village to climate vulnerability and finalized in consultation with stake holders. Creation of enabling conditions through village level institutions to enhance adoption of the practices and to promote spread of climate resilient technologies among farmers so as to enhance their adaptive capacity and coping ability to climate risks is an important aspect of TDC.

Table 1.1: Zone-wise distribution of KVKs involved in Technology Demonstrations under NICRA

Zone	ATARI (Headquaters)	Domain States and Union Territories	No. of KVKs involved
I	Ludhiana	Jammu & Kashmir (3), Himachal Pradesh (4), Punjab (4) and Uttarakhand (2)	10+3
II	Jodhpur	Haryana (2) and Rajasthan (5)	7
III	Kanpur	Uttar Pradesh (13)	13
IV	Patna	Bihar (7) and Jharkhand (6)	13
V	Kolkata	West Bengal (3), Odisha (5) and UT of Andaman & Nicobar Islands (1)	8 + 1
VI	Guwahati	Assam (5), Arunachal Pradesh (3) and Sikkim (1)	9
VII	Barapani	Tripura (2), Manipur (3), Meghalaya (3), Mizoram (2) and Nagaland (4)	14
VIII	Pune	Maharashtra (8) and Gujarat (5)	13
IX	Jabalpur	Madhya Pradesh (9) and Chhattisgarh (3)	12
X	Hyderabad	Andhra Pradesh (5), Telangana (2) and Tamil Nadu (4)	11
XI	Bengaluru	Karnataka (6) and Kerala (1)	7
		Total: 28 states + 2 UT	**121**

Technology Modules and Interventions

Climate resilient practices and technologies demonstrated can be categorized in to four modules which are as follows:

Module I: Natural Resource Management

Interventions related to *in-situ* moisture conservation, biomass mulching, residue incorporation instead of burning, green manuring, water harvesting and efficient use, improved drainage in flood prone areas, zero tillage, artificial ground water recharge and water saving irrigation methods are being demonstrated.

Module II: Crop Production

Introducing drought/ temperature tolerant varieties, advancement of planting dates of *rabi* crops in areas with terminal heat stress, water saving paddy cultivation methods (SRI, aerobic, direct seeding), frost management in horticulture through fumigation, staggered community nurseries for delayed monsoon, location specific intercropping systems with high sustainable yield index, farming systems are being demonstrated.

Module III: Livestock and Fisheries

Use of community lands for fodder production which can be utilized during droughts/floods, augmentation of fodder production through improved planting material, improved fodder/feed storage methods, fodder enrichment, prophylaxis, improved shelters for reducing heat stress in livestock, management of fish ponds/tanks during water scarcity and excess water and promotion of livestock component as a climate change adaptation strategy are being taken up.

Module IV: Institutional Interventions

Institutional interventions either by strengthening the existing ones or initiating new one relating to community seed bank, fodder bank, custom hiring centre, village climate risk management committee, collective marketing group, commodity groups, are important interventions being taken up as part of the project.

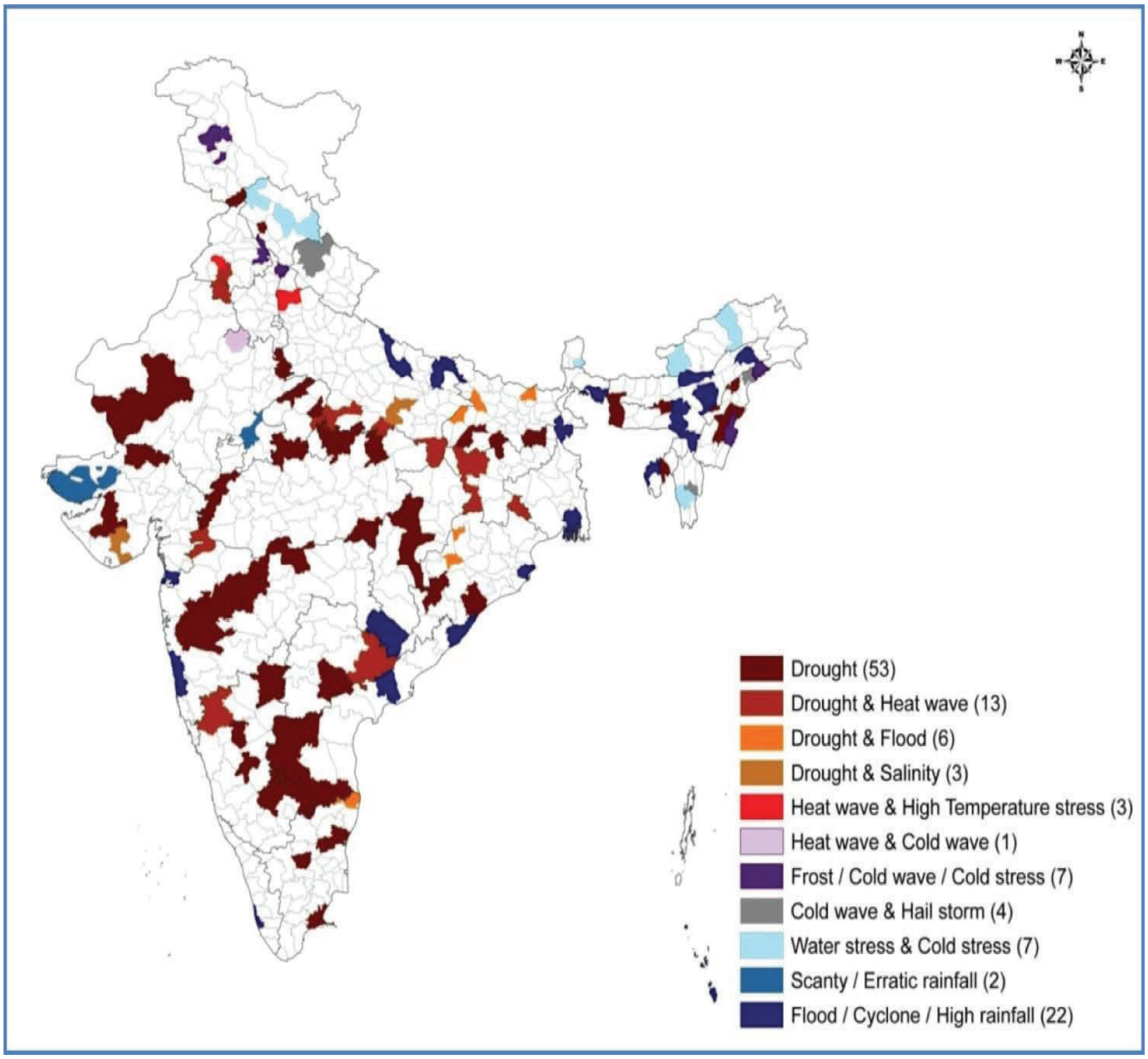


Figure 1.1: Location of 121 NICRA-KVK districts along with the climate vulnerabilities addressed

2. Rainfall Analysis

During the *kharif* 2018, significant variability in rainfall was observed in the project locations. Several NICRA districts received sub normal rainfall. About four NICRA districts have received large deficit rainfall of 60% and above and 46 districts received deficient rainfall between 20-59%. KVKs located in the western region and parts of north east have received deficient rainfall in the months of June and July. Several locations in the Western India, central and eastern India received deficient rainfall during the months of August and September months impacting crop growth at reproductive stage and at maturity. Several project locations in the states of Andhra Pradesh, Karnataka, Gujarat, Madhya Pradesh and Maharashtra experienced prolonged dry spells especially during the months of August and September impacting crop growth and yields.

Table 2.1: Seasonal rainfall and rainfall variability during *kharif* 2018 in different KVKs

State	KVK	Actual rainfall (mm)	Normal rainfall (mm)	% Departure
Arunachal Pradesh	Tirap	783	2386	-67
Gujarat	Kutch	131	361	-64
Gujarat	Banaskanta	215	564	-62
Uttar Pradesh	Kushinagar	208	1158	-82
Andhra Pradesh	Kurnool	281	460	-39
	Chittoor	291	417	-30
	Anantapur	236	323	-27
Arunachal Pradesh	West Kameng	1330	2485	-46
	West Siang	1214	1613	-25
Assam	Dhubri	1144	1917	-40
Bihar	Saran	452	974	-54
	Jehanabad	497	820	-39
	Supaul	785	1056	-26
Chattisgarh	Bilaspur	822	1081	-24
Gujarat	Rajkot	369	577	-36
Himachal Pradesh	Chamba	874	1406	-38
	Kinnaur	180	264	-32
Jharkhand	Koderma	481	930	-48
	Chatra	567	1031	-45
	Godda	641	943	-32
	Palamu	666	975	-32
	Gumla	831	1197	-31
Karnataka	Kalaburgi (Gulbarga)	393	621	-37
	Gadag	236	368	-36
	Kolar	247	383	-35
Madhya Pradesh	Balaghat	983	1335	-26
	Satna	765	953	-20

State	KVK	Actual rainfall (mm)	Normal rainfall (mm)	% Departure
Maharashtra	Nandurbar	564	828	-32
	Aurangabad	408	594	-31
	Jalna	429	606	-29
	Buldana	472	647	-27
	Ahmednagar	340	438	-22
Manipur	Senapati	568	1281	-56
	Imphal East	737	1164	-37
Meghalaya	West Garo Hills	1014	1682	-40
Nagaland	Phek	871	1308	-33
Punjab	Bathinda	209	321	-35
Rajasthan	Barmer	123	243	-49
Tamil Nadu	Thiruvarur	182	296	-39
	Villupuram	257	408	-37
	Ramanathapuram	96	149	-35
	Namakkal	257	339	-24
Tripura	West Tripura	855	1396	-39
Uttar Pradesh	Maharajganj	654	1214	-46
	Gonda	649	1027	-37
	Kaushambi	490	766	-36
	Gorakhpur	845	1176	-28
Uttarakhand	Tehri Garhwal	724	1047	-31
West Bengal	Malda	588	1117	-47
	Coochbehar	1604	2738	-41

Table 2.2: Month wise deficit rainfall during *kharif* 2018 in different districts

State	KVK	Monthly rainfall departure from Normal (%)			
		June	July	August	September
Andhra Pradesh	Anantapur	32	-21	-33	-27
	Kurnool	-6	-37	-43	-39
	Chittoor	7	-29	-36	-30
Arunachal Pradesh	Tirap	-45	-68	-67	-67
	West Kameng	-47	-49	-44	-46
	West Siang	-34	-45	-37	-25
Assam	Cachar	5	-16	-18	-13
	Dhubri	-43	-51	-53	-40
	Dibrugarh	-6	-12	-16	-17
	Sonitpur	-45	-24	-19	-13
	Karbi-Anglong	10	-14	-12	-17
Bihar	Aurangabad	-52	-11	-15	-19
	Jehanabad	-43	-19	-34	-39
	Nawadah	-17	-18	-21	-19
	Saran	-74	-55	-48	-54
	Supaul	-22	-29	-24	-26
Chattisgarh	Bilaspur	8	-14	-18	-24
	Raipur	-4	-7	27	18

Gujarat	Kutch	-100	-75	-59	-64
	Rajkot	-97	-19	-29	-36
	Banaskanta	-87	-45	-55	-62
Himachal Pradesh	Chamba	23	-54	-50	-38
	Hamirpur	18	-12	15	29
	Kinnaur	-30	-31	-48	-32
Jammu & Kashmir	Kathua	2	-28	18	21
Jharkhand	Chatra	-69	-53	-42	-45
	Gumla	-35	0	-16	-31
	Koderma	-68	-51	-48	-48
	Palamu	-41	-31	-27	-32
	Godda	-25	-19	-21	-32
Karnataka	Davanagere	-5	-17	-2	-10
	Kolar	-35	-37	-43	-35
	Gadag	9	-28	-35	-36
	Kalaburgi (Gulbarga)	28	-24	-28	-37
Madhya Pradesh	Balaghat	-20	-17	-21	-26
	Chhatarpur	-18	1	-14	-10
	Guna	37	15	-10	-4
	Satna	-35	-5	-23	-20
Maharashtra	Amravati (Durgapur)	25	0	-14	-19
	Aurangabad	-4	-30	-16	-31
	Buldana	-31	-22	-18	-27
	Nandurbar	-12	-26	-24	-32
	Jalna	-23	-29	-12	-29
Manipur	Imphal East	-12	-23	-26	-37
	Senapati	-62	-42	-47	-56
Meghalaya	West Garo Hills	-40	-38	-40	-40
Odisha	Jharsuguda	-17	-9	-7	-14
	Kalahandi	-60	16	52	40
Rajasthan	Bharatpur	193	81	32	35
	Jhunjhunu	100	19	-8	-2
	Jodhpur	16	12	-11	-15
	Kota	7	1	-11	-4
	Barmer	-47	-36	-41	-49
Sikkim	East Sikkim	-3	-11	-8	-10
Tamil Nadu	Thiruvarur	-10	-13	-24	-39
	Namakkal	-27	-33	-35	-24
	Ramanathapuram	-1	-27	-40	-35
	Villupuram	-15	-51	-45	-37
Telangana	Nalgonda	29	-14	-12	-15
Tripura	West Tripura	1	-24	-34	-39
Uttar Pradesh	Gonda	-73	-41	-29	-37
	Gorakhpur	-9	-12	-18	-28
	Jhansi	-34	-3	-13	-8
	Kushinagar	-94	-80	-79	-82
	Maharajganj	-90	-57	-44	-46
	Sonbhadra	-37	-28	1	1
	Kaushambi	-96	-32	-32	-36
Uttarakhand	Tehri Garhwal	15	-29	-30	-31
	Uttarkashi	14	3	-5	-3
West Bengal	Coochbehar	-47	-38	-43	-41
	Malda	-60	-43	-46	-47
	South 24 Paraganas	23	6	-9	-19

3. Highlights of Technology Demonstrations

3.1 Natural Resource Management

Efficient management of natural resources is key for enhancing resilience and adaptive capacity of farmers to climate change and variability. Successful crop production depends on how effectively we manage moisture and soil during deficient and excess moisture conditions. Various promising, location specific resource management practices were demonstrated so as to enhance their adoption and consequently the adaptive capacity of communities to climate change and variability.

3.1.1 Impact of *in-situ* moisture conservation measures in different rainfall regions

Location specific *in-situ* moisture conservation practices were demonstrated depending on the rainfall received, soil, slope and crops being grown. The aim is to conserve as much moisture as possible in low rainfall regions and harvesting excess runoff and efficient usage of the harvested water for sustainable intensification. During 2018-19, about 244 demonstrations were taken up on *in-situ* measures involving 7221 farmers. The highlights are as follows:

In Said-Sohal village of Kathua, Jammu and Kashmir, *in-situ* moisture conservation measures such as ploughing across the slope and farm bunding in 47 ha area by 59 farmers helped to conserve moisture and to overcome the problem of moisture stress during cropping period. Crop yields of maize, black gram and sesame increased upto 14, 25 and 35 per cent respectively over the farmers' practice (Table 3.1.1).

Table 3.1.1: Crop yields impacted by *in-situ* moisture conservation measures at Kathua district

Intervention	Crop	Crop yields (kg ha^{-1})		Yield improvement (%)
		Farmers' practice	Improved practice	
Ploughing across the slope and bunding	Maize	3200	3650	14
	Black gram	800	1050	25
	Sesame	350	470	35



Ploughing across the slope and bunding and cultivation of sesame and black gram at Kathua in Jammu and Kashmir

At Dunda village of Uttarkashi, digging of trenches helped to conserve moisture and to minimize the problem of moisture stress. Trenches helped to reduce soil erosion, conserved moisture and contributed to regeneration of fodder in the forest land. Trenches coupled with land leveling enhanced pigeon pea yield upto 54.2 per cent over the farmers' practice.

Trenches for in-situ moisture conservation for pigeonpea cultivation at Uttarkasi in Uttarakhand

In Sitara village of Bharatpur, Rajasthan, summer deep ploughing was demonstrated during 2011-13 to enhance infiltration and to reduce salt concentration in the surface soil layers which is a major problem in the district. In view of the impact of the intervention, during 2018, summer deep ploughing was adopted in 45 ha area by 64 farmers in the village. The yield advantage in mustard due to deep summer ploughing was upto 550 kg ha^{-1} over the farmers' practice. This impact was observed in *rabi* crop as well (Table 3.1.2).

Table 3.1.2: Impact of *in-situ* moisture conservation measure on crop yields at Bharatpur, Rajasthan

Intervention	Crop		Average yield (kg ha^{-1})	Gross returns (Rs. ha^{-1})	Net returns (Rs. ha^{-1})	B:C ratio
	Name	Area(ha)				
Without deep ploughing	Mustard	5	1800	75600	53600	1:3.43
With deep ploughing	Mustard	45	2350	98700	73700	1:3.95

Summer deep ploughing and cultivation of mustard at Bharatpur, Rajasthan

Contour bunding, conservation furrow, furrow irrigated raised bed (FIRB), broad bed furrow and summer deep ploughing practices were scaled up in 10, 25, 15, 16 and 425 ha area, involving 8, 6, 15, 10 and 170 farmers, respectively in Chomakot village of Kota. These *in-situ* moisture conservation measures helped to conserve moisture for longer period to overcome moisture stress during the cropping period and contributed to higher yield and income. Wheat grown on FIRB method gave higher yield than farmers' practice (Table 3.1.3).

Table 3.1.3: Wheat yield and economics under FIRB method of planting at Chomakot village of Kota

Interventions	Grain yield (kg ha^{-1})	Gross cost (Rs. ha^{-1})	Gross returns (Rs. ha^{-1})	Net returns (Rs. ha^{-1})	B:C ratio
Farmers' practice	5150	30285	94760	64475	3.13
FIRB	5410	30497	99544	69047	3.26

Summer deep ploughing, broad bed furrow and cultivation of soybean at Kota, Rajasthan

At Titihara village of Chitrakoot, Uttar Pradesh, which lies in the frequently drought prone Bundelkhand region, *in-situ* conservation measures like contour bunding was demonstrated in 3 ha area covering 6 farmers. The intervention of contour bunding enhanced pigeon pea yields and net returns by 320 kg ha^{-1} and Rs. 9,375 ha^{-1}, respectively, over the farmers' practice and B:C ratio increased from 2.56 to 2.83.

Contour bunding and cultivation of pigeon pea at Chitrakoot, Uttar Pradesh

Demonstration of *in-situ* moisture conservation practices such as ridge and furrow and deep summer ploughing in Gandhinagar village of Jhansi, Uttar Pradesh, minimized the impact of moisture stress due to dry spells in 27.3 ha area benefiting 56 farmers in the village. Yields of groundnut and black gram enhanced by 270 and 90 kg ha^{-1} respectively, over the farmers' practice and correspondingly net returns increased by 60 and 16 per cent.

Ridge and furrow, deep ploughing and cultivation of groundnut and chickpea at Jhansi, Uttar Pradesh

At Kukurha village of Buxar, summer ploughing and farm bunding were demonstrated to minimise the impact of variable rainfall in 49.1 ha area involving 71 farmers. The village received deficient rainfall during the months of August and September. *In-situ* measures like farm bunding enhanced yields of pigeon pea compared to the farmers' practice (Table 3.1.4).

Table 3.1.4: Impact of farm bunding on crop yields at Buxar, Bihar

Crop	Crop yields (kg ha^{-1})		Yield improvement (%)
	Farmers' practice	Improved practice	
Rice	3950	4425	12
Pigeon pea	1750	2140	22

Farm bunding and cultivation of rice and pigeon pea at Buxar in Bihar

Contour bunding and trench cum bunding were adopted in 33 ha area and benefited 27 farmers in the village in Mardanpur village of Chatra. This intervention helped to overcome the problem of moisture stress. Trench cum bunding intervention in maize has produced an additional yield of 450 kg ha^{-1} and bunding in rice enhanced yields by 300 kg ha^{-1} over the farmers' practice.

Trench cum bunding in maize at Chatra in Jharkhand

In village Bhelwa of Godda district, adoption of summer deep ploughing and farm bunding was adopted in 10 and 52 ha respectively, benefiting 142 farmers in the village. The yield of rice due to summer ploughing and farm bunding increased by 500 and 300 kg ha^{-1} respectively, over the farmers' practice and net returns increased by Rs. 31,100 and Rs. 27,900 ha^{-1} respectively.

Summer deep ploughing and farm bunding in rice at Godda in Jharkhand

In-situ moisture conservation measures such as ridges and furrows and poly mulching was demonstrated in 4 and 1 ha respectively, covering 20 and 10 farmers in Tharkaspur village of Jharsuguda. Ridge and furrow method was demonstrated for cowpea and radish contributed towards improvement in water use efficiency. Crop yields of cowpea and radish in ridge and furrow system obtained were higher by 1850 and 1400 kg ha^{-1} over the farmers' practice and correspondingly additional net returns obtained were Rs. 28854 and Rs. 13323 ha^{-1} than farmers' practice (Table 3.1.5).

Table 3.1.5: Crop yields and economics under ridge and furrow system at Jharsuguda, Odisha

Crops	Treatment	Area (ha)	Yield (kg ha^{-1})	% Change in yield	Net return (Rs. ha^{-1})	B:C ratio
Radish	Farmers' Practice	0.5	8200	17.00	73427	2.1
	Ridge and furrow method	2.0	9600		86750	2.5
Cowpea	Farmers' Practice	0.4	5800	31.89	49146	2.1
	Ridge and furrow method	4.0	7650		78000	2.7

Ridge and furrow for cowpea and radish and poly mulching in tomato at Jharsuguda in Odisha

Ridges and furrow cultivation in maize was demonstrated as moisture conservation practice in 32 ha area involving 24 farmers in Pipalpada village of Kalahandi. The yield of maize due to ridge and furrow increased by 500 kg ha^{-1} over the farmers' practice and B:C ratio obtained upto 2.06.

Ridge and furrow to conserve moisture in maize crop at Kalahandi in Odisha

Crop residue mulching was demonstrated for ginger in 5.2 ha and plastic mulching for chilli (Red Cherry Pepper) in 3.5 ha involving a total of 58 farmers in Nandok village of East Sikkim. Mulching helped to conserve moisture for longer period under the deficit rainfall conditions in the village. This practice resulted in higher yields of ginger and chilli and net returns were higher upto Rs. 1,16,150 and Rs. 1,42,810 ha^{-1}.

Residue mulching in ginger and plastic mulching in chilli at East Sikkim in Sikkim

Straw mulching was demonstrated in potato and pea for enhancing soil moisture in 8 ha and benefited 8 farmers in the village during the post rainy season with the harvested water in Andro village of Imphal East. Low rainfall was received during October, November and December, which is the crop growing period. Mulching practice helped the crops to survive under dry spells and the yields of potato and pea enhanced upto 28 and 19 per cent respectively over the farmers' practice of no mulching.

Rice straw mulching in potato and pea at Imphal East in Manipur

At shekta village of Aurungabad in Maharashtra, furrow was opened in alternate rows of Bt-cotton and pigeon pea by 100 farmers covering 80 ha area. In spite of deficit rainfall in the September, *in-situ* moisture conservation measure of opening of furrows retained moisture for longer time and made available for the crop growth. The yields of pigeon pea and *Bt*-cotton were enhanced due to opening of furrows in alternate rows. The yields and economics of pigeon pea and Bt-cotton are summarized in Table 3.1.6.

Table 3.1.6: Crop yields and economics enhanced due to conservation furrows in Shekta village of Aurungabad

Crop	Interventions	Seed yield (kg ha^{-1})	Cost of cultivation (Rs. ha^{-1})	Gross income (Rs. ha^{-1})	Net income (Rs. ha^{-1})	B:C ratio
Pigeon pea	Farmers' practice	720	23147	43200	20053	1:1.86
	Conservation furrow	910	24987	54600	29613	1:2.18
Bt-Cotton	Farmers' practice	690	26105	39330	13225	1:1.50
	Conservation furrow	850	28229	48450	20221	1:1.71

Conservation furrows in pigeon pea and Bt-Cotton in Shekta village of Aurangabad, Maharashtra

Impact and spread of conservation furrows in various KVKs

Conservation furrows helps in *in-situ* moisture conservation in standing crops and were demonstrated in 22 locations under NICRA for widely spaced crops and in regions which are prone to prolonged dry spells and droughts such as Anantapur, Kurnool, Nalgonda, Khammam, Amaravati, Aurangabad, etc. The practice was demonstrated in crops like cotton, pigeon pea, castor, groundnut etc. The extent of yield improvement observed was upto 22% over farmers' practice. Convinced with the performance of this practice, several farmers in these districts are now adopting this practice on their own and is spreading fast. For example, in the NICRA villages of Aurangabad, Maharashtra, the technology is being adopted in 80 ha by 100 farmers. The availability of the equipment, field visits to the locations and interactions with the adopted farmers contributed towards the adoption and spread of the technology.

In Jalgaon KT village of Baramati district in Maharashtra, *in-situ* practices, compartmental bunding and broad bed and furrows were adopted by farmers helped to overcome the dry spells during crop growth stages. Sorghum was taken up by farmers during *rabi* and compartmental bunding provided more opportunity time for water to infiltrate into the soil and conserved moisture for crop growth. About 90 farmers covering an area of 72 ha adopted these interventions and obtained higher yields. The yield of *rabi* sorghum enhanced by 730 kg ha^{-1} over the farmers practice.

Compartmental bunding in rabi sorghum at Baramati district of Maharashtra

Ridge and furrow and sowing across the slope was demonstrated in 12 ha area by involving 20 farmers in Chhapri village of Jhabua in Madhya Pradesh. Ridge and furrow was taken up in maize and soybean, provided more time for infiltration and contributed towards improvement in yields in spite of occurrence of dry spells during September month. The yield advantage of maize and soybean was upto 577 kg ha^{-1} and 218 kg ha^{-1} respectively over the farmers' practice (Table 3.1.7).

Table 3.1.7: Impact of ridge and furrow in Jhabua district of Madhya Pradesh on crop yields and economics

Crop	Interventions	Seed yield (kg ha^{-1})	Gross income (Rs. ha^{-1})	Net income (Rs. ha^{-1})	B:C ratio
Soybean	Farmers' practice	1020	31110	12610	1:1.68
	Ridge and furrow	1238	37759	18443	1:1.96
Maize	Farmers' practice	2203	31385	14885	1:0.38
	Ridge and furrow	2780	39615	22265	1:0.80

Ridge and furrow for maize and soybean crops at Jhabua district of Madhya Pradesh

At Fatepura village of Banaskantha district in Gujarat, deep ploughing in summer was practiced as *in-situ* measure in 29 ha area involving 38 farmers in the village. The village experienced dry spells during the August and September. Crop yields were enhanced due to moisture availability at critical stages and improved water use efficiency (Table 3.1.8).

Summer deep ploughings for castor crop as in-situ measure at Banaskantha district in Gujarat

Table 3.1.8: Crop yields and economics due to summer deep ploughings in Banaskantha district of Gujarat

Crop	Intervention	Crop yield (kg ha^{-1})	Gross cost (Rs. ha^{-1})	Gross return (Rs. ha^{-1})	Net return (Rs. ha^{-1})	B:C ratio
Castor	Farmers' practice	2567	25200	66355	41155	2.63
	Deep ploughing	2755	30145	143260	113115	4.75

In frequently drought prone Yagantipalle village of Kurnool, demonstration of *in-situ* conservation practices such as ridge and furrow and conservation furrow were demonstrated in 16 ha area involving 30 farmers. Conservation furrows in pigeon pea helped to cope with deficit rainfall during July, August and September in the village. The crop performed well under dry spells and yield advantage was upto 202 kg ha^{-1} over the check and the additional net income and B:C ratio were Rs. 7251 ha^{-1} and 1.51, respectively (Table 3.1.9).

Table 3.1.9: Yield and economics of pigeon pea due to conservation furrow in Yagantipalle village of Kurnool district, Andhra Pradesh

Interventions	Crop	Seed yield (kg ha^{-1})	Gross cost (Rs. ha^{-1})	Gross returns (Rs. ha^{-1})	Net returns (Rs. ha^{-1})	B:C ratio
Farmers' practice	Pigeon pea	316	14680	16748	2068	1.14
Conservation furrow	Pigeon pea	518	18135	27454	9319	1 .51



Ridge and furrow and conservation furrow in Pigeon pea at Yagantipalle village of Kurnool district

In-situ conservation measures like trench cum bund and polythene mulching were practiced in the Chittecherla village of Chittoor district. Yields of mango got increased by 1000 kg ha^{-1} and net return increased by Rs. 23,798 ha^{-1} due to the intervention. In tomato crop grown with polythene mulching, increased the net returns by Rs. 17,924 ha^{-1} in comparison to no mulching (Table 3.1.10).

Table 3.1.10: Crop yields due to *in-situ* moisture measures in Chittoor district of Andhra Pradesh

Crop	Intervention	Crop yield (kg ha^{-1})	Net return (Rs. ha^{-1})
Mango	Farmers' practice	6740	128498
	Trench cum bunding	7740	152296
Tomato	Farmers' practice	48580	69183
	Plastic mulching	56650	87107


Trench cum bunding and plastic mulching at Chittoor in Andhra Pradesh

Impact, adoption and spread of trench cum bunding

Trench cum bunding is an important *in-situ* conservation practice recommended for low rainfall regions with slopes up to 25%. The practice is being demonstrated in 15 districts as a part of the programme in several crops such as groundnut, pigeon pea, finger millet, cotton, maize, mango *etc*. Yield improvement to the extent of 56% was recorded due to this practice. The practice also helps in minimising soil erosion and the excess water was safely drained from the stone outlet particularly in soils with steep slopes. As part of the TDC of NICRA, so far 24 demonstrations were taken up on trench cum bunding involving 615 farmers in 7 states. There was a demand from the farmers to take up the practice and to facilitate with the department. In some of the NICRA villages, the extent of adoption of the practice was up to 85% of the total rainfed area in the village. The large scale adoption became possible due to convergence with the developmental programmes.

Demonstrations of broad bed and furrow planting in pigeon pea with broad bed furrow planter covering 4 ha by 4 farmers and dead furrows in cotton covering 28.8 ha by 36 farmers were taken up. These interventions helped to conserve moisture and enhanced the productivity under rainfed conditions at Nandyalavari gudem village of Nalgonda and helped to obtain additional yield of 170 kg ha^{-1} from pigeon pea and 253 kg ha^{-1} from cotton over the farmers' practice.

Broad bed and dead furrow systems at Nalgonda in Telangana

At Mahalingapur village of Gadag, conservation furrows in 55 ha area, contour cultivation in 65 ha area and compartmental bunding in 55 ha area was adopted and benefited a total of 412 farmers in the village. These practices encouraged farmers to grow intercropping systems which enhanced income over the farmers' practice. The details of crop yields and economics were summarized in Table 3.1.11.

Table 3.1.11: Crop yields and economics under *in-situ* measures at Mahalingapur village of Gadag district

Particulars	Yield (kg ha^{-1})	Gross cost (Rs. ha^{-1})	Net return (Rs. ha^{-1})	B:C ratio
Farmers' practice (Greengram as a sole crop)	573	24110	3417	1.14
Demo (Green gram + Pigeon pea intercropping) (i) Green gram	532	27385	10539	1.38
(ii) Pigeon pea	299			
Farmers' practice (Maize sole crop)	2477	26150	8528	1.33
Demo: Maize + Pigeon pea intercropping system (i) Maize	2150	29860	12607	1.42
(ii) Pigeon pea	298			

In-situ conservation practices with intercropping systems at Mahalingapur village of Gadag district

Table 3.1.12: Summary of *in-situ* moisture conservation practices across different districts during 2018-19

Interventions	States	Districts	Crops	No. of farmers involved	Area taken up (ha)
Broad bed and furrow	Maharashtra, Madhya Pradesh, Karnataka, Rajasthan	Baramati, Ratnagiri, Jalna, Amravati, Ratlam, Chikkaballapura, Kota	Sorghum, Watermelon, Cucumber, Marigold, Soybean, Pigeon pea, Soybean, Mustard	106	190
Compartmental bunding	Bihar, Karnataka	Banka, Kalaburgi	Chick pea, Sorghum	30	34
Conservation furrow	Bihar, Maharashtra, Andhra Pradesh	Banka, Saran, Chittoor, Anantapur, Kurnool, Jalna, Amravati	Rice, Wheat, Ground nut, Pigeon pea, Cotton	123	335
Field bunding	Jammu and Kashmir, Bihar, Jharkhand, Karnataka, Rajasthan	Kathua, Banka, Buxar, Jehanabad, Saran, Godda, Tumkur, Jodhpur, Kota	Rice, Wheat, Bajra, Soybean	1137	343
FIRB method	Uttar Pradesh, Bihar	Jhansi, Saran	Rice , Wheat	36	17
Land levelling	Uttar Pradesh, Punjab, Gujarat, Karnataka, Bihar, Haryana	Muzaffarnagar, Kaushambi, Sirsa Pratapgarh, Bathinda, Kutch, Tumkur, Jehanabad, Saran	Rice, Finger millet, Wheat	265	185
Mulching	Himachal Pradesh, Uttar Pradesh, Bihar, Assam, Sikkim, Arunachal Pradesh, Tripura, Manipur, Meghalaya, Odisha Maharashtra, Andhra Pradesh, Karnataka	Chamba, Kinnaur, Kullu, Hamirpur, Pratapgarh, Banka, Cachar, Dhubri, Dibrugarh, East Sikkim, Tirap, Dhalai, Imphal East, West Garo Hills, Baramati, Ratnagiri, Chittoor, Chikkaballapura, Baghpat, Jalna, Muzaffarnagar, Jehanabad, Saran, Gonda, Kendrapara	Wheat, Rajmah, Colocasia, Pumpkin, Chilli, Vegetable Pea, Field pea, Bitter gourd, Pea, Tomato, Watermelon, Cucumber, Marigold, Tomato, Okra, Bitter guard, Cauliflower, Brinjal, Litchi, Gauva, Sugarcane	604	248
Ridges and furrow	Himachal Pradesh, Manipur, Karnataka, Maharashtra, Madhya Pradesh, Uttar Pradesh	Hamirpur, Imphal East, Nandurbar, Amravati, Datia, Kalaburgi, Gonda	Rice, Field bean, Black gram, Maize, Pigeon pea, Soybean,	183	366
Summer deep ploughing	Jharkhand, Uttar Pradesh, Bihar, Gujarat, Rajasthan Andhra Pradesh	Bharatpur, Jhunjhunu, Jhansi, Banka, Buxar, Saran, Godda, Rajkot, Anantapur, Jodhpur, Kota	Cluster bean, Groundnut, Rice, Bajra, Soybean	630	1066
Trench cum bunding	Uttar Pradesh, Bihar, Karnataka, Andhra Pradesh, Maharashtra, Uttarakhand	Chitrakoot, Banka, Buxar, Chittoor, Tumkur, Jalna, Uttarkasi	Wheat, Mango, Ground nut, Rice	266	245

3.1.2 Rainwater harvesting and efficient use to enhance resilience

Harvesting water and its efficient utilization is the key intervention for minimising the impact of variable rainfall in various agro-climatic regions of the country. Emphasis has been laid on strengthening of community water harvesting structures in the NICRA villages so as to provide access to water to as many farmers as possible. During the year 2018-19, about 116 demonstrations were taken up involving 2956 farmers. In frequently drought prone regions, emphasis is also laid on recharging of bore and open wells, low cost sand bag check dams where ever possible and other water harvesting systems so as to make water accessible to communities. In frequently flood prone regions, emphasis has been on desilting of drainage channels for faster recession of flood water. Some of the salient achievements are as follows:

In Bharatpur, Rajasthan, community pond was renovated and 66 tube wells got recharged. There are four intensive rain spells of more than 60 mm per day occurred during July and August, helped to fill water harvesting structures created in the village. The harvested water was used for supplemental irrigation during 20 days dry spell occurred during maturity stage of the crop, which benefitted 320 farmers covering an area of 255 ha. Before NICRA, farmers used to grow only mustard but after the initiation of NICRA program, farmers started cultivation of wheat and barley crops. The wheat, barley and mustard yields increased upto 45, 36.4 and 56.3 per cent more compared to farmers without supplemental irrigation in the village.

Utilization of harvested water for critical irrigation to mustard and wheat crops at Bharatpur, Rajasthan

Bore well recharge - Bharatpur

As the ground water is not suitable for irrigation and the salt content of the soil is high, *in-situ* and *ex-situ* harvesting of water and use of harvested water for ensuring optimum plant stand is essential. Water harvesting and bore well recharge is taken up in a big way in the village. About 66 tube wells were recharged and 95% was successfully at a cost of Rs. 10,000 to 12,000 per tube well. Water made available to irrigate 272 ha out of 365 ha of cultivated area. The yield loss in the major *rabi* crops such as wheat, mustered and barley was very less (10%) even in case of prolonged dry spells due to availability of recharged ground water. This technology has also been adopted by the 35 farmers in adjoining villages of Sahenti and Mukundpura in Bharatpur district. Ground water level improved significantly (8 to 10 ft). Water in the tube well, helped farmers to provide pre sowing irrigation to the field for sowing of *rabi* crops when September rains were not received. Area under wheat and barley increased year after year and it helped to minimise the risk of failure of September rains and ensured optimum establishment of *rabi* crops.

Jhunjhunu in Rajasthan is frequently affected by drought, heat wave and cold wave. In the NICRA village, 5 small ponds were constructed/renovated and 11 tube wells were recharged. Due to intensive rainfall during the month of July 2018, helped to fill water harvesting structures created in the village. There were 3 dry spells of 20 days duration in each of the months of July, August and September 2018 and harvested water was used to provide supplemental irrigation during vegetative, developmental and grain filling stages for vegetables and wheat crops which benefitted 16 farmers covering 5.6 ha area. The green gram, cowpea and wheat yield enhanced by 80, 250 and 450 kg ha^{-1} over the farmers' practice and correspondingly net returns increased by Rs. 3,060, Rs. 4,640 and Rs. 8,445 ha^{-1}.


Utilization of harvested water for critical irrigation at Jhunjhunu, Rajasthan

During 2018 in Chomakot village of Kota, constructed/renovated two farm ponds, one community pond, one check dam and recharged open and tube wells through filter units to harvest 457300 cubic meters of water. The harvested water was used to provide supplemental irrigation for 515 ha area during vegetative and flowering stages of the crop and benefited 273 farmers. Before the interventions, only 250 ha area could be provided with supplemental irrigation during dry spells, but after the intervention, it increased upto 515 ha area. The increased yields of mustard, black gram and chickpea increased were upto 360, 60 and 610 kg ha^{-1} over the farmers' practice and correspondingly additional net returns enhanced upto Rs. 12,360, Rs. 5,229 and 9212 ha^{-1}.



Harvested water utilized for supplemental irrigation to chickpea and black gram at Kota, Rajasthan

In Titihara village of Chitrakoot, constructed/renovated two farm ponds and three check dams, which could provide water to cultivate 40 ha area with supplemental irrigation during dry spells, which benefited 77 farmers in the village. There were three high rainfall events of more than 60 mm per day were occurred in each of the months of July, August and September 2018, which helped to fill the water harvesting structures created in the village. The supplemental irrigation given after 50 days of sowing helped to enhance the yields of the crops. The yields of green gram and sesame during *kharif* season were enhanced compared to farmers' practice and the yields of toria and wheat crops were also enhanced compared to farmers' practice during *rabi* season (Table 3.1.13).

Table 3.1.13: Crop yields from the harvested water of check dams at Chitrakoot district, Uttar Pradesh

Crops	Crop yields (kg ha^{-1})	
	Demonstration (one irrigation)	Farmers' practice (No irrigation)
Greengram	860	650
Sesame	1200	850
Toria	1500	1210
Wheat	2950	1360

Utilization of harvested water for supplemental irrigation at Chitrakoot, Uttar Pradesh

Gonda district in Uttar Pradesh is frequently affected by flood. In the NICRA village, desilted and renovated drainage channel lead to quick discharge of flood water from 32 ha area and benefited 105 farmers in the village. NICRA intervention helped to overcome the problem of flooding due to high rainfall in *kharif* season and desilted channel stored excess water, which helped to take *rabi* crops with supplemental irrigation during dry spells. The rice and wheat yields increased by 1820 kg ha^{-1} and 632 kg ha^{-1} respectively over the farmers' practice and correspondingly B:C ratio obtained upto 2.63 and 1.94.

Utilization of harvested water for supplemental irrigation at Gonda, Uttar Pradesh

Impact of check dams in arid regions of Kutch

Low and erratic rainfall, high evaporative transpiration due to high wind velocity, frequent cyclone and drought are the main constraints for successful crop production in Bhalot village of Kutch district in Gujarat state. About 8 check dams were constructed and 19 were renovated for effective water storage with funds of DWDU and 20% contribution from farmers. Moreover, 15 small size check dams were constructed earlier under Agakhan Rural Support Programmes. Due to these interventions, groundwater level has raised by 3 to 6 meter and water in 5 open wells are overflowing during monsoon. Area under irrigation was increased to 120, 115 and 12 ha during *kharif*, *rabi* and summer seasons respectively due to the rainwater harvesting structures. Thus, an area of 247 ha area has been provided access to irrigation which is about 50% of the cultivated area of the village.

In Bishrekhi village of Sonbhadra, construction and renovation of water harvesting structures enhanced the water storage capacity upto 56250 cubic meters, recharged several wells in the village, which provided access to supplemental irrigation for 242 ha area benefiting 55 farmers in the village. There were three intensive rain spells occurred between July and August 2018-19, helped to fill the water harvesting structures and to provide supplemental irrigation during dry spells of more than 15 days observed in August, September and October 2018-19. Rice, mustard and wheat crop yields increased by 1559, 204 and 793 kg ha^{-1} respectively, over the farmers' practice and correspondingly B:C ratio increased to 3.24, 2.56 and 3.51 respectively.

Harvested water used for supplemental irrigation at Sonbhadra in Uttar Pradesh

At Mehra village of Banka, constructed/renovated three Jalkunds, one community pond, recharged 12 open wells with silt trap, constructed one sand bang check dam and desilted one drainage channel and these interventions harvested 22166 cubic meters of water and benefited 86 farmers by providing access to irrigation to 26.5 ha area in the village. High intense rainfalls of 63.6 mm and 63.2 mm occurred on 3^{rd} and 6^{th} July 2018 filled the water harvesting structures created in the village. Harvested water was utilized for giving supplemental irrigation at grain filling stages of the crops which helped to overcome problem of dry spells occurred during October 2018. The yields of rice, chickpea and lentil increased upto 35.86, 35.41 and 28.45 per cent compared to farmers' practice and correspondingly additional net return increased upto Rs. 15,700, Rs. 3100 and Rs. 13,500 ha^{-1} respectively.

Utilization of harvested water for supplemental irrigation at Banka in Bihar

Several districts in Bihar received deficient rainfall during the kharif 2018 severely impacting crop growth. As part of NICRA program, one farm pond, 4 community ponds, 3 open wells with silt trap for recharging, 4 check dams and 5 model ponds were constructed/renovated in Sakrorha village of Jehanabad, which harvested 50866 cubic meter of water. The water harvesting structures in the village were filled due to high rainfall events of 36.4 mm, 40.2 mm and 50.2 mm occurred at 27^{th}, 29^{th} July and 6^{th} August, 2018 respectively, which helped to provide supplemental irrigation for 109 ha area during dry spells occurred in September 2018 and pre sowing irrigation for 27.3 ha area during *rabi* season. The harvested water was used for supplemental irrigation in rice crop during dry spells, and enhanced the rice yield upto 11.73 per cent over the farmers' practice and correspondingly B:C ratio increased from 1.71 to 1.92. The pre sowing irrigation was given to chickpea and lentil crop and increased the crop yields by 560 and 160 kg ha^{-1} and correspondingly B:C ratio upto 4.42 and 3.66 respectively, over the farmers' practice (Table 3.1.14).

Supplemental irrigation using harvested water for rice crop at Jehanabad, Bihar

Table 3.1.14: Use of harvested water as a supplemental irrigation during 2018-19 at Jehanabad

Crops	Farmers' practice yield (kg ha^{-1})	Demo yield (kg ha^{-1})
Rice	3580	4000
Chick pea	1720	2280
Lentil	1310	1470

During the 2018, Harigaon village of Aurangabad received deficient rainfall. Under NICRA, 9 farm ponds were either constructed or renovated, 5 open wells were recharged with silt trap, one arha was desilted and 2 check dams were constructed which harvested 313950 cubic meter of water. There were three high rainfall events of 64.8, 56 and 37.8 mm occurred on 29^{th} July, 2018, 17^{th}, and 23^{rd} August, 2019 respectively, which helped in filling water harvesting structures created in the village. Harvested water was used to give supplemental irrigation for 327 ha during dry spell occurred at grain filling stage in October 2018 and also pre sowing irrigation for 229 ha area during *rabi* season. The harvested water was used as supplemental irrigation for three times for rice crop during dry spells, which enhanced the rice yield by 700 kg ha^{-1} compared to farmers' practice and B:C ratio increased from 2.24 to 2.41. The pre sowing irrigation was given to wheat, chick pea and lentil crop increased the crop yields upto 550, 340 and 370 kg ha^{-1} respectively over the farmers' practice and B:C ratio was 1.92, 2.56 and 3.93 for wheat, chick pea and lentil respectively (Table 3.1.15).

Harvested water used for supplemental irrigation to irrigate wheat and chickpea crops at Aurangabad in Bihar

Table 3.1.15: Use of harvested water as a supplemental irrigation during the year 2018-19 at Aurangabad

Crops	Farmers' practice yield (kg ha^{-1})	Demo yield (kg ha^{-1})
Rice	4236	4935
Wheat	2085	2644
Chick pea	785	1125
Lentil	700	1065

At Lowkeshra village of East Singhbhum, five farm ponds, 40 percolation ponds and three check dams were constructed or renovated, recharged 16 open dug wells and harvested 141780 cubic meter of water to provide supplemental irrigation for 60 ha area in *kharif* season and 44 ha area in *rabi* season, benefited 183 farmers in the village. The high rainfall events occurred were 45.8 mm on 2nd June, 55.2 mm on 13th June, 32.7 mm on 26th June, 30.2 mm on 1st July, 71.6 mm on 18th July, 48.6 mm on 21st July, 79.4 mm on 6th August, 23.6 mm on 16th August, and 46.6 mm on 31st August 2018 respectively, and these high rainfall events helped to fill the water harvesting structures created in the village in different times. Harvested water was used to give supplemental irrigation during dry spells observed at flowering and grain filling stages of the crop. The crop yields of rice, linseed and mustard increased by 1000, 440 and 370 kg ha^{-1} respectively, over the farmers' practice and net returns gained by Rs. 16,000, Rs. 5,300 and Rs. 31445 ha^{-1} (Table 3.1.16).



Utilization of harvested water for critical irrigation at East Singhbhum in Jharkhand

Table 3.1.16: Use of harvested water as a supplemental irrigation at East Singhbhum during the year 2018-19

Crops	Farmers' practice yield (kg ha^{-1})	Demo yield (kg ha^{-1})
Rice	3000	4000
Mustard	390	830
Linseed	478	845

As part of NICRA in Gumla, Jharkhand, 3 farm ponds, 2 community ponds, one percolation tank, eight recharging of open well with silt trap, 9 permanent check dam, 88 sand bag check dam and 12 Dobha were constructed/renovated which helped in harvesting 68574 cubic meter of water. High rainfall events of 34.1, 36.2, 42.3 and 49.4 mm occurred on 3rd, 10th, 25th June and 25th July, 2019 respectively, filled the water harvesting structures in the village. The harvested water helped to provide protective irrigation to 211 ha area in *kharif* season during dry spells and 3230 ha area in *rabi* season as pre-sowing irrigations. The yields of rice and wheat enhanced over the farmers' practice (Table 3.1.17). Though the NICRA village has received deficient rainfall during the year 2018-19, crop yields were not impacted due to critical irrigation provided during the dry spells.

Table 3.1.17: Crop yields from water harvesting structures at Gumla district

Crops	Crop yields (kg ha^{-1})	
	Demo	Farmers' Practice
Rice	3200	2500
Wheat	3600	2700



Sand bag check dam and utilization of harvested water for supplemental irrigation at Gumla, Jharkhand

Impact of sand bag check dam- Gumla

As part of NICRA, KVK-Gumla constructed about 313 sand bag check dams with the involvement of 9285 farmers. The KVK in consultation with the villagers of Gunja decided to try and extend the availability of water in Mahasaria stream by arresting its flow with the help of a sand bag check dam. Nearly 500 villagers gathered on the banks of Mahasaria and started laying sand bags one above the other across the flow of water. The bags were arranged in two rows with about a meter's gap in between in which sand was filled and trampled for the required strength. The series of check dams unleashed farmers' aspirations for cultivating second and third season crops (*rabi* and summer). This was first- of-its-kind initiative by the farmers of Gumla district. The news of success of sand bag check dam in Gunia spread across the district of Gumla and also about KVK, NICRA and its initiatives. The area under second and third crop increased significantly. Over 3200 ha area was sown in this cluster of villages during *rabi* and many more farmers took to cultivation of vegetables during summer. After intervention, *rabi* and summer season area expanded by 80%. The cropping intensity in these areas enhanced by more than 250%. The impact of the sand bag lead to inclusion of this intervention in other developmental programs so that communities can benefit at large.

In the ecologically fragile region of Sunderbans, in South 24 Paraganas district of West Bengal, 35 farm ponds and 4000 m of drainage channel were constructed/desilted and harvested 512000 cubic meter of water which helped in cultivation of 93.4 ha and 234 ha area with supplemental irrigation during *kharif* and *rabi* seasons respectively and benefited a total of 622 farmers in the village. There were six intensive rain spells of more than 60 mm per day occurred during cropping period, which helped to fill all water harvesting bodies and harvested water was utilized to give supplemental irrigation during two dry spells occurred at vegetative and flowering stages of the crop. The yields of rice, green gram and cucumber obtained upto 4180, 830 and 11400 kg ha^{-1} respectively and correspondingly B:C ratio obtained were 1.55, 3.29 and 3.32.

Utilization of harvested water for critical irrigation at South 24 Parganas, West Bengal

At Chopara village of Ganjam, construction/renovation of 2 farm ponds, one community pond, one check dam and recharging of 3 open dug wells with silt trap harvested 33600 cubic meter of water and utilised for providing critical irrigation to 32.2 ha area in *kharif* season and 9 ha area in *rabi* season with pre-sowing and supplemental irrigation during dry spells. The yields of rice and green gram enhanced by 250 and 210 kg ha^{-1} respectively over the farmers' practice. The harvested water also helped to cultivate vegetables like onion and their yield obtained was upto 19000 kg ha^{-1}.

Harvested water for supplemental irrigation at Ganjam in Odisha

Impact of farm ponds

Small scale water harvesting structures at individual farm level enables use of harvested water during critical periods of crop growth and for providing pre-sowing irrigation to *rabi* crops. Farm ponds have been considered as one of the key interventions in NICRA villages and have been widely adopted in the villages. The extent of yield improvement was upto 120% in some of the crops. For example, in village Kadegaon of Jalna district in Maharashtra, 60 demonstrations were conducted on farm ponds providing 2-3 protective irrigation during dry spells. Farm ponds were taken up in a big way in the rainfed districts of Aurangabad, Nawada, Saran, Chatra, Supaul, Mokokchung, Chitrakoot, Kushinagar, Amravati, Anantpur, Aurangabad, Kurnool, Khammam, Pune, Kota, Rajkot, Bilaspur, Dantewada, Datia, Ganjam, Kendrapara, Morena, Chikkballapur, Davangere, Tumkur, Nagapattinam, Namakkal and Ramanathpuram.

In the frequently drought prone district of Datia in Bundelkhand, demonstration of 27 farm ponds and 19 check dams resulted in enhancing the water storage capacity by 176310 cubic meters. Harvested rainwater was used for providing two supplemental irrigations to black gram and groundnut crops at the critical flowering and maturity stages as the village experienced dry spell during the year 2018. This intervention is being taken up in 103 ha benefiting 238 farmers with 42.5 to 39.9% increase in yield of groundnut and black gram. These structures recharged 19 nearby open wells in downstream which retained water till the month of January thus enabled farmers to take up *rabi* crops such as wheat, mustard and vegetables successfully in an area of 277 ha. The yields of wheat and mustard increased upto 19 and 30 per cent respectively over the farmers' practice.

In Bhargawan village of Satna, Madhya Pradesh, desilting of farm pond increased the capacity significantly. The harvested pond water was used for supplemental irrigation through sprinkler during dry spells covering an area of 40 ha and benefited 9 farmers. The yields of rice and wheat were increased by 29 and 30 per cent, respectively over the check.

Water harvesting for critical irrigation at Satna in Madhya Pradesh

In the frequently drought prone district Ahmednagar, of Marathwada in Maharashtra, water storage capacity has been increased by desilting of 9 tanks and 3 KT weirs. The total water storage increased by 64000 cubic meters and benefited 196 wells and 236 bore wells which were used to provide supplemental irrigation.

The water harvesting structures created in the village filled during the high rainfall events of 59 mm on 21st June, 80 mm on 23rd June, 57 mm on 16th August, and 51 mm on October during 2018-19, and helped to give supplemental irrigation during dry spells occurred at vegetative, flowering and grain filling stages of the crops. The yields of soybean and onion enhanced by 395 and 3600 kg ha^{-1} respectively over the farmers' practice and correspondingly additional net returns enhanced upto Rs. 3,589 and Rs. 26,256 ha^{-1} in comparison to the farmers' practice (Table 3.1.18).

Use of water evaporation retardant in farm pond, Nirmal Pimpri village in Ahmednagar, Maharashtra

Table 3.1.18: Use of harvested water for supplemental irrigation at Ahmednagar during the year 2018-19

Crops	Farmers' practice yield (kg ha^{-1})	Demo yield (kg ha^{-1})
Soybean	1520	1915
Onion	28600	32200

In the frequently drought prone Amaravati district of Vidarbha region in Maharashtra, 17 farm ponds, 271 recharge structures for open and bore well with silt trap, 22 check dams, 4038 m drainage channel, 2 Mati Nala and 2 Wanrai bandhara were renovated. In 2018-19, the NICRA village received deficient rainfall during the entire crop growing period. High intense rainfall events occurred at 11th, 19th, 27th, 28th June, 8th, 10th July, 17th, 20th August and 21st October 2019 which were of 26.1, 31.8, 35, 25, 25.1, 33, 55, 29 and 64.1 mm respectively. The water harvesting structures created in the village helped to harvest the water during the cropping period and almost all the water harvesting structures in the village got filled up two times. This helped to provide supplemental irrigation to about 888 ha in the *kharif* season and 684 ha in the *rabi* season. Supplemental irrigation has significantly enhanced soybean yields by 563 kg ha^{-1} over farmers' practice and obtained additional net returns to the tune of Rs. 22237 ha^{-1}. Due to increased water availability the chickpea yields increased by 813 kg ha^{-1} over farmers practice and obtained additional net returns to the tune of Rs. 11,270 ha^{-1} (Table 3.1.19).

Use of harvested and recharged water at Amravati in Maharashtra

Table 3.1.19: Use of harvested water for supplemental irrigation during the year 2018-19 at Amravati

Crops	Farmers' practice yield (kg ha^{-1})	Demo yield (kg ha^{-1})
Soybean	1562.0	2125.0
Chick pea	1437.0	2250.0

Desilting of check dam was taken up during 2018 which has contributed towards increase in groundwater table by 7 feet and recharged 19 bore wells covering 24.5 ha of land at Fatepura village of Banasakanta, Gujarat,. The harvested water was efficiently used through micro irrigation systems and these systems were scaled-up in village resulting in an increase in area from 25.67 to 170 ha in 4 years. About 5 farm ponds were constructed for water harvesting and recharging of bore well and two drainage channels in the village were renovated for quick drainage of excess rainfall. Due to NRM interventions Bt. Cotton yield has increased by 490 kg ha^{-1} with net returns of Rs. 22,000 ha^{-1}over farmers' practice.

Utilization of harvested water for critical irrigation at Banasakanta of Gujarat

Chittecherla village of Chittoor district is frequently affected by drought. In the village, 9 farm ponds and 8 artificial groundwater recharge structures were constructed. The total area having access to water from the project is 96 ha benefiting 208 farmers. Groundnut is the predominant crop grown in this NICRA village and in the district during *kharif* season. During 2018, crop experienced a dry spell of 10 days in September and critical irrigation resulted in an additional yield of 700 kg ha^{-1} over the rainfed crop. Supplemental irrigation was provided using rain gun and sprinklers during dry spells occurred at flowering stage of the crop and resulted in higher income to the extent of Rs. 14,284 ha^{-1} and the B:C ratio increased from 1.14 to 1.43.

Harvested water for critical irrigation at Chittoor, Andhra Pradesh

At Nacharam village of Khammam, construction/renovation of 4 farm ponds, 2 community ponds and one check dam harvested 4832475 liter of water. There were two high rainfall events of more than 60 mm per day occurred in the month of August 2019 which helped to fill water harvesting structures in the village. The harvested water was utilized to give supplemental irrigation during dry spell occurred at grain filling stage of rice crop and bulb formation stage of cotton. The crop yields of rice and cotton enhanced by 350 and 150 kg ha^{-1} respectively over the farmers' practice and correspondingly net return increased by Rs. 10,139 and Rs. 6,335 ha^{-1} than farmers' practice.

Water harvesting and utilization for supplemental irrigation at Khammam of Telangana

At Vadavathur village of Namakkal, one old community pond was renovated during the year 2018 and the capacity after the renovation was 12453 cubic meter and area under cultivation increased from 13.6 ha to 29.6 ha. Supplemental irrigation became possible due to recharge of open and bore wells and the yields of groundnut and black gram were increased by 1040 and 2040 kg ha^{-1} resulting in an additional income of Rs. 46,300 and Rs. 11,080 ha^{-1} respectively. The B:C ratio from groundnut and black gram with supplemental irrigation were 2.81 and 2.63 respectively. The water harvesting in this village helped to expand the area under small onion cultivation from 320 ha to 425 ha. Small onion is one of the important commercial crop and increased water storage helped in reducing the impact of dry spells during the *kharif* and also enhanced net returns.

Utilization of harvested water for supplemental irrigation at Namakkal, Tamil Nadu

Impact of community pond - Namakkal

Large number of tanks with substantial water storage capacity constructed long ago have become defunct due to neglect, non-maintenance and silting up. The rich silt deposited in these structures were removed and used by farmers for spreading in the fields, wherever necessary, to improve the water holding capacity of soils. This intervention increased the surface water storage and groundwater recharge in wells located nearer to the tanks. Four community ponds repaired at the NICRA villages of Vadavathur and Jambumadai in Namakkal district helped to harvest 58, 509 m^3 of water during last four years. The stored water recharged 354 bore wells and 135 open wells in the vicinity of the community ponds. This intervention enabled 254 ha of land under supplemental irrigation during *rabi* season and the farmers raised high value vegetable, flower and horticultural crops with micro irrigation facility.

At D. Nagenahalli village of Tumakuru, two farm ponds, one community pond and two check dams were constructed/renovated during the year 2018. In two farm ponds, the storage capacity created was 200 m^3, which got filled three times. Supplemental irrigation of stored water from farm ponds through furrow enhanced the rice, finger millet and groundnut yield by 930, 730 and 120 kg ha^{-1} compared to farmers' practice of no irrigation. With supplemental irrigation of stored water from check dams through furrow and sprinkler during the dry spells, the yield of finger millet was enhanced. From the two renovated check dams, the groundwater levels has improved significantly in bore wells and in open wells. This helped 15 farmers to grow tomato and chrysanthemum during the *rabi* season, which provided additional returns upto Rs. 20,000 which is otherwise not possible without water harvesting (Table 3.1.20).

Table 3.1.20: Crop acreage and yields with the intervention of water harvesting structures at Tumkuru district

Crops	Area (ha)		Crop yields (kg ha^{-1})	
	Before	After	Demo	Farmers' practice
Groundnut	1	1	960	840
Finger millet	2	3.5	2680	1950
Rice	0.2	0.4	3420	2680

Harvested water for critical irrigation at D. Nagenahalli, Karnataka

3.1.3 Harvesting water in Himalayan Regions - boon to farmers in hilly region

At Lagga village of Chamba, two Jalkunds and one check dam were constructed/renovated which filled twice during June and September was used to provide irrigations during transplanting and heading stages of crops in *kharif* season and pre sowing irrigation for *rabi* crops and benefited 102 farmers covering 89 ha area. Before the intervention, farmers used to grow maize and yielded 2160 kg ha^{-1} whereas, after the intervention, farmers started cultivating high value vegetable crop cabbage with an yield of 23050 kg ha^{-1} and helped farmer in getting additional profits compared to earlier practice (Table 3.1.21).

Table 3.1.21: Crop yields due to irrigation from the harvested water at Chamba, Himachal Pradesh

Intervention	Crops	Area (ha)	Yields (kg ha^{-1})
Supplemental irrigation	Cabbage	2.5	23050
Farmers' practice	Maize	3.4	2160

Utilization of harvested water for irrigation in cabbage at Chamba, Himachal Pradesh

At Mann village of Hamirpur, 6 Jalkunds were constructed during the year 2018. Harvested water helped to give irrigations at transplanting and vegetative stages for cauliflower in 0.32 ha area during dry spells, thereby increased crop yield and additional income by 8000 kg ha^{-1} and Rs. 1,60,000 ha^{-1} over no irrigation.


Harvested water for irrigation to cauliflower at Hamirpur, Himachal Pradesh

In Chhoel Gaduari village of Kullu, four Jalkunds with storage of 110 m^3 of water, 36 water tanks and one community tank were constructed/renovated and used to provide supplemental irrigation to *kharif* crops during dry spells and pre sowing irrigation for *rabi* crops and benefitted 65 farmers covering 27 ha area. Before the intervention, farmers used to grow maize and wheat crops with yields of 2920 and 2600 kg ha^{-1} respectively. After the interventions, farmers started cultivating high value vegetable crops like tomato with irrigations at seedling establishment and fruit development stage and garlic with irrigations at vegetative and bulbing stages and obtained yields of 34580 kg ha^{-1} and 12550 kg ha^{-1} respectively. Farmers received additional profit of Rs. 3,73,800 and Rs. 1,73,507 ha^{-1} from tomato and garlic respectively, compared to earlier practice (Table 3.1.22).

Table 3.1.22: Crop acreage and yields due to water harvesting structures at Kullu district

Demo crops	Farmers crops	Area (ha)		Crop yields (kg ha^{-1})	
		Before	After	Demo	Farmers' practice
Tomato	Maize	0.6	4.6	34580	2920
Garlic	Wheat	8.5	15.0	12550	2600



Water harvested in community tanks for irrigating tomato and garlic crops at Kullu, Himachal Pradesh

At Kaleth village of Tehri Garhwal, one farm pond was constructed/desilted which got filled thrice and harvested water (48000 cubic meter) and also constructed water tanks and two drainage channels. These interventions helped to provide supplemental irrigation for 25 ha during dry spells and benefitted 45 farmers. The yields of rice and wheat increased by 1600 and 500 kg ha^{-1} respectively over the farmers' practice and farmers started growing high value vegetable crops after the NICRA interventions. The yields of capsicum and tomato increased over the farmers' practice and correspondingly additional net return obtained upto Rs. 63,000 and Rs. 75,000 ha^{-1} inspite of deficient rainfall received during the year (Table 3.1.23).

Utilization of harvested water from farm pond to irrigate rice and wheat at Tehri Garhwal, Uttarakhand

Table 3.1.23: Impact of farm pond in Tehri Garhwal, Uttarakhand

Area irrigated (ha)				Crops cultivated				Average crop yields (kg ha^{-1})			
Kharif		*Rabi*		*Kharif*		*Rabi*		*Kharif*		*Rabi*	
Before	After	Before	After	Before	After	Before	After	Before	After	Before	After
3.0	5.0	3.0	5.0	Rice	Rice	Wheat	Wheat Tomato Capsicum	1100	2700	500	1000 11500 12600

At Dunda village of Uttarkashi, 18 LDPE tanks were constructed/repaired and harvested 216000 m^3 of water which helped to give supplemental irrigation for high value vegetable crops in 1.7 ha area and benefitted 18 farmers in the village. The yields of okra, vegetable pea and cabbage were enhanced by 26.48, 27.37 and 23.0 per cent respectively, over the farmers' practice and the net returns obtained upto Rs. 50,200, Rs. 75,225 and 57500 ha^{-1} over the farmers' practice.

Water harvesting for supplemental irrigation at Uttarkashi, Uttarakhand

Impact of Jalkunds -East Sikkim

In East Sikkim, Jalkunds were constructed for harvesting runoff water. This technology of water harvesting is gaining popularity in the village. About 72 Jalkunds were constructed in the village and harvested 3040 m^3 of water. Before the intervention, only single crop of maize was cultivated during *kharif* and leave the field was left fallow during *rabi* season. The returns from farming were very nominal. Increased availability of water encouraged the farmers to diversify the cropping system with organic cabbage, cauliflower, broccoli cultivation and vegetable seedlings production with low cost structures during the *rabi* season was taken up. Efficient use of Jalkund water to irrigate *rabi* crops during dry spells with micro-irrigation systems (sprinkler and drip) made vegetable production a profitable venture in East Sikkim.

Dhubri district receives a seasonal rainfall of 2692 mm and farmers in the village generally grow rice, toria, black gram and high value vegetable crops under rainfed conditions. At Udmari village, 6 Jalkunds, one check dam and 12000 m drainage channel were renovated resulting in harvest of significant quantity of water. The harvested water was utilized to provide supplementary irrigation to more than 100 ha area during *kharif* season and 22 ha area in *rabi* season and benefitted 594 farmers in the village. The yields of rice, black gram and toria were enhanced by 1120, 85 and 182 kg ha^{-1} respectively more compared to pre-NICRA period and correspondingly B:C ratio obtained upto 1.61 and 2.12 and 1.57.

Utilization of harvested water for supplemental irrigation at Dhubri, Assam

At Purandarpur village of Cachar, 7 Jalkunds and 3 community ponds were constructed/renovated and harvested 1613 cubic meter of water and provided 10 ha area with supplemental irrigation during dry spells. The NICRA interventions helped to grow broccoli, tomato and coriander and average yields upto 12,000, 60,000 and 4000 kg ha^{-1} respectively were realized and correspondingly B:C ratio were 3.69, 4.48 and 1.92 respectively.

Water harvesting for supplemental irrigation at Cachar in Assam

At Nandok village of East Sikkim, during the year 2018, 11 Jalkunds were constructed/renovated and it helped to cultivate 12.5 ha area with supplemental irrigation and benefitted 72 farmers in the village. The yields of cabbage, cauliflower, broccoli, vegetable pea and tomato were increased by 48.9, 47.3, 59.6, 29.4 and 7.97 per cent respectively over the farmers' practice and correspondingly net returns increased by Rs. 64610, Rs. 62,732, Rs. 151160, Rs. 11010 and Rs. 94820 ha^{-1} than the farmers' practice.

Water harvesting and its utilization for supplemental irrigation at East Sikkim

In North Pulinpur village of Khowai district of Tripura, 12 Jalkunds and 4 community ponds were constructed/ renovated, which helped to cultivate 55 ha area with pre sowing and supplemental irrigation during *rabi* season and benefitted 32 farmers in the village. The yield and net return from maize crop increased upto 79 and 74 per cent respectively over the farmers' practice.

Harvested water for supplemental irrigation in Maize at Khowai in Tripura

In Dhansiripar village of Dimapur, 15 Jalkunds and one check dam was constructed/renovated and harvested 4360 cubic meter of water which helped to grow high value vegetable crops with supplemental irrigation. Due to the check dam, groundwater level increased considerably in nearby areas and it increased rice yields and cultivation of *rabi* crops. The Jalkunds provided source of irrigation for growing vegetables. The yields of crops were summarized in Table 3.1.24.

Table 3.1.24: Yields of crops cultivated near check dam at Dhansiripar village of Dimapur

Crops cultivated				Average crop yields (kg ha^{-1})			
Kharif		***Rabi***		***Kharif***		***Rabi***	
Before	**After**	**Before**	**After**	**Before**	**After**	**Before**	**After**
Rice	Rice	-	Toria	2450	3050	-	860

Water harvesting and supplemental irrigation at Dimapur, Nagaland

At Aliba village of Mokokchung, construction/renovation of 14 Jalkunds resulted in harvesting of 90000 liters of water which helped to give supplemental irrigation to 7.5 ha during *kharif* and 3 ha area during *rabi* season respectively. The yields of cucumber and broccoli were increased by 45 and 39 per cent respectively over the farmers' practice.

Utilization of harvested water for supplemental irrigation at Mokokchung, Nagaland

In Ramva village of Ukhurl, construction/renovation of 5 Jalkunds helped to provide life saving irrigation to garden pea in 1 ha area during *rabi* season and benefitted 5 farmers. The yield and net return from garden pea were increased by 600 kg ha^{-1} and Rs. 840000 ha^{-1} respectively over the farmers' practice and B:C ratio increased from 1.8 to 3.2.

Water harvesting for supplemental irrigation at Ukhrul, Manipur

At Andro village of Imphal East, construction/renovation of 18 jalkunds, one community pond and 3 check dams harvested 14685 cubic meter of water and provided access to supplemental irrigation to 41.5 ha area during *kharif* season and 20 ha area during *rabi* season. The yields of rice and pea increased by 800 and 600 kg ha^{-1} respectively over the farmers' practice (Table 3.1.25).

Table 3.1.25: Crop yields with irrigation from check dams at Andro village of Imphal East

Crops cultivated		Average crop yields (kg ha^{-1})			
Kharif	***Rabi***	***Kharif***		***Rabi***	
		Before	After	Before	After
Rice	Pea	4800	5600	7200	7800

Utilization of harvested water for supplemental irrigation at Imphal East, Manipur

At Umjalasiaw village of Jaintia Hills, 8 Jalkunds were constructed since the inception of the NICRA project and benefited 4 farmers each covering an area of 4.0 ha. Before interventions, there was no area under cultivation and supplemental irrigation became possible after NICRA interventions and the yield of tomato and cabbage were 28500 and 12500 kg ha^{-1} respectively and correspondingly net returns of Rs. 12,5000 and Rs. 91,220 ha^{-1} was realized in spite of deficient of rainfall received during the year.

Water harvesting and its utilization for supplemental irrigation at Jaintia Hills, Meghalaya

Table 3.1.26: Summary of rain water harvesting structures being taken up during 2018-19

Interventions	States	Districts	Crops	No. of farmers benefited	Area irrigated (ha)
Bore well recharging	Rajasthan, Assam, Karnataka, Bihar	Bharatpur, Dibrugarh, Chikkaballapura, Saran	Rice, Carrot, Wheat	120	120
Check dam	Uttar Pradesh, Nagaland, Maharashtra, Karnataka, Bihar, Rajasthan	Jhansi, Dimapur, Baramati, Davanagere, Chikkaballapura, Tumkur, Jehanabad, Saran, Kota	Wheat, Chickpea, Rice, Pigeon pea, Bajra, Sorghum, Bengal gram, Maize, Tomato, Soybean, Black gram, Mustard	242	277
Community pond	Jammu and Kashmir, Bihar, Assam, Gujarat	Kathua, Banka, Jehanabad, Saran, Cachar, Kutch	Rice, Chick pea, *Rabi* Vegetables, Wheat, Mustard	176	103
Desilting	Andhra Pradesh, Tamil Nadu, Karnataka	Anantapur, Thiruvarur, Tumkur	Groundnut, Rice, China aster	545	105
Farm pond	Assam, Manipur, Nagaland, Maharashtra, Karnataka, Uttarakhand, Bihar, Andaman and Nicobar, Rajasthan	Cachar, Imphal East, Mokokchung, Baramati, Chikkaballapura, Tumkur, Uttarkashi, Jehanabad, Saran, Port blair, Jodhpur, Kota	Duck cum Fish cum Horticulture, cucumber, Broccoli, Bajra, Fodder maize, Sorghum, Bengal gram, Wheat, Ragi, China aster, Rice, Mustard, Lentil	217	73
Groundwater recharge	Gujarat, Madhya Pradesh, Karnataka, Maharashtra, Gujarat, Odisha, Bihar	Amreli, Balaghat, Datia, Gadag, Aurangabad, Valsad, Kalahandi, Saran	Cotton, Groundnut, Sesame, Castor, Rice, Chilli, Brinjal, Tomato, Soybean,	296	315
Jalkund	Assam, Sikkim, Arunachal Pradesh, Meghalaya, Manipur, Andaman and Nicobar	Cachar, Karbi-anglong, Sonitpur, East Sikkim, Tirap, West Siang, Jaintia Hills, Ri Bhoi, West Garo Hills, Ukhrul, Port blair	Potato, Rajmah, Broccoli, Cauliflower, Brinjal, Cabbage, Tomato, Green Magic, Coriander, Garden Pea	105	20
Nala bund	Karnataka	Chikkaballapura	Ragi	4	4
Open well recharging	Uttar Pradesh, Madhya Pradesh, Bihar	Jhansi, Ratlam, Jehanabad, Saran	Wheat, Groundnut, Mustard, Rice	106	64
Percolation tank	Madhya Pradesh, Karnataka, Bihar	Ratlam, Chikkaballapura, Saran	Wheat, Groundnut, Pointed gourd	17	5
Rainwater harvesting	Jammu and Kashmir, Jharkhand, West Bengal, Nagaland, Gujarat, Chhatisgarh, Madhya Pradesh, Karnataka, Maharashtra, Punjab, Uttarkhand, Odisha	Pulwama, Palamu, South 24-paraganas, Lunglei, Rajkot, Bhatapara, Bilaspur, Dantewada, Chhatarpur, Guna, Satna, Tikamgarh, Belgaum, Aurangabad, Faridkot, Tehri Garhwal, Ganjam	French bean, Rice, Wheat, Barley, Chilli, Wheat, Mustard, Chickpea, Maize, Soybean, Jowar, Capsicum	941	890
Sand bag check dam	Bihar, Maharashtra	Banka, Nandurbar	Lentil, Soybean	33	14.5

3.2 Crops and Cropping systems

Climate resilient varieties for drought, moisture stress, floods, heat and cold waves and soil salinity were demonstrated in various parts of the country. Resilient intercropping systems with improved varieties were demonstrated for stabilizing yields and for efficient resource use and higher land utilisation. Crop diversification with high value and suitable drought tolerant crops were taken up against frequent crop failure. In case of paddy and wheat cropping systems, System of Rice Intensification (SRI), Direct Seeded Rice (DSR), zero tillage of wheat were demonstrated for water saving and mitigation of greenhouse gases. Protected cultivation in hilly areas and Himalayan region were taken up to demonstrate production of high value crops and vegetables during the entire season.

3.2.1 Short duration and improved / drought escaping varieties:

Demonstration of short duration and improved varieties which can perform under shortened growing season due to either delayed onset or early withdrawal of monsoon is an important intervention being taken up in the programme. During the year 2018-19, about 177 demonstrations of 38 crops are being demonstrated involving about 4984 farmers. In addition, drought tolerant cultivars of crops commonly grown under rainfed conditions were demonstrated on a significant scale. The salient findings are as follows:

Short duration paddy variety Naveen, suitable for direct seeding under rainfed situation was demonstrated in NICRA village Dulshulma and Murma of Palamu district in Jharkhand. Crop was sown in the month of June under rainfed condition and produced 38.2 q ha^{-1} of grain yield compared to local variety of 29.8 q ha^{-1}. The improved variety produced 29% higher yield and demonstrated in 10 ha area involving 34 farmers.

Demonstration of short duration paddy variety Naveen at Palamu district of Jharkhand

Table 3.2.1: Crop yield and economics of drought tolerant paddy variety Naveen at Palamu district of Jharkhand

Treatments	Yield (q ha^{-1})	Cost of cultivation (Rs. ha^{-1})	Gross income (Rs.ha^{-1})	Net income (Rs. ha^{-1})	B:C ratio
Farmers' practice	29.8	24578	37262	12684	1.51
Improved - Naveen	38.2	27375	53480	26105	1.95

Rice variety Anjali is drought tolerant, semi-tall (85-90 cm) and early maturing (95-95 days), In NICRA village of Mardanpur in Chatra district, Anjali variety was demonstrated under delayed monsoon condition. The variety has produced 26.0 q ha^{-1} of grain yield with benefit cost ratio of 1.91. Other improved varieties of paddy *i.e.,* Vandana, Abhishek and Sahbhagi dhan were demonstrated earlier which were accepted by communities and spread in considerable area in the district.

Table 3.2.2: Crop yield and economics of short duration paddy variety Anjali in Chatra district of Jharkhand.

Treatments	Yield (q ha^{-1})	Cost of cultivation (Rs.ha^{-1})	Gross income (Rs.ha^{-1})	Net income (Rs.ha^{-1})	B:C ratio
Farmers' practice	20.0	23200	34200	11000	1.47
Improved-Anjali	26.0	24400	46800	22400	1.91

Harigoan village of Aurangabad in Bihar district received 59% and 24% deficit rainfall during June and September months, respectively. Demonstration of short duration paddy varieties Sahbhagi dhan and Sabour Ardhjal were conducted at farmer's field. These short duration (110-120 days) drought tolerant varieties can play and important role in sustainable intensification. These varieties gave 10 per cent additional yield and net returns of Rs. 38,000 ha^{-1} compared to lower yields in traditional long duration varieties. During 2018, 90 farmers were benefitted due to cultivation of short duration variety in the village in area of 90 ha under these varieties in NICRA and adjoining villages under drought situation.

Table 3.2.3: Crop yields and economics of short duration varieties of paddy at Aurangabad district of Bihar

Treatments	Yield (q ha^{-1})	Cost of cultivation (Rs. ha^{-1})	Gross income (Rs. ha^{-1})	Net income (Rs. ha^{-1})	B:C Ratio
Farmer's practice-Paddy (MTU-7029)	41.25	27730	62250	34250	2.24
Improved-Sahbhagi dhan	44.22	28215	66330	38205	2.35
Improved-Sabour Ardhjal	43.36	26890	65040	38150	2.41

Short duration linseed varieties Divya, Priyam and Neelam were introduced in rice fallows replacing traditional long duration linseed variety T-397 in East Singhbhum district of Jharkhand. However, Divya, Priyam and Neelam recorded 76, 35 and 46 per cent higher yields compared to local variety with B:C ratio of 1.69, 1.30 and 1.43 respectively.

Table 3.2.4: Crop yields and economics of linseed cultivars at East Singhbhum district of Jharkhand

Treatments	Yield (q ha^{-1})	Cost of cultivation (Rs. ha^{-1})	Gross income (Rs. ha^{-1})	Net income (Rs. ha^{-1})	B:C Ratio
Farmer's practice Linseed (T-397)	4.80	8000	9600	1600	1.20
Improved-Divya	8.45	10000	16900	6900	1.69
Improved-Priyam	6.50	10000	13000	3000	1.30
Improved-Neelam	7.15	10000	14300	4300	1.43

Demonstration of short duration linseed (Divya) at East Singhbhum, Jharkhand

Short duration rice varieties were introduced in NICRA village, Badhauchhi Kalan of KVK-Fatehgarh Sahib replacing local long duration paddy variety PUSA-44 which was susceptible to diseases. Short-duration paddy varieties PR-126 (125 days) and Pusa Basmati 1509 (120 days) a semi-dwarf (95-100 cm) basmati rice variety were demonstrated for early sowing of wheat (*rabi*) crop. Both varieties performed well with additional productivity of 2.6 and 1.4 q ha^{-1} compared to control with less water. The short duration varieties provide an opportunity for timely sowing of wheat and provide sufficient time for decomposition of paddy residue, if incorporated.

Table 3.2.5: Crop yield and economics of short duration paddy varieties PR-126 and Pusa Basmati 1509 at Fatehgarh Sahib district of Punjab

Treatments	Yield (q ha^{-1})	Cost of cultivation (Rs. ha^{-1})	Gross income (Rs. ha^{-1})	Net income (Rs. ha^{-1})	B:C ratio
Improved - Paddy PR-126	74.0	28840	117660	88820	4.08
Improved - Pusa Basmati 1509	40.6	35525	136010	100485	3.82

Demonstration of short duration paddy varieties PR-126 and Pusa Basmati 1509 at Fatehgarh Sahib, Punjab

Kathua district of Jammu and Kashmir received 42.8 mm and 200.70 mm of rainfall during June and July months, respectively. Short duration paddy cultivars NDR 97 and Pusa Basmati 1509 were demonstrated replacing traditional sharbhati paddy varieties under moisture deficit condition. The short duration varieties *viz.,* NDR 97 and Pusa Basmati 1509 recorded 25 and 34 per cent higher productivity and B:C ratio of 2.02 and 3.34, respectively, while cost of cultivation was similar for both traditional and short duration varieties.


Demonstration of short duration paddy varieties NDR 97 and Pusa Basmati 1509 in Kathua district of Jammu and Kashmir

Short duration cluster bean variety (RGC-HG-2-20) which mature in 90-100 days escaped the terminal drought and dry spells in NICRA village, Sitara of KVK-Bharatpur. The short duration cultivar of cluster bean performed well under low rainfall situation in the month of June (94 mm) and recorded yield of 16.80 q ha^{-1} compared to farmer's practice (15.0 q ha^{-1}). Similarly, short duration and improved cluster bean variety

(HG 2-20) at NICRA village, Rupana Khurd of Sirsa district produced 33 per cent additional yield compared to the old cultivar HG-563.

In NICRA village, Chomakot of KVK-Kota introduced short duration and YMV tolerant high yielding blackgram variety Pratap Urd-31 as alternative to soybean which gets regularly impacted by erratic rainfall received during *kharif* season. The improved variety Pratap Urd-31 recorded significantly higher yield (480 kg ha^{-1}) compared to farmer's practice (350 kg ha^{-1}).

Table 3.2.6: Crop yield and economics of short duration blackgram variety Pratap Urd-31 at Kota district of Rajasthan

Treatments	Yield (q ha^{-1})	Cost of cultivation (Rs. ha^{-1})	Gross income (Rs. ha^{-1})	Net income (Rs. ha^{-1})	B:C ratio
Farmer's practice - Local variety	3.50	15250	19600	4350	1.29
Improved - Pratap Urd-31	4.80	17301	26880	9579	1.55

Demonstration of short duration blackgram variety Pratap Urd-31 at Kota, Rajasthan

Short duration and improved variety of chickpea (GJG-5) and cumin (GC-4) was introduced at NICRA village Magharwada of Rajkot district in Gujarat. Entire *kharif* season rainfall was distributed in 15 rainy days and crop suffered form long dry spells in June, August and September. Improved varieties of chick pea and cumin produced 14 and 17% higher yield compared to traditional varieties with B:C ratio of 3.88 and 5.16, respectively.

Table 3.2.7: Crop yields and economics of short duration and improved varieties of chick pea and cumin at Rajkot district of Gujarat

Treatments	Yield (q ha^{-1})	Cost of cultivation (Rs. ha^{-1})	Gross income (Rs. ha^{-1})	Net income (Rs. ha^{-1})	B:C ratio
Farmers' practice- chickpea local variety	11.90	21695	65305	43610	3.01
Improved-chickpea (GJG-5)	13.60	22625	87925	65300	3.88
Farmers' practice-cumin local variety	6.32	27640	129565	104850	4.68
Improved- cumin (GC-4)	7.45	28215	145280	117155	5.16

Demonstration of short duration and improved varieties of chickpea (GJG-5) and cumin (GC-4) at Rajkot district of Gujarat

Improved variety of wheat (Raj-4120) was demonstrated in Jhansi, Uttar Pradesh which can tolerate heat stress. Demonstrations were taken up in 45 farmer's fields resulted in an average 38 per cent higher yield compared to local variety. Likewise, heat tolerant chickpea variety (JG-14) produced higher yield in comparison to the traditional chickpea with net income of Rs. 58,166 ha^{-1} and B:C ratio of 3.99.

Table 3.2.8: Crop yield and economics of heat tolerant wheat (Raj-4120) and chick pea (JG-14) in Jhansi district of Uttar Pradesh

Treatments	Yield (q ha^{-1})	Cost of cultivation (Rs. ha^{-1})	Gross income (Rs. ha^{-1})	Net income (Rs. ha^{-1})	B:C ratio
Farmers' practice-wheat local variety	31.50	21050	57960	36910	2.75
Improved-wheat (Raj-4120)	43.70	22100	80408	58308	3.63
Farmers' practice-chickpea local variety	11.60	18750	53592	34842	2.85
Improved-chickpea (JG-14)	16.80	19450	77616	58166	3.99

Demonstration of heat tolerant wheat (Raj-4120) and chick pea (JG-14) in Jhansi district of Uttar Pradesh

Impact and spread of short duration variety of soybean

Short duration soybean variety JS-9560 is suitable for delayed sowing, uplands and fits in cropping sequence and can escape of terminal drought with duration of 82-85 days. Farmers of Tikamgarh district of Madhya Pradesh adopted short duration soybean variety (JS-9560) and realized a yield of 14.5 q ha^{-1} with net income of Rs. 30,500 ha^{-1} compared to local despite facing water shortages during crop growth. During *kharif* 2018, thirty farmers adopted in an area of 12 ha in NICRA village of Tikamgarh district of Madhya Pradesh. The variety was demonstrated in Datia district of Madhya Pradesh and found to be promising and spreading fast in the district. This variety had spread to other districts namely Morena, Tikamgarh, Guna and Chhatarpur in Madhya Pradesh. The seed produced in the NICRA village is also contributing towards its spread.

Short duration drought tolerant variety of pigeon pea (GS-3R) and sorghum (GS-23) was introduced for drought hit Kalaburagi district of Karnataka. During *kharif* 2018, NICRA village received 323 mm of rainfall with three dry spells of above 10 days.

Demonstration of short duration and improved varieties of pigeonpea (TS-3R) and sorghum (GS-23) at Kalaburagi district of Karnataka.

The improved sorghum variety had high grain and fodder yield, better grain, high protein content than local variety (M-35-1) and tolerant to charcoal rot disease and resistant to rust. Seed treatment with calcium, compartmental bunding in sorghum and use of pulse magic improved performance of variety further with 12.4 and 13.5 q ha^{-1}of seed yield in pigeon pea and sorghum. The two varieties were adopted by 105 farmers in 42 ha.

Impact and spread of short duration variety of finger millet (ML-365)

Finger millet is the one of the staple food of south Karnataka. Improved and short duration variety of ML-365 (110 days) performed well under delayed monsoon and drought condition. The variety is resistant to neck blast and tolerant to drought. Farmers in D. Nagenahalli, Tumkur, Karnataka adopted short duration finger millet variety ML-365 in about 26 ha by 73 farmers in the village resulted in 40 percent increase in productivity compared to traditional medium duration varieties and occupying more than ninety percent of the ragi cultivated area in the village. The variety was brought under 3,275 ha during *kharif* 2018 crop season in Tumkur district and spreading fast. Apart from good grain quality and fitting into contingency situations, this variety has good fodder quality and improved milk productivity in milch animals. The variety was adopted by the farmers of adjacent Chikkballapura, Davanagere and Gadag districts because of higher productivity under rainfed condition.

Table 3.2.9: Performance of short duration and improved varieties in various NICRA districts

State	KVK	Crop	No. of farmers	Area (ha)	Extent of improvement in yield (%)
Andhra Pradesh	West Godavari	Paddy (MTU-1121 and MTU 1156)	50	40	up to 10
Arunachal Pradesh	Tirap	Maize (HQPM-1), Rapeseed (TS-46)	22	4	6-37
Bihar	Buxar Jehanabad Saran	Maize (P-3377) Paddy (Rajendra sweta, Sahabhagi, Chandan, Komal, Prabhat)	73	16	7-17
Chhatisgarh	Dantewada	Paddy (Samleshwari), Pigeonpea (TJT 501)	28	13	37-44

Gujarat	Kutch Amreli Valsad	Bengal gram (GJG-3) Wheat (GW-173) Blackgram (PU-31) Indian bean (Guj Val-2)	114	27	18-45
Haryana	Yamunanagar	Paddy (PB-1509, Sava 127)	26	4	5-7
Himachal Pradesh	Kinnaur Kullu Hamirpur	Buckwheat (Phafra-Local, Ogla-Local), Maize (Early Composite, Girija, Bajaura Makka, KH-517), Mustard	145	32	11-35
Jammu and Kashmir	Bandipora Kathua	Wheat (Shalimar Wheat-1), Mustard (KS-101), Paddy (NDR-97, PUSA-1509)	83	14	12-48
Jharkhand	Chatra Godda Palamu	Paddy (Anjali, Swarn Shreya, Naveen, Sahbhagi dhan, GB-1, Vandana), Maize (SCMH - 411), Horse gram (BK-1)	333	122	13-76
	Gumla East Singhbhum	Bengal gram (JAKI 9218) Wheat (K-9107) Blackgram (PU-31) Greengram (HUM 16) Mustard (NRCHB-1) Linseed (Divya, Neelam))	69	174	19-50
Karnataka	Belgaum Davanagere Kalaburagi Chikkaballapura Tumkur	Fox tail millet (DHFT-109-3) Blackgram (DBGV-5) Pigeon Pea (TS-3R, BRG-4, BRG-5) Finger millet (ML-365)	316	109	14-88
Madhya Pradesh	Balaghat Guna Satna Tikamgarh	Wheat (HI-1544) Pigeonpea (TJT- 501) Blackgram (Shekhar 2, IPU 94-1) Greengram (TJM -3, IPM 2-3) Sesame (JT-21, TKG-306) Soybean (JS-9560) Chickpea (JAKI 9218)	376	142	15-104
Maharashtra	Baramati Nandurbar Ratnagiri Aurangabad Jalna Ratnagiri Amravati	*Rabi* sorghum (Phule- Revati, Phule- Anuradha, Phule- Vasudha) Maize (GM-6) Horse gram (Dapoli-1) Soybean (MAUS -158, JS-9305) Greengram (Utkarsha) Pigeon Pea (BDN-711) Bengal gram (JAKI-9218) Red Rice (Ratnagiri-7) Wheat (PDKV- WAHIM)	5	2	15-43
Meghalaya	West Garo Hills	Mustard (TS-67)	43	13	26-80
Nagaland	Dimapur Mokokchung Mon	Paddy (RCM-12, CAU R1) Mustard (TS-67) Maize (HQPM 1, RCM 76) Soybean (JS 335)	20	8	5-11
Odisha	Ganjam	Paddy (Bina-11)	98	50	2-16
Punjab	Bathinda Ropar Faridkot	Greengram (SML-832, SML-668) Wheat (HD-3086, HD-2967, PBW -1, PBW-343, Raj -4079, Raj-4238)	295	118	10-21

Rajasthan	Bharatpur Jhunjhunu Jodhpur Kota	Bajra (RHB-173, MPMH-17) Guar (RGC-HG-2-20) Mustard (RT-351) Cow pea (RC-19) Moth bean (CZM-2) Blackgram (PU-31)	44	6.0	24-51
Sikkim	East Sikkim	Maize (RCM 1-3) Mustard (TS-38) Paddy (Pusa Sugandha 5)	105	490	17-23
Tamil Nadu	Ramanathapuram Thiruvarur	Paddy (CO (R) 51, CR1009 sub 1) Blackgram (ADT 5, T9)	20	4	10- 33
Tripura	Dhalai	Pea (Arka Priya)	602	162	11-74
Uttar Pradesh	Chitrakoot Gorakhpur Hamirpur Baghpat Gonda Chitrakoot Gorakhpur Sonbhadra Bahraich	Pigeonpea (JKM-189) Greengram (IPM 2-3, Virat, PM-2-3) Onion (ALR, N-53) Vegetable Pea (AP-3) Bengal gram (JG-14, Jaki-5218) Blackgram (PU-31) Mustard (RH 749, NDR-8501, Urvasi) Pea (Pragati) Paddy (NDR-97, BPT-5204, V-9, NDR-2065) Lentil (IPL-36) Garlic (Jamuna Saphed) Toria (Uttara) Wheat (K-9533 , HD-2967, HD-3058)	50	40	12-25
Uttarakhand	Uttarkashi	Blackgram (Pant Urd 35) Maize (VL Maize 31) Lentil (VLM-126, VLM-514) Bean (Pant Anupama), Wheat (VL G-907, VL G-892)	22	4	6-36

3.2.2 Drought tolerant/escaping varieties:

Paddy variety Swarna Shreya is suitable for rainfed low land and direct seeded aerobic condition with maturity period of 120-125 days and Rajendra Sweta a new high yielding, medium duration (135-140 days) quality rice variety for Bihar's irrigated ecosystem were demonstrated in Kukurha village of Buxar district. Both varieties performed well and produced 42 and 45.5 q ha^{-1} compared to local variety (38.5 q ha^{-1}). The percent yield improvement was 9 and 13% respectively for Rajendra Sweta and Swarna Shreya varieties. During the season the area covered was 14.5 ha benefitting 45 farmers. The net income from the varieties was higher by Rs. 6000-8000 per hectare compared to traditional varieties.

Table 3.2.10: Crop yield and economics of drought tolerant/improved paddy varieties Rajendra Sweta and Swarna Shreya at Buxar district of Bihar

Treatments	Yield (q ha^{-1})	Cost of cultivation (Rs. ha^{-1})	Gross income (Rs. ha^{-1})	Net income (Rs. ha^{-1})	B:C ratio
Farmers practice	38.5	29700	67375	37675	2.26
Improved - Rajendra Sweta	42.0	30800	73500	43420	2.38
Improved - Swarna Shreya	45.7	26200	80062	53862	3.05

Demonstration of drought tolerant paddy varieties of Rajendra Sweta and Swarna Shreya at Buxar district of Bihar

Farmers of NICRA village, Chopnadih of Koderma district of Jharkhand state cultivate traditional paddy varieties during *kharif* season and suffered by low rainfall (deficit by-49%) and long dry spells in June and July months. Cultivation of drought tolerant short duration paddy cultivars IR-64-DRT-1, Abhishek and Sahbhagi dhan which withstand long dry spells of up to 3 weeks and moderately resistant to brown spot and sheath blight diseases were demonstrated. These cultivars recorded 15 per cent higher productivity and gave net return of Rs. 25000 ha^{-1} compared to traditional varieties of long duration which require more water

Demonstration of drought tolerant paddy cultivars IR-64-DRT-1, Abhishek and Sahbhagi dhan in NICRA village Chopnadih of Koderma district of Jharkhand

Impact and spread of drought tolerant variety of paddy (Sahbhagi dhan)

Most of the traditional high yielding varieties of the eastern India are susceptible to water scarcity and of long duration. In recent years, short duration Sahabhagi dhan, Shusk samrat, NDR 97, Indira Barani developed for drought situations were demonstrated in NICRA. In NICRA villages of Buxar and Jehanabad, due to deficit rainfall in June and July affected the timely transplanting of paddy and delayed the transplanting to August that resulted in the low productivity and delayed planting of *rabi* crops. With the improved variety average yield in farmers' fields was 38 q ha^{-1} with yield advantage of 18-20 percent compared to traditional long duration varieties. The short duration, drought escaping paddy cultivars are being demonstrated in the paddy growing district of Bihar, Jharkhand, Odisha and West Bengal. The promising varieties are spreading fast in Eastern Indian districts *i.e.,* Buxar, Jehanabad, Saran, Aurangabad, Supaul in Bihar; Koderma, Gumla, Chatra, East Singhbhum and Palamu in Jharkhand; Jharsuguda, Sonepur and Ganjam in Odisha.

West Garo hills of Meghalaya state lies in the North-Eastern hill zone which received deficit rainfall (-54%) during *kharif* season and delayed the sowing of toria due to long duration paddy cultivars in *kharif*. Under these circumstances, KVK has demonstrated the Utera cropping of drought tolerant toria variety TS-67 in rice fallows. This drought tolerant and late sown variety has resulted in 64 per cent higher productivity and B:C ratio of 2.82 compared to local variety (Besual). Variety TS-67 can be sown up to second week of December without any significant decrease in yield and hence could be best fitted in rice-toria cropping sequence of West Garo hills region.

Demonstration of drought tolerant toria var. TS-67 in KVK-West Garo hills of Meghalaya

Purkhawas and Lunawas Khara NICRA villages of the KVK-Jodhpur received lowest rainfall (211.8 mm) with four and five rainy days in June and July months, respectively during *kharif* season of 2018-19. Introduction of dual-purpose hybrid pearl millet MPMH-17 was boon to 145 NICRA farmers as it yielded higher grain and stover under drought condition with large seed size and high iron content. Whereas, local cultivar failed to overcome the drought condition. MPMH-17 recorded seed yield of 5.77 q ha^{-1} and fodder yield of 10.2 q ha^{-1} and recorded a B:C ratio of 1.44. Correspondingly, demonstrations on drought tolerant moth bean (CZM-02) were conducted in 25 farmer's field and recorded 2.97 q ha^{-1} with net income of Rs. 6924 ha^{-1} and B:C ratio of 2.25.

Table 3.2.11: Crop yields and economics of pearl millet MPMH-17 and moth bean (CZM-02) in Jodhpur district

Treatments	Yield (q ha^{-1})	Cost of cultivation (Rs. ha^{-1})	Gross income (Rs. ha^{-1})	Net income (Rs. ha^{-1})	B:C ratio
Improved-bajra (MPMH-17)	5.77	8000	11540	3540	1.44
Farmers practice-moth bean local variety	1.10	5150	3948	-530	0.76
Improved-moth bean (CZM-02)	2.97	5550	12474	6924	2.25

Demonstration of drought tolerant pearl millet (MPMH-17) at Jodhpur district

In NICRA village Jalgaon (KP) of Baramati in Pune district of Maharashtra experienced severe drought (rainfall of 199 mm) during *kharif*-2018 and crops like green gram, redgram and onion failed to establish. Therefore, one of the NICRA intervention, drought tolerant varieties of *rabi* sorghum (Phule-Revati, Phule-Anuradha and Phule-Vasudha) helped farmers to get sustainable yield during *rabi* season. These varieties, Phule-Revati, Phule-Anuradha and Phule-Vasudha resulted in 44, 84 and 52 per cent higher productivity compared to traditional varieties with higher B:C ratio of 2.7, 3.7 and 3.5.

Demonstration of drought tolerant rabi sorghum var. Phule- Revati and Phule- Anuradha in NICRA village Jalgaon (KP) of Baramati district of Maharashtra

Impact and spread of drought tolerant varieties of *rabi* sorghum-Baramati

High yielding sorghum varieties *viz.,* Phule Revathi, Phule Anuradha and Phule Vasudha were cultivated in the *rabi* season every year by farmers of NICRA village in Baramati, Pune district of Maharashtra. Farmers of this village, grow local varieties of sorghum (Maldandi derivatives) with traditional cultivation practices before the intervention of NICRA. However, as the yielding ability of local varieties of this region was less, the income obtained was also low and susceptible to moisture stress. The improved varieties viz., Phule Revathi, Phule Anuradha and Phule Vasudha recorded higher grain yield of 11.3, 11.25 and 16.3 q ha^{-1} compared to local variety (7.8, 6.1 and 11.1 q ha^{-1}). The maintenance of animals throughout the year also became easy due to high fodder yield from the improved varieties. About 75 farmers got benefitted by cultivating improved varieties in an area of 30 ha in the NICRA village during the season. In NICRA village (Jalgaon KP), demonstrations covered an area of 295 ha benefitting 761 farmers.

Takali (BK) village of Amravati district of Maharashtra state received 25 per cent deficit annual rainfall with long dry spells during the year 2018 and erratic rainfall is common. To overcome these dry spells cultivation of short duration (90-95 days) drought tolerant soybean var. JS 93-05 during *kharif* was demonstrated and resulted in higher seed yield of 2250 kg ha^{-1}, net returns of Rs. 52775 ha^{-1} and B:C ratio of 1.7 compared to traditional variety (1687 kg ha^{-1}). In the same village during *rabi* season drought tolerant chickpea cultivar Jaki-9218 sown on Broad Bed Furrow (BBF) system increased the productivity by 285 kg ha^{-1} and net returns by Rs. 11270 ha^{-1} compared to farmer's practice. BBF system also improved moisture use efficiency and enhanced moisture availability.

Yadagud village under KVK-Belgavi received annual rainfall of 475 mm against the normal rainfall of 772 mm, which was deficit by 38 per cent and was not sufficient for crop production with traditional varieties. Under these conditions, KVK has demonstrated drought tolerant varieties of foxtail millet (DHFT-109-3) and black gram (DBGV-5) during *kharif* season on 303 farmer's fields (73 ha). Both foxtail millet and blackgram recorded 30 per cent increased productivity with B:C ratio of 2.16 and 2.97 respectively, compared to traditional varieties. These varieties helped in crop diversification during *kharif* season to could get sustainable yield under drought condition.

Demonstration of drought tolerant foxtail millet var. DHFT-109-3 and Black gram var. DBGV-5 in Yadagud village of Belgavi district

Tumkur district of Karnataka lies in the central dry zone which frequently suffers with long dry spells and droughts. NICRA village D. Nagenahalli received 272 mm (-19% deficit rainfall) with no rain during the critical month of July-2018. Under these dry conditions, cultivation of drought tolerant crops like ragi (ML-365) and redgram (BRG-4) resulted in 20 and 39 per cent higher yields respectively, compared to locally available varieties. Improved cultivars of ML-365 and BRG-4 resulted in higher net returns of Rs. 4331 and 6470 ha^{-1} respectively, under drought condition.

Demonstration of drought tolerant ragi (ML-365) and redgram (BRG-4) in NICRA village D. Nagenahalli of Tumkur district

Impact and spread of drought tolerant variety of Redgram (PRG-176)

Pigeonpea is suitable for light chalka soils (light red soils with low water retention) of Andhra Pradesh and Telangana states. In Yagantipalle village of Kurnool district, frequent drought and terminal moisture stress during flowering and pod development stages generally result in the lower yields of pigeonpea. Introduction of drought tolerant variety PRG-176 with 130 days duration is an alternative to long duration (180 days) varieties which face moisture stress at flowering and pod development stages. Results indicated that redgram variety PRG-176 with improved production technologies gave higher yield of 438 kg ha^{-1} than that of farmers' practice, 313 kg ha^{-1} in medium black soils during severe drought year (2018). High income and economic security of climate resilient varieties covered 80 percent in the village during the last few years as intercrop and sole crop. During 2018-19 crop season the variety was cultivated in 148 ha benefitting 178 farmers and spreading in Kurnool, Nalgonda, Khammam and Chittoor districts.

NICRA villages of Chamaluru and Peravali of Ananthapuramu district of Andhra Pradesh received total annual rainfall of 142 mm during *kharif* distributed in 11 rainy days and eight long dry spells of more than 10 days. During *kharif*, K-6 groundnut variety suffered moisture stress at critical growth stages but demonstrations on drought tolerant improved groundnut varieties K-Harithandra and Dharani on farmers' field resulted in 44 per cent higher yield compared to (K-6) with higher haulm yield as fodder for livestock.

Demonstration of drought tolerant groundnut var. K Harithandra in comparison with K-6 at NICRA village Chamaluru and Peravali in Ananthapuramu, Andhra Pradesh

Impact and adoption of drought tolerant variety of chickpea (Jaki-9218)

Large areas of chickpea in the Maharashtra, Karnataka and Chhattisgarh often experience short winters, terminal moisture and heat stresses, wilt disease and pod borer problems, leading to low yields. New chick pea variety JAKI-9218 which is resistant to wilt, root rot, color rot and matures in 100-110 days improved crop yield by 15 per cent in Takali (Bk.) village of Amravati district under severe moisture stress condition. Seed required at the village level was produced by establishment of seed bank, which produced 45 q of seed during the *rabi* season-2018. The variety was demonstrated in 613 ha benefitting 594 farmers in NICRA villages of Maharashtra, Madhya Pradesh, Chhattisgarh and Maharashtra.

Table 3.2.12: Summary of drought tolerant/escaping varieties at NICRA villages

State	KVK	Crop and Variety	No. of farmers	Area (ha)	Extent of yield improvement (%) over the farmers practice
Andhra Pradesh	Chittoor, Anantapur, Kurnool	Groundnut (Dharani), Paddy (BPT-5204, NJ-2647), Pigeon pea (PRG-176), Chick pea (NBEG-3), Dolichos, Cotton Foxtail millet (SIA-3085)	346	1620	21 to 65
Arunachal Pradesh	Tirap	Mustard (TS-46)	10	3	15 to 44
Bihar	Banka,Supaul, Nawadah, Buxar, Jehanabad, Saran	Paddy (Sahbhagi dhan, Swarn Shreya, Abhishek), Wheat (HD-3086, HI 1563, HD 2967), Pigeon pea (ND-2), Maize (Shourya)	699	124	30 to 55
Chhatisgarh	Bhatapara, Bilaspur, Dantewada	Paddy (Swarn Shreya, Maheshwari, Indira Barani Dhan 1, MTU - 1010, Indira Ragi -1), Wheat (Ratan), Blackgram (PU-31)	106	41	15 to 72
Gujartat	Banaskantha, Valsad, Rajkot	Wheat (GW-451), Chick pea (GJG-3, and 5), Pigeonpea (BDN-711), Cumin (GC-4)	100	24	14 to 38
Himachal Pradesh	Kullu	Wheat (HS-542, HPW-368), Blackgram (Palampur -93)	221	44	18 to 29
Jammu and Kashmir	Bandipora, Kathua, Pulwama	Maize (C-3, 7, 15, Double Dekalb, PMH-1), Wheat (WH-1105, 1080 and HD-3509), Sesame (Punjan til -02), Green gram (Shalimar)	119	31	16 to 60

Jharkhand	Chatra, Godda, Palamu, Gumla, East Sinbhbhum, Koderma	Finger millet (A-404, GPU-28), Paddy (Sahbhagi dhan, Naveen, IR-64 Drt-1, Abhishek), Mustard (Pusa Mustard – 28, Shivani, Tapeshwani, Pusa vijay, Pusa-28), Wheat (K-9107, HD-3118, HD-2733), Chick pea (PG - 186, GNG-1581), Chilli (KA-2), Green gram (IPM-2-3), Lentil (PL-8), Black gram (PU-31), Maize (Kanchan, HQPM-1), Niger (Birsa Niger, JNC-6, Puja Niger), Pigeon pea (PKV-TARA, Bisra Arhar-1, NDA-2)	910	279	30 to 60
Karnataka	Belgaum, Davanagere, Kalaburgi, Chikkaballapura, Tumkur	Paddy (M 35-1, GS-23), Chick pea (Jaki-9218, JG-11), Wheat (DWR-2006), Finger millet (ML-365, 322, KMR-204), Pigeon pea (BRG-1)	610	169	13 to 39
Madhya Pradesh	Balaghat, Chhatarpur, Datia, Guna, Jhabua,Morena, Ratlam, Satna	Paddy (JRH-5), Wheat (Jw-3211, RVW-4106, MP-1203, HI-8498, 8713, 8663, 8737, 1531, 1605, JW-17), Chick pea (JG-14, 30, RVG-202), Barley (JB-58), Black gram (Pratap urd-1), Mustard (RVM-2, Pusa tarak, RH-406), Pigeon pea (ICPL-88039)	331	12	6 to 69
Maharashtra	Baramati, Nandurbar, Aurangabad, Jalna, Amravati	Bajra (ICTP-8203), Cotton (JLA-505), Chcik pea (Jaki-9218, Akash, BDNG-797), Paddy (CSH-16, Parbhani Moti), Pigeon pea 9BDN-711)	330	131	15 to 65
Manipur	Ukhrul	Maize (RCM-76), Vegetable pea (Arkel)	12	6	33 to 36
Meghalaya	West Garo Hills	Paddy (Bhalum-III)	2	1	18 to 77
Nagaland	Dimapur, Lunglei, Mon	Paddy (Gitesh, Pusa Sugandh-5, IR-36), Field pea (Prakash), Maize (Shri Ram 9662 habrid), Soybean (JS-335)	26	10	7 to 60
Odisha	Sonepur, Ganjam	Paddy (Mandakini, Sahabhagidhan), Pigeon pea	75	28	20 to 75
Rajasthan	Bharatpur, Jhunjhunu, Barmer, Jodhpur, Kota	Mustard (DRMRIJ-31, Giriraj), Barley (RD-2786, 2849), Cluster bean (RGC-1066), Chick pea (GNG-1581, 1958), Isabgoal (RI-1), Cumin (GC-4), Moth bean (CZM-2), Green gram (GAM-05)	445	178	10 to 55
Uttar Pradesh	Chitrakoot, Sonbhadra, Jhansi, Bahraich, Hamirpur, Muzaffarnagar	Mustard (RS-749, Urvashi, Pitambri, RH-406), Wheat (GW-273, HD-2967, WH-1105), Chick pea (Pusa-1103, RVG-202), Paddy (NDA-2, Sambha Mansoori), Pigeon pea (NDA-2), Groundnut (Kadiri-6), Field pea (Prakash, Aman), Green gram (IPM-02-03), Black gram (Shekhar-2), Sesame (Pragati)	566	182	16 to 78
Uttarkhand	Uttarkashi, Tehri Garhwal	Pigeon pea (Vl Arhar 1), Wheat (HS-507, VL-907, UP-2572)	226	13	30 to 43

3.2.3 Flood tolerant varieties:

Thiruvarur district of Tamil Nadu located in the east coastal plains of cauvery delta zone usually affected with cyclones and heavy rainfall during *kharif* season. During October and November months NICRA village Rayapuram received 208 and 404 mm of rainfall. Heavy rainfall was received on 6th October (60 mm), 16th November (66 mm) and 24th November (153 mm) which led to water logging of paddy for 15-20 days. Flood tolerant varieties CR 1009 sub-1 and Swarna sub-1 were demonstrated to minimise the impact of flooding conditions up to 15 to 17 days resulted in obtaining higher yield of 33 and 21 per cent with B:C ratio of 2.43 and 2.83 respectively, compared to the traditional varieties.

Check: CR1009

Demo: CR1009 Sub1

Demonstration of flood tolerant paddy var. CR 1009 sub 1 and Swarna sub 1 with control plot at Thiruvarur district of Tamil Nadu

NICRA villages *i.e.,* Sirusuvada, VN Puram and Kondavalasa were severely affected by the flash floods due to Vamsadhara river and back water of Marripadugedda caused by two cyclones (Titli and Pethai) happened in October and December months of 2018. Crops which were in medium and high inundation area were completely under submergence for 6-10 days. Demonstration of flood tolerant varieties MTU-1061 and RGL-2537 resulted in 27 and 23 per cent more productivity under flooding conditions compared to local variety (MTU-7029). The improved varieties are high yielding with good grain quality apart from possessing submergence tolerance and performed better under flooded situations. This attribute of dwarf stature and lodging resistance reduced the loss of grain and fodder under cyclone.

Demonstration of flood tolerant paddy var. local (MTU-1061 and RGL-2537) at Srikakulam district of Andhra Pradesh

Lodging of paddy varieties was the most common problem in West Godavari district of Andhra Pradesh due to the cyclones and floods during monsoon period. Demonstration of flood tolerant varieties MTU 1140 and MTU 1064 were done to replace the local lodging varieties to minimize the losses during floods and cyclones. Cultivation of MTU 1140 (Bhima) resulted in 8.6 per cent higher yield compared to traditional variety MTU-7029 (Swarna).

Demonstration of flood tolerant paddy var. MTU 1140 and MTU 1064 at West Godavari district of Andhra Pradesh

Coochbehar district of West Bengal received rainfall of 1744 mm during *kharif* season and resulted in flood situation. Demonstration of flood tolerant paddy cultivar (Swarna sub-1) helped in improving rice yields by 44 per cent with B:C ratio of 2.62 compared to local cultivar (GB-1). Similarly, floods and salinity are the problems for low land paddy cultivation in Bhongri village of South 24 parganas district in West Bengal. Cultivation of paddy var. SR 26 B, Amalmona and Jarava resulted in 27, 18 and 70 per cent higher crop yield compared to farmer's practice (Morishal).

Demonstration of Swarna sub-1 and Naveen flood tolerant varieties at Coochbehar (West Bengal) and Valsad (Gujarat)

Low lying area in the Chopara village of Ganjam district face frequent floods during the *kharif* season. BINA dhan-11 is a medium duration (110-135 days) high yielding rice variety tolerant to water logging conditions up to 7-8 days. Demonstrations on flood tolerant varieties, Swarna sub -1 and Bina dhan -11 were conducted and improved the rice yields by 10 per cent due to the survival of crop even after two weeks of submergence and could tolerate flood condition.

Demonstration of flood tolerant paddy var. Swarna sub -1 and Bina dhan -11 at Ganjam district of Odisha

Submergence is a recurring problem in the rice-producing rainfed lowlands of Cachar in Assam. NICRA village of Cacher district received high rainfall of 658 mm, 467 mm and 528 mm which led to submergence of paddy in lowlands. Introduction of submergence tolerant paddy cultivars Ranjit sub-I, Bahadur sub-I and Swarna sub-1 gave better yield by 15 per cent compared to traditional varieties.

Demonstration of flood tolerant paddy var. Ranjit sub-I, Bahadur sub-I and Swarna sub-1 at Cachar district of Assam

Flood is the major constraint affecting productivity of rice in Dhubri district of Assam. Flood situations occur about two to seven times in a year during May to September months. Annual rainfall of 3278 mm was received with 2842 mm of rainfall during *kharif* season. Resilient varieties for delayed and staggered sowing, deep water cultivation and submergence tolerance were important for minimizing the impact of rainfall variability. Local summer rice was affected by floods at the time of harvesting due to lodging conditions. Summer rice variety 'Joymati' can escape the flood damage under irrigated, lowland/medium land situations, escaping temporary or shallow flooding situations at harvest were demonstrated in 53 farmer's fields. The improved variety has recorded seed yield of 45.2 q ha^{-1} as against the farmer's practice of 39.1 q ha^{-1}, with monetary increase of Rs. 25700 ha^{-1}. Staggered planting rice variety 'Gitesh' was demonstrated in the village during *kharif* season under aberrant weather condition. The improved variety recorded seed yield of 39.80 q ha^{-1} as against of farmers practice with 28.64 q ha^{-1}. Yield improvement of rice varieties Joymati and Gitesh were by 16 and 43 percent, respectively. Submergence tolerance rice variety Swarna Sub-1 and Ranjit Sub-1 were demonstrated in the village with submergence tolerance capacity of 10-15 days in flood situations. The extent of adoption of this intervention has increased to 247 ha in the village and the yield recorded for Swarna Sub-1 and Ranjit Sub-1 were 33.5 q ha^{-1} and 43.5 q ha^{-1} respectively, compared to farmer's practice. Due to medium deep/semi deep land situation in some areas of NICRA village, farmers were unable to cultivate HYV's of winter rice due to stagnation of water even after post flood situations. Semi deep water rice variety 'Dipholu' were intervened under semi deep water situations and recorded 41.2 q ha^{-1} with net returns of Rs. 15775 ha^{-1}

Demonstration of submergence tolerant paddy var. Swarna sub-1 and Ranjit sub-1 at Udmari Pt-IV & V village of Dhubri district in Assam

Demonstration staggered planting rice variety Gitesh, semi-deep water rice variety dipholu and HYV Summer rice variety Joymati at Udmari Pt-IV & V village of Dhubri district in Assam state

Varietal options for minimising the impact of flood and their impact-Dhubri-Assam

Flash flood and submergence is a common phenomenon in rice growing rainfed lowland areas of Assam, Odisha, West Bengal and parts of coastal Andhra Pradesh and Tamil Nadu, seriously affects crop establishment leading to severe yield losses. Swarna sub-1 is one of the variety developed for tolerance of 7-12 days of submergence. Similar constrains prevail for rice production in the NICRA villages of Udmari IV & V of Dhubri district in Assam. Submergence tolerance rice variety 'Swarna Sub-1' and Ranjit Sub-1 were demonstrated in the village and the extent of adoption of the intervention has increased from 2 ha during 2013 to 1630 ha in the district and the yielded 4.5 t ha^{-1} compared to farmers' practice (2.25 t ha^{-1}) and yield improvement was up to 78% and net return increased up to Rs. 16,115 ha^{-1}. The varieties are spreading to other flood affected regions of eastern India and demonstrated in 460 ha benefitting 1092 farmers.

Table 3.2.13: Performance of flood tolerant varieties at various NICRA Districts

State	KVK	Variety	No. of farmers	Area (ha)	Extent of yield improvement (%)
Andaman and Nicobar	Port Blair	CR dhan 500	2	1	10
Andhra Pradesh	West Godavari	MTU-1061, MTU 1064	65	115	5 to 10
Assam	Cachar, Dhubri	Ranjit sub-I, Bahadur sub-I and swarna sub-1, Dipholu, Joymati,Gitesh	151	38	10 to 39
Bihar	Supaul, Buxar, Saran	SS-1, Swarna sub 1	55	17	9 to 40
Gujarat	Valsad	Naveen, GAR-13, Naveen	100	20	10 to 30
Jammu and Kashmir	Pulwama	SR-2	6	2	8 to 27
Madhya Pradesh	Balaghat	JRH-19	15	6	10 to 15
Maharashtra	Ratnagiri	Karjat-2, Ratnagiri-1, Ratnagiri-5, Ratnagiri-6, Ratnagiri-73	210	22	30 to 46
Odisha	Ganjam, Kendrapara	Swarna sub-1	31	12	4 to 9
Tamil Nadu	Thiruvarur	CR 1009 sub 1, Swarna sub-1	285	64	23 to 33
Tripura	Dhalai	Swarna sub-1	20	10	16 to 35
Uttar Pradesh	Gonda	NDR -2065, Sabha sub-1	17	4	16 to 17
West Bengal	Coochbehar, South 24 Parganas	Swarna sub-1	10	3	20 to 45

3.2.4 Salt Tolerant Varieties:

Soil salinity is one of the important constraint in Sirsa district in Haryana. In order to minimise the impact of salinity, salt tolerant wheat cultivars such as KRL-210 and KRL-213 were demonstrated in Rupana Khurd village of Sirsa district in Haryana. Variety KRL 210 recorded a net return of Rs. 19450 ha^{-1} and B:C ratio of 1.6 compared to local variety (PBW343) of Rs. 15200 ha^{-1} and 0.5.

Salt tolerant wheat var. KRL -210 and 213 in NICRA village Rupana Khurd of Sirsa district in Haryana

Higher pH and soil salinity are the major constrains in the soils of Umarchha village in Kaushambi district due to which low productivity was observed in paddy, wheat and vegetables. Demonstration of salinity tolerant Paddy (CSR-43), Wheat (KRL-210), Mustard (CS-56), Spinach (Pusa jyoti) and Beet root (Early wonder) contributed to higher yield by 10-15 per cent compared to salinity susceptible varieties. Salinity tolerance of these varieties helped in increasing the coverage to 51 ha from nil area. The performance and economics are given below.

Table 3.2.14: Crop yields and economics of paddy, wheat, mustard, spinach and beet root at Kaushambi, UP

Treatments	Yield ($q\ ha^{-1}$)	Cost of cultivation ($Rs.ha^{-1}$)	Gross income ($Rs.ha^{-1}$)	Net income ($Rs.ha^{-1}$)	B:C ratio
Traditional variety-rice	40.24	29538	70420	40882	2.38
Improved variety (CSR-43)	44.65	31064	78138	47074	2.52
Traditional variety-wheat	35.00	26810	64400	37590	2.40
Improved variety-(CSR-43)	38.20	27500	70288	42788	2.55
Traditional variety-Mustard	14.90	14950	62580	47630	4.18
Improved variety-(CS-56)	17.25	16450	72450	56000	4.40
Traditional variety-spinach	96.30	39565	128955	89390	3.25
Improved variety spinach (Pusa jyoti)	125.20	40140	167185	127045	4.16
Traditional variety-beet root	121.90	47562	490900	443338	10.32
Improved variety beet root-(Early wonder)	139.80	48650	557100	508450	11.45

Demonstration of salt tolerant mustard variety (CS-56) and wheat variety (KRL-210) in Kaushambi district of UP

Salinity tolerant varieties of paddy (CSR-36), wheat (KRL-210), mustard (CS-58) and barley (NBD-943) were demonstrated in saline soils of Chhachhamau village of Pratapgarh district of Uttar Pradesh which resulted in 23, 22.6, 8.4 and 28 per cent higher yield respectively, compared to the traditional varieties. The yield of the improved cultivars are higher than local varieties due to higher tolerance to salinity.

Table 3.2.15: Crop yield and economics of barley, paddy, wheat and mustard at Pratapgarh district of Uttar Pradesh

Treatments	Yield (q ha^{-1})	Cost of cultivation (Rs. ha^{-1})	Gross income (Rs. ha^{-1})	Net income (Rs. ha^{-1})	B:C ratio
Traditional variety-barley	28.00	18100	47060	28960	2.60
Improved variety-(NDB-943)	44.26	18650	66390	27590	3.56
Traditional variety-rice	35.90	23230	57440	34210	2.47
Improved variety-(CSR-36)	44.20	24140	70720	46580	2.93
Traditional variety-wheat	22.60	20640	39211	18571	1.90
Improved variety-(KRL-210)	28.40	21080	49247	28167	2.34
Traditional variety-Mustard	8.40	11800	32760	20960	2.77
Improved variety-(CS-56)	10.60	11340	41340	30000	3.65

Demonstration of salt tolerant paddy (CSR-36) and mustard variety (CS-56) in Pratapgarh district of Uttar Pradesh state

Similarly, salinity tolerant high yielding paddy variety Siddi (WGL-44) was demonstrated at Nacharam village of Khammam district. Improved variety had resulted in 222 kg additional yield per hectare with additional income of Rs. 8424 ha^{-1} when compared to popular paddy cultivar of BPT-5204.

Demonstration of salinity tolerant paddy Siddi (WGL-44) in Khammam district of Telangana

Salt tolerant varieties - Pratapgarh & Kaushambi

Soil salinity is the major problem for crop production in NICRA village Chhachhamau of Pratapgarh and Umarchha village of Kaushambi district of Uttar Pradesh. Salt tolerant variety of paddy (CSR-43) which is short duration (110 days) and similarly for *rabi* season wheat variety (KRL-210), mustard, oats and vegetables was demonstrated for higher productivity in saline soils. During 2018-19 year farmers adopted in 142 ha resulted in higher yield (40.0 q ha^{-1}) and net income (Rs. 35,000 ha^{-1}) with a benefit cost ratio of 2.65. Crop yield on an average improved by 15-20 per cent compared to sensitive cultivars. These salt tolerant varieties are occupying most saline tracks of Sirsa district in Haryana, Kaushambi and Pratapgarh districts of Uttar Pradesh, Port Blair in Andaman Nicobar Islands, Parts of Khammam in Telangana and South 24 Parganas in West Bengal.

3.2.5 Resilient Intercropping Systems:

NICRA village at Aurangabad district of Maharashtra received 54 per cent deficit rainfall during *kharif* season. Growing of sole Bt cotton is risky if rains are not received during September. Intercropping of green gram (Utkarsha) + Bt cotton (Ajeet) and black gram (Vijay) + Bt cotton were demonstrated and results indicated that total system productivity in terms of seed cotton equivalent yield was higher by 12 and 20 percent, respectively, than the sole Bt cotton crop. Intercropping Bt- cotton with black gram (Rs. 26250 ha^{-1}) and green gram (Rs. 25758 ha^{-1}) recorded higher net returns compared to sole cotton crop (Rs. 21200 ha^{-1}). Higher monetary advantage and yield stability led to an area of 21500 ha horizontal spread of intercropping in adjoining villages of Aurangabad district compared to 39 ha during 2012.

Demonstration of cotton based intercropping systems in Aurangabad district of Maharashtra

Intercropping of soybean and pigeonpea was demonstrated in frequent drought affected rainfed NICRA village of Takali (Bk.) in Amaravati district of Maharashtra to provide stability in returns and to improve the total productivity through better utilization of resources. The drought tolerant varieties of soybean (JS 93-05) and pigeonpea (BDN-711) produced higher yield (soybean - 700 kg ha^{-1} and pigeonpea 900 kg ha^{-1}) compared to farmers practice of soybean crop (1950 kg ha^{-1}). The higher net returns were obtained in intercropping systems (Rs. 82650 ha^{-1}) with B:C ratio of 2.2 compared to sole cropping of soybean (net returns Rs. 46250 ha^{-1} and B:C ratio of 1.6).


Demonstration of soybean and pigeonpea intercropping systems at Amaravati district of Maharashtra

Sugarcane is the main crop in NICRA village of Muzaffarnagar district of Uttar Pradesh. Sugarcane is a long duration crop and takes about 90-120 days for canopy development and suitable for growing intercrops at early stage. Sugarcane + mustard (RH-406) intercropping system was demonstrated for getting higher returns without affecting the sugarcane yield. This intervention recorded 9.09 per cent higher crop equivalent yields of sugarcane with B:C ratio of 1.72 compared to sole sugarcane (825 q ha^{-1}). Similarly, intercropping of greengram with sugarcane (3:1) was taken up and recorded 750 q ha^{-1} of cane yield and 6 q ha^{-1} greengram yield compared to sole sugarcane (675 qha^{-1}).

Demonstration of sugarcane + mustard and sugarcane + green gram (3:1) intercropping systems in Muzaffarnagar district of Uttar Pradesh

The Kurnool district falls under scarce rainfall zone of Rayalaseema region of Andhra Pradesh with an average annual rainfall of 630 mm. During months of June-September and October-December rainfall received was 33 and 75 per cent deficit compared to normal rainfall. Demonstration of Seteria + Redgram (5:1) intercropping was taken up to minimize the risk and bring stability in income under scarce rainfall conditions. Intercropping resulted in additional redgram yield of 376 kg ha^{-1} and seteria grain yield of 465 kg ha^{-1} in comparison to sole setaria crop yield of 286 kg ha^{-1}. Intervention increased the B:C ratio of 2.34 compared to sole crop of setaria (1.08).

Demonstration of setaria + red gram intercropping systems (5:1) in Kurnool district of Andhra Pradesh

Resilient intercropping systems and their spread in the District - Aurangabad, MH

In NICRA village of Aurangabad district, the rainfall is erratic and experience terminal droughts resulting in failure of sole crops of Bt-Cotton, soybean and pigeonpea. The farmers are facing crop failures due to frequent droughts. In NICRA, KVK, Aurangabad demonstrated intercropping of *Bt*-cotton+ black gram (1:1), soybean + pigeonpea (4:2), pigeonpea + bajra (6:3) and *rabi* sorghum +safflower (6:3), which performed significantly better than their sole crops. Intercropping of these crops is more profitable and is a key drought coping strategy. Farmers realized the advantage of higher net income with intercropping of the main crops such as cotton, pigeonpea, sorghum and soybean ranging from 1.5 to 2.0 times higher than the sole crops. The intercropping systems are being adopted by large number of farmers in the district.

Maize + Pigeonpea (BRG-5) was demonstrated for moisture stress condition during *kharif* season replacing traditional maize crop at Siddanuru village of Davanagere district of Karnataka state. Demonstration resulted in maize equivalent yield of 84.5 q ha^{-1} and B:C ratio of 2.55 compared to sole maize crop yield of 44.5 q ha^{-1} and B:C ratio of 1.65. The higher returns were due to the efficient moisture utilisation and fertility under rainfed situations.

Demonstration of maize + pigeonpea intercropping systems at Davanagere district of Karnataka

Apple cultivation is the important tree based farming system in Chamba region of Himachal Pradesh. With changing climate and to diversify, KVK Chamba introduced the cabbage (saint) and cauliflower (megha) as intercrops between the rows of apple trees during the second week of May month. Intercrop of cabbage/ cauliflower helped farmers to get additional income of Rs. 60,000 per hectare with B:C ratio of 2.5 without affecting the yield of apple. During rainy season farmers are growing orchard grass (*Dactylis glomerata*) with net returns of Rs. 40,000 ha^{-1} in alley as green fodder to feed the cattle.


Demonstration of apple + cabbage intercropping systems at chamba district of Himachal Pradesh

Demonstration was conducted to grow pigeonpea as intercrop with groundnut instead of sole groundnut in NICRA village of Villupuram district of Tamil Nadu. Intervention of Groundnut (TMV-13) + pigeonpea (VBN-3) increased net returns of farmers from Rs. 34,880 ha^{-1} to Rs. 45,469 ha^{-1} and B:C ratio of 2.0 to 2.3. Yield obtained from sole groundnut cultivation was 2020 kg ha^{-1}, while intercrop yields of groundnut was 1890 kg ha^{-1} and of pigeonpea was 234 kg ha^{-1}.


Demonstration of groundnut + redgram intercropping systems at villupuram district of Tamil Nadu

Resilient intercropping systems-Khammam

Pigeonpea and cotton are the main crops in Nacharam village of Khammam district, which are affected due to late onset of monsoon followed by dry spell at critical crop growth stages. Intercropping of pigeon pea (WRG-65) and Bt cotton was demonstrated in the village during 2014 in 25 ha which spread to 470 ha benefiting 385 farmers in the village. By intercropping (cotton + pigeonpea) farmers were able to get an additional income of Rs. 3716/- per hectare and surity of income from minimum of one crop. Resource and land utilisation was observed higher in intercropping system compared to sole and farmers observed less weed infestation in intercropping due to quick ground cover compared to sole. Intercropping cotton and pigeonpea was taken up in Nalgonda as well.

3.2.6 Crop Diversification:

Farmers in NICRA village of Udmari, Dhubri, Assam cultivation of HYV of toria (TS-38 and TS-46) was demonstrated during winter in place of traditional rice crop. The low productivity of winter rice was due to the moisture stress and low water availability during October-March months. Crop diversification stress tolerant crop and variety was demonstrated to 22 farmers during 2018-19 and toria varieties TS-38 and TS-46 yielded 8.64 and 8.47 q ha^{-1}, net returns were Rs. 12,501 ha^{-1} and Rs. 11,286 ha^{-1} and B:C ratio was 1.57 and 1.54, respectively, compared to low income from traditional paddy crop.

Crop diversification with toria crop at Dhubri district of Assam

During *kharif* season 2018 at Belgaum district of Karnataka, dry spells occurred in June and July months which led to the failure of traditional maize crop. Blackgram was introduced as alternative to maize and taken up in 80 ha involving 303 farmers.

Table 3.2.16: Performance and economics of crop diversification with black gram at Belgaum district of Karnataka

Crop	Yield (q ha^{-1})	Cost of cultivation (Rs. ha^{-1})	Gross return (Rs. ha^{-1})	Net return (Rs. ha^{-1})	B:C ratio
Traditional crop-Maize	19.39	14600	27146	12546	1.85
Crop diversification-Black gram	9.27	17362	46162	28800	2.66

Crop diversification with black gram crop at NICRA villages-Ammanagi and Yadagud in Belgaum district of Karnataka

At Jharsuguda district of Odisha traditional paddy crop was replaced by maize and sweet corn crops which provided higher monetary returns and higher yield. A total of 32 farmers covering an area of 4.8 ha were benefitted due to the introduction of both crops in the NICRA village.

Table 3.2.17: Performance and economics of crop diversification with maize and sweet corn at Jharsuguda district of Odisha

Treatments	Yield (q ha^{-1})	Cost of cultivation (Rs. ha^{-1})	Gross income (Rs. ha^{-1})	Net income (Rs. ha^{-1})	B:C ratio
Traditional crop-Paddy	65	32500	65000	32500	2.00
Improved practice-Maize (Kaveri)	118	45200	118000	72800	2.61
Improved practice-Sweet corn (Sugar-75)	116	72000	232000	160000	3.22


Crop diversification with hybrid maize and sweet corn at KVK - Jharsuguda of Odisha

3.2.7 Water saving paddy cultivation-Direct Seeded Rice (DSR) and System of Rice Cultivation (SRI):

Bathinda district of Punjab received less rainfall during the last two years and cultivation of puddled paddy during *kharif* season utilise large quantity of ground water. Introduction of water saving direct seeded rice cultivation instead of transplanting in puddled field requires less labour, water and tend to mature earlier than traditional rice cultivation. Demonstration of rice variety Pusa Basmati-1121 in 33 farmers' fields under direct seeded recorded higher yield of 1.6 q ha^{-1} with B:C ratio of 3.4 and water saving of 15-20 per cent compared to farmer's practice.


Direct seeded rice (var. Pusa Basmati-1121) at Bathinda, Punjab

In NICRA village of Bishrekhi at Sonbhadra district of Uttar Pradesh received less rainfall during June and July months with 69.8mm and 195.2 mm compared to normal rainfall of 109.1mm and 256.1 mm, respectively. Therefore, drought tolerant rice variety NDR-2064 was demonstrated for cultivation under direct seeded rice. The adoption of improved variety had resulted in increased yield by 47 per cent with less water usage compared to puddled conditions. The net returns and B:C ratio improved from Rs. 25,687 and 2.26 (farmer's practice) to Rs. 51,920 and 3.24.


Direct seeded rice cultivation of variety NDR-2064 in Sonbhadra district of Uttar Pradesh

Water saving paddy cultivation became a feasible alternative to traditional paddy cultivation in Gumla district of Jharkhand for rainfed areas saving water and reducing labour. The yield and economics of the improved varieties with water saving cultivation are as follows:



Water saving paddy cultivation-SRI (Lalat), DSR (Anjali) and Aerobic (Anjali) at Gumla district of Jharkhand

Table 3.2.18: The yield and economics of the water saving cultivation at Gumla district of Jharkhand

Treatments	Yield (q ha^{-1})	Cost of cultivation (Rs. ha^{-1})	Gross income (Rs. ha^{-1})	Net income (Rs. ha^{-1})	B:C ratio
Traditional practice-paddy	31.50	31800	48825	17025	1.53
Improved practice-SRI (Lalat)	38.50	30100	59675	29575	1.98
Traditional practice-paddy	22.00	20000	34100	14100	1.70
Improved practice-DSR (Anjali)	27.10	21600	42005	20405	1.94
Traditional practice-paddy	19.40	17500	30070	12570	1.71
Improved practice-Aerobic (Anjali)	24.22	18500	37355	18855	2.01

Paddy is the major *kharif* crop in Balaghat district of Madhya Pradesh but prolonged dry spells during monsoon season necessitated shift to water saving practices like System of Rice Intensification (SRI) and Direct Seeded Rice (DSR). In NICRA and adjoining villages these practices were spread in almost 56 ha during 2018-19 due to demonstrations taken up as part of NICRA.

Table 3.2.19: The yield and economics of SRI and DSR cultivation at Balaghat district of Madhya Pradesh

Treatments	Yield (q ha^{-1})	Cost of cultivation (Rs. ha^{-1})	Gross income (Rs. ha^{-1})	Net income (Rs. ha^{-1})	B:C ratio
Traditional practice-paddy	34.20	20950	59850	38900	2.85
Improved practice-SRI (MTU-1010)	54.00	24100	94500	70400	3.92
Improved practice-DSR (MTU-1010)	41.00	21229	71750	50521	3.37

DSR and SRI cultivation of Variety MTU – 1010 at Balaghat district of Madhya Pradesh

KVKs of Villupuram and Thiruvarur districts of Tamil Nadu demonstrated the water saving technology-alternate wetting and drying (pani pipe) in paddy fields for higher water use efficiency and productivity. Pani pipe enables the farmers to monitor the water level and this simple intervention saves about 30 per cent of water compared to puddled cultivation. This is one of the simple and low cost intervention which can reduce water use significantly.

Table 3.2.20: The yield and economics of alternate wetting and drying in paddy at Villupuram and Thiruvarur districts of Tamil Nadu

Treatments	Yield (q ha^{-1})	Cost of cultivation (Rs. ha^{-1})	Gross income (Rs. ha^{-1})	Net income (Rs. ha^{-1})	B:C ratio
Villupuram					
Traditional practice-paddy	46.90	41470	75024	33553	1.81
Improved practice-Alternate wetting and drying (BPT-5204)	49.00	41795	78400	36604	1.88
Thiruvarur					
Traditional practice-paddy	45.99	33500	75424	41924	2.25
Improved practice-Alternate wetting and drying (CR 1009 Sub-1)	56.70	31050	92988	61938	2.99

Demonstration of paddy varieties under Alternate wetting and drying (pani pipe technology) method at Villupuram district of TamilNadu

In Pindi Blochan village of Faridkot, land levelling, mulching, green manuring, shredding of crop residue were adopted in 263, 5.5, 232 and 58 ha area and total numbers of farmers involving were 211. The NICRA interventions helped to increase the crop yields of sugarcane, paddy and wheat upto 30, 1 and 1.7 q ha^{-1} over the check and correspondingly increased the income up to Rs. 15015, 4410 and 1232 over the farmers' practice.

Land leveling, shredding of crop residue and straw mulching at Faridkot in Punjab

Laser land levelling adopted by the farmers in NICRA villages of Ropar and Faridkot districts increased the water use efficiency and reduced the irrigation time due to the even land surface for irrigation. Laser land levelling was extent to NICRA adjoining villages in about 2174 ha in Faridkot district and 472 ha in Ropar district. The cultivable area of the NICRA village is 1060 ha in Faridkot and nearly all area is laser levelled. Laser land levelling considerably lowers irrigation time for rice and wheat crops and improved crop yields up to 5 per cent.

Demonstration of laser land levelling at Ropar and Faridkot district of Punjab

At Rupana Khurd of Sirsa, laser land levelling was practiced in 100 ha area covering 60 farmers in the village which helped in saving upto 20 percent of water for paddy and wheat. The paddy yield and net return increased upto 4 q ha^{-1} and Rs. 18,550 ha^{-1}, respectively over the farmers' practice and B:C ratio increased from 2.35 to 3.19. The wheat yield and net return increased upto 15 and 28 per cent, respectively more over the farmers' practice and B:C ratio upto 1.6.

Laser land levelling in wheat at Sirsa, Haryana

Adoption and spread of Laser Land levelling in Punjab and Haryana

Larger paddy fields in Pindi Blochan village, Faridkot district of Punjab takes longer time, energy, labour and water for irrigation and for uniform water distribution. Laser land levelling, a simple operation to prepare the land before sowing, can reap massive returns such as increasing yield, saving water and reducing greenhouse gas emissions. The cultivable area of the village is 1060 ha and the entire cultivated area of the village is laser levelled. By adoption of this technology, their yield has increased up to 2-3%. It is also reported by farmers that they irrigate more land with same amount of water. The area covered is 1860 ha benefitting 542 farmers in the adjacent villages. Huge potential exists in Indo-Gangetic Plains (IGP) of Punjab and Haryana states in rice-wheat cropping system.

Table 3.2.21: Summary of demonstration on water saving paddy technologies in NICRA districts

State	KVK	Variety	No. of farmers	Area (ha)	Extent of yield improvement (%)
Andhra Pradesh	Chittoor	ADT-37	2	1	16
Arunachal Pradesh	Tirap	Disang	10	2	59
Bihar	Banka, Supaul, Jehanabad, Saran	Sahbhagi dhan	41	6	13-56
Chhattisgarh	Bhatapara, Bilaspur	Swarna Shreya, Maheshwari, Indira Barani Dhan 1, IGKV R-1	58	23	16-31
Haryana	Yamunanagar	PB-1, PB-1121, PR-126, PB-1509	22	2	6-8
Jharkhand	Gumla, Koderma	Lalat, Anjali, Sahbhagidhan	58	47	8-22
Madhya Pradesh	Datia, Satna	Pusa-1121, MTU-1010	28	9	5-29
Nagaland	Mon	IR-36	3	1	42
Punjab	Bathinda, Faridkot	Pusa Basmati- 1121, PR-126	68	76	3-4
Uttar Pradesh	Chitrakoot, Kushinagar, Muzaffarnagar	Sahbhagidhan, PB-1637	41	13	14-58

3.2.8 Protected cultivation of high value crops:

Himalayan village Lagga of Chamba district became prosperous by adopting protective cultivation of high value vegetable crops. To protect the vegetable crops under seasonal snow and very cold winters, KVK introduced the low volume and high value protective cultivation in poly houses. Protected cultivation has significantly helped the farmers in reducing dependency on rainfall and efficient utilization of land and water resources. Since 2011, with the assistance of the NICRA project, 30 poly houses were constructed with 1320 m^2 of utilisable area. Protected cultivation of Capsicum (Indira) in poly houses, recorded 545 q ha^{-1} compared to open cultivation (320 q ha^{-1}).

Protected cultivation of Capsicum in poly houses at Lagga village of Chamba district, Himachal Pradesh

High intensity rainfall, frost and cold wave caused damage to vegetable crops during summer and winter season. Therefore, protected cultivation of knol-khol, cabbage, cucumber, capsicum, tomato and broccoli improved crops was demonstrated in Ri-Bhoi district of Meghalaya. This intervention improved the crops yield by 50 per cent and improved income significantly.

Protected cultivation of vegetables at Ri-Bhoi district of Meghalaya

Low cost poly house cum rain shelter was constructed in NICRA village of Phek district of Nagaland for year round production of vegetables. King chilly production under low cost poly house resulted in sustainable yield and details are mentioned below.

Table 3.2.22: The yield and economics of King chilli cultivation in Phek district of Nagaland

Treatments	Yield (q ha^{-1})	Cost of cultivation (Rs. ha^{-1})	Gross income (Rs. ha^{-1})	Net income (Rs. ha^{-1})	B:C ratio
Farmers' practice of open cultivation-King chilly	41.6	455302	831800	376497	1.82
Protected cultivation- King chilly	71.5	719047	1788000	1068953	2.49

Protected cultivation of King chilly in Phek district of Nagaland

Protected cultivation of vegetables: To minimise the impact of cold stress

To protect the vegetable crops under seasonal snow and very cold winters, demonstrated the low volume and high value protected cultivation in poly houses by several KVKs. Protected cultivation has significantly helped the farmers in reducing dependency on rainfall and minimised the impact of cold stress. Construction of polyhouse in the village started in the year 2011 onwards. As part of the NICRA project, 38 poly houses were constructed with 1320 m^2 of utilisable area. Protected cultivation of capsicum in poly houses, recorded 3 times the productivity (about 545 q ha^{-1}) compared to the open cultivation. The vegetable quality, market value and shelf life improved significantly. The unemployed youth which formed a small society and established additional 12-15 poly houses during last few years and many new members got affiliated with the society. Vegetable production in polyhouses, as one of the enterprises helped farmers in Lagga village to diversify the farm activities and obtain higher income. Farmers shifted from traditional maize crop to high value vegetable crops like cabbage, cauliflower, capsicum and tomato and minimised the impact of cold stress.

Table 3.2.23: Summary of Protected cultivation structures established at NICRA villages

State	KVK	Crop	No. of farmers
Himachal Pradesh	Chamba	Capsicum (Indira), Tomato	5
Bihar	Supaul	Sponge Guard (Rajendra Nenua-1), Bottle Guard (Sarita Hybrid), Cucumber (NCH2 Hybrid), Bitter guard(VNR Hybrid)	56
Assam	Cachar	Tomato (Arka Rakshak), Coriander	3
Sikkim	East Sikkim	Cole crops	22
Meghalaya	Ri-Bhoi	Knol Khol, Cabbage, Cucumber, Capsicum, Tomato	50
Jammu and Kashmir	Pulwama	Kale, Knol-Khol (Early white vinnea and purple vienna), cabbage, Tomato (F1-hybrid), Brinjal (Shalimar Hybrid-I) Cauliflower (F1-Hybrid), Cabbage	10
Jharkhand	Koderma	Onion	15

3.2.9 Zero till cultivation:

Paddy crop residue management is crucial for early sowing of wheat to reduce the effect of terminal heat stress. In NICRA village, Pindi Balochan of Faridkot district of Punjab, effective paddy residue management was done by sowing the wheat under zero till condition with happy seeder. Total of 114 farmers in 535 ha of area were benefitted with this technology and timely sowing of wheat crop was done with the help of machinery available with custom hiring centres and also with progressive farmers in the village.

Table 3.2.24: The yield and economics of zero till sown and happy seeder wheat crop at Faridkot district of Punjab

Treatments	Yield (q ha^{-1})	Cost of cultivation (Rs. ha^{-1})	Gross income (Rs. ha^{-1})	Net income (Rs. ha^{-1})	B:C ratio
Traditional practice	5390	37285	99176	61891	2.66
Improved practice-zero till wheat (HD-3086)	5450	34085	100280	65475	2.94
Traditional practice	5220	37285	99176	61891	2.65
Improved practice-Happy seeder sown wheat (PBW-725)	5390	35450	96048	60659	2.70

Wheat sowing with Zero till seed drill and happy seeder at Pindi Balochan of Faridkot districts of Punjab

Impact and spread of Happy Seeder technology in NICRA villages

Happy seeder is one of the promising technologies which can effectively be used for sowing wheat under high residue conditions. Happy seeder was demonstrated after the harvest of the rice by combine harvester. A total of 221 demonstrations were conducted on happy seeder in Punjab and Haryana benefiting the 227 framers during 2018-19 crop season in 5 NICRA villages. Since the inception of the project, 1392 demonstrations were conducted in the farmers' fields on the use of happy seeder and these demonstrations helped farmers to get convinced about the crop stand with the machine which resulted in significant adoption in these villages. Several farmers have purchased happy seeders with their own resources which has helped in the adoption of zero till sowing and resulted in timely sowing without burning of crop residues. The technology helped in paddy straw management and saves Rs. 3580 ha^{-1}. The custom hiring centres established in the village also helped in the purchase of the machinery by progressive farmers which has resulted in making the requisite machinery available at the village level resulting in effective use of the machinery by large number of farmers thus effectively minimising the burning in these villages and making these 25 villages as minimal crop residue burning villages during the year 2018.

Zero-tillage planting of wheat after rice is one of the successful resource-conserving technology in rice-wheat system of Indo-Gangetic Plains. Tractor drawn zero till seed drill and happy seeder were introduced for wheat sowing at NICRA village of Yamunanagar district of Haryana to save water and energy, early sowing of wheat and reduce environmental pollution. Zero till wheat produced an additional yield of 2-3q ha^{-1}.

Table 3.2.25: The yield and economics of zero till and happy seeder sown wheat crop at Yamunanagar district of Haryana

Treatments	Yield (q ha^{-1})	Cost of cultivation (Rs. ha^{-1})	Gross income (Rs. ha^{-1})	Net income (Rs. ha^{-1})	B:C ratio
Traditional practice-wheat	55.70	38610	109488	70878	2.83
Improved practice-zero till wheat (HD-2967)	57.40	31810	111616	79806	3.51
Improved practice-Happy seeder sown wheat (HD-2967)	58.80	33310	114204	80894	3.43


Wheat sowing with zero till and happy seeder at Radauri village of Yamunanagar district of Haryana

Moisture stress and little rainfall during *rabi* season are the main constrains for successful growing of pea and mustard crops at Nandok village of East Sikkim. During *kharif* season of 2018-19 rainfall of 1871 mm was received and during *rabi* season rainfall of 7 mm was received. Demonstrations of vegetable pea in rice-fallows was conducted during winter season. The productivity of vegetable pea was better in no till than conventional tillage due to timely sowing and got benefit of residual soil moisture after harvest of rice. Farmers observed 90.61 per cent yield advantage over conventionally planted vegetable pea. This practice also improved higher soil organic matter after three years of continuous cultivation.


No-till vegetable pea cultivation in rice-fallows at Nandok village of East Sikkim

Table 3.2.26: The yield and economics of zero till pea cultivation in rice-fallows at East Sikkim district

Treatments	Yield (q ha^{-1})	Cost of cultivation (Rs. ha^{-1})	Gross income (Rs. ha^{-1})	Net income (Rs. ha^{-1})	B:C ratio
Traditional practice-vegetable pea	39.4	85800	189000	104000	2.20
Improved practice-Zero till vegetable pea (Abira-11)	75.1	46457	153254	106797	3.29

Cropping intensification with regular tillage is difficult in Imphal east due to water scarcity during post-monsoon season, lack of irrigation facilities and short time lag after harvest of rice crop for seed sowing. Therefore, demonstration of zero till mustard (TS-38) was taken up which resulted in improved seed yield of 14 per cent and net monetary returns of Rs. 15050 ha^{-1} with B:C ratio of 1.71.

Table 27: Summary of zero till cultivation in NICRA districts

State	KVKs	Crops	No. of farmers	Area (ha)
Arunachal Pradesh	Tirap	Field Pea	12	2
Assam	Cachar	Blackgram	12	5
Bihar	Banka, Buxar, Saran, Supaul and Jehanabad	Paddy, Lentil, Wheat	195	121
Chhatisgarh	Bhatapara_Raipur, Bilaspur	Wheat, Chickpea, lathyrus	29	28
Jammu and Kashmir	Kathua	Wheat, Toria	12	32
Madhya Pradesh	Balaghat, Guna, Morena, Tikamgarh	Wheat, Soybean, Chickpea	43	19
Manipur	Imphal East, Senapati	Rapeseed	46	26
Mizoram	Serchhip	Toria	8	5
Nagaland	Lunglei, Mon, Phek	Rice, Pea, Rape seed	14	9
Punjab	Faridkot, Bathinda, Ropar,Fatehgarh Shaib	Wheat	254	259
Tamil Nadu	Villupuram	Rice	150	100
Tripura	Dhalai	Lentil	20	10
Uttar Pradesh	Pratapgarh, Muzaffarnagar, Gorakhpur, Sonbhadra, Gonda	Paddy, Wheat	338	185
West Bengal	Coochbehar	Wheat, Maize, Mustard, Lentil	80	13

3.3 Livestock interventions

Climate change has been, and continues to be the most important cause of instability in ruminant animal production systems in tropical countries like India through crop failures, fodder scarcity and increased incidence of endemic animal diseases. Alterations in rainfall affect the fresh water availability for feed production and also drinking water for livestock. Further, scenario of feed and fodder resources and demand in the country explicitly indicates the necessity of efficient utilization of available resources from crop and cropping systems and development fodder production systems for sustainability of not only farmers' income but also the productivity of livestock. To mitigate the adverse affects of extreme weather events and cope with changing climate, much précised resilient technologies suitable to local conditions and resources are needed in view of highly diversified and heterogeneous group of farmers and the resources accessible to them. Highlights of interventions related to sustainable livestock production being demonstrated in NICRA villages are given below:

3.3.1 Introduction of high yielding resilient breeds:

Improved stress tolerant and high yielding breeds were introduced in NICRA villages. Resilience and impact of introduced breeds on farmers income has been assessed at different locations. High productive and resilient Tharparker and Murrah bulls and Sirohi buck were introduced in Jodhpur, Rajasthan for sustaining the productivity (milk and meat) under high ambient temperatures. This resulted in increased milk yield (about 3 litres day^{-1}) in graded Murrah buffaloes and Tharparkar cows (2.25 litres day^{-1}) compared to non-descriptive local breeds. Sirohi bred goats were well adopted and showed greater resistance to major endemic diseases in the village and on an average 30 per cent higher body weight compared to non-descriptive goat breeds in the village.

Introduced Tharparker bull, Murrah buffalo and Sirohi buck at Jodhpur district of Rajasthan

Breeds of poultry (Jharsim) and duck (Khaki cambell) were demonstrated at Sakorha village in Jehanabad district of Bihar for higher productivity and returns. This resulted in 25 per cent lower mortality in ducks and one kg additional body weight gain in poultry birds compared to local breeds. Similarly, introduction of Black Bengal breed of goats in the village contributed to enhanced productivity and higher net returns.

Table 3.3.1: Live weight and economics of Black Bengal goat at Jehanabad district

Treatments	Live weight (kg) (12 months age)	Cost of rearing per animal (Rs.)	Gross income per animal (Rs.)	Net income per animal (Rs.)	B:C ratio
Goats-Local breed	16.0	4200	8400	4200	2.0
Black bengal breed	22.0	4200	12600	8400	3.0

Improved breeds of poultry-Jharsim and Black Bengal goats at Jehanabad district of Bihar

Breed upgradation-Jodhpur

Animal agriculture is the major economic activity for the farmers of arid regions of Rajasthan. Genetic improvement in the livestock for resilience and higher productivity (milk and meat) is one of the major objective under NICRA for higher and sustainable livelihoods and income under climatic variability. Initially at the inception of NICRA during 2011, two Tharparker and Murrah bulls were introduced at NICRA villages of Lunawas Khara and Purkhawas in Jodhpur district. Six bucks of goat breed Sirohi was introduced for breeding of non-descriptive goat population in the village. The resultant graded Murrah buffaloes and Tharparkar cows yielding 18 and 25% higher milk yield compared to non-descriptive local animals. Sirohi progeny goats were well adopted and showed greater resistance to major endemic diseases in the village and gained average of 30% higher body weight compared to non-descriptive goat breeds in the village. In two NICRA villages (Lunawas Khara and Purkhawas) of the Jodhpur district alone the upgraded animal population was increased to 462 Tharparkar cross cows, 384 graded Murrah buffaloes and 1368 Sirohi cross goats. The breed upgradation was also demonstrated and spread in Barmer, Kota and Jhunjhunu districts of Rajasthan. Farmers are getting nearly double the income from selling upgraded breed progeny compared to non-descriptive local animals.

Introduced coloured plumage synthetic poultry breed -Rainbow rooster to improve low productive desi birds at Jharsuguda district of Odisha. About 39 and 68 per cent higher body weight and egg production were recorded in Rainbow rooster compared to desi birds. Similarly, Khaki Campbell duck breed was introduced for increasing the productivity of native non-descriptive ducks in the village.

Improved breeds of poultry-Rainbow rooster and duck-Khaki campbell at Jharsuguda district of Odisha

Table 3.3.2: Live weight and egg production of improved poultry and duck breeds at Jharsuguda district of Odisha

Treatments	Live weight at 6 months age (kg)	Egg laying (No. per annum)	Cost of rearing (Rs. / bird)	Gross income (Rs. / bird)	Net income (Rs. / bird)	B:C ratio
Local hen	1.8	80	120	450	330	3.75
Rainbow rooster hen	2.5	135	140	630	490	4.50
Local duck	1.8	150	300	1100	800	3.66
Khaki Campbell duck	2.4	280	500	2100	1600	4.20

KVK-Cachar in Assam has demonstrated backyard poultry with improved breed of Rainbow rooster by distributing 240 chicks for 10 farmers. Rainbow rooster showed 58 and 55 per cent higher meat and egg production respectively, compared to native poultry breeds.

Table 3.3.3: Live weight and egg production of Rainbow rooster backyard poultry at Cachar district in Assam

Treatments	Live weight at 6 months age (kg)	Egg laying (No. per annum)	Cost of rearing (Rs. / bird)	Gross income (Rs. / bird)	Net income (Rs. / bird)	B:C ratio
Local birds	1.9	84	168	570	402	3.39
Rainbow rooster birds	2.5	150	370	1500	1090	4.05

Non-availability of piglets of improved breed was one of the reasons for not meeting the commercial pork demand in North Eastern India. In Panimirigaon village of Dibrugarh district demonstrated Piggery with Hampshire crossbred. During 2018-19, KVK has established 15 units in the villages for higher pork availability. Also demonstrated rearing of Hampshire crossbred pigs with low cost deep litter system of housing in East Sikkim for 50 farmers. This practice resulted in lower mortality and disease spread and higher net returns from piggery.

Table 3.3.4: Meat production and economics of Hampshire crossbred piggery at Dibrugarh district of Assam

Treatments	Live weight in kg (per annum / pig)	Cost of rearing (Rs. / pig)	Gross income (Rs. / pig)	Net income (Rs. / pig)	B:C ratio
Piggery-local breed	44.6	3200	7200	4000	2.25
Piggery-Hampshire, cross breed	65.8	3500	10400	6900	2.97

Demonstration of Hampshire cross bred piggery with low cost deep litter type housing at Dibrugarh district of Assam and East Sikkim

Egg and chicken production in Northeast is largely dependent on backyard farming with indigenous poultry breed. The genetic potential of these local breed is very poor with annual egg production of 30-50 eggs per hen and low body weight gain. To improve the productivity (higher meat and egg production) of backyard poultry, introduced improved poultry breed of Vanaraja chicks at NICRA village of West Siang district in Arunachal Pradesh. Higher body weight (3.3 kg) per bird was achieved compared to local poultry breeds (1.65 kg) in 20 weeks of rearing. Income from sale of eggs was also higher (140 eggs/ annum) with Vanaraja compared to local hens (61 eggs/annum). The net returns were nearly double with Vanaraja backyard poultry compared to local breed.

Table 3.3.5: Performance of backyard poultry with Vanaraja breed at West Siang district of Arunachal Pradesh

Treatments	Live weight at 20 weeks age (kg per bird)	Egg laying per annum (No.)	Cost of rearing (Rs. / unit)	Gross income (Rs. / unit)	Net income (Rs. / unit)	B:C ratio
Local Birds	1.65	61	4705	10605	5900	2.25
Vanaraja breed	3.30	140	5742	16320	10578	2.84



Demonstration of improved poultry breed-Vanaraja at West Siang district of Arunachal Pradesh.

Improved breed of Gramapriya which have coloured plumage, high survivability and lay bigger size brown eggs compared to local breeds was introduced as backyard poultry in Hengbung village of Senapthi district for additional income to the farmers and also for nutritional security at household level. The Gamapriya birds gained 34 per cent more body weight compared to local breeds in 180 days.

Table 3.3.6: Performance of backyard poultry with Gramapriya breed at Hengbung village of senapthi district

Treatments	Live weight at 180 days age (kg/bird)	Cost of rearing (Rs. / unit)	Gross income (Rs. / unit)	Net income (Rs. / unit)	B:C ratio
Local birds	1.86	11500	16200	4700	1:40
Improved-Gramapriya breed	2.76	12000	20700	8700	1:73

Demonstration of improved poultry breed-Gramapriya at senapati district of Manipur

Introduction of Murrah buffalo bull during 2011-12 for upgradation of local non-descriptive buffaloes in Sanora and Barodi NICRA villages of Datia district changed the milk production profile of the village by producing 2017 kilo litres of milk per annum compared to 1372 kilo litres before the introduction of the bull. At present, there are 257 lactating graded murrah buffaloes in the village with average milk production of 12.5 litres day^{-1} compared to local buffaloes with 4.5 litres day^{-1}. This intervention helped in 47 per cent higher milk production and Rs. 3,600 more net returns per animal per month in the village.

Impact of introduced murrah breed buffalo at Datia district of Madhya Pradesh

To sustain livelihoods and supplement income of small and marginal women farmers through backyard poultry, Rajasri breed which is hardy, attractive with multi-coloured plumage, capable of self propagation, having good body conformation with capacity to escape from predators, a good scavenger and less susceptible to diseases was introduced in the Nacharam village of Khammam district in Telangana. Improved Rajasri hen laid about 160-170 eggs per annum with bigger egg size (55g) and gained higher (72%) live weight compared to local hens. In order to commercialise backyard poultry in the village, egg incubator and hatching unit was established. This resulted in higher hatching percentage (80%) from the fertile eggs and availability of more number of chicks within the village. For the protection of chicks from predators 200 number improved poultry housing units were also established in the village.

Table 3.3.7: Performance of backyard poultry with Rajasri Chicks at Nacharam village of Khammam district

Treatments	Egg production (No. / annum)	Body weight (kg)	Cost of rearing (Rs. / unit)	Gross income (Rs. / unit)	Net income (Rs. / unit)	B:C ratio
Local birds	40-60	1.3	520	1640	1120	3.15
Improved- Raja Sri birds	160-170	2.0	1000	3850	2850	3.85

Improved backyard poultry breed-Rajasri, improved housing unit and hatching unit at Khammam district

Table 3.3.8: Livestock breeds introduced in different NICRA villages

State	NICRA village	Species	Introduced Breed	No. of farmers
Arunachal Pradesh	West Siang	Pig	Large White Yorkshire	5
Assam	Dibrugarh	Pig	Hampshire cross	57
Bihar	Aurangabad	Goat	Black Bengal and Jamunapari	14
	Jehanabad	Goat	Black Bengal	6
		Pig	Tamworth with local indigenous (Desi)	6
Chhattisgarh	Dantewada	Cattle	Sahiwal	4
Gujarat	Banaskanta	Cattle	Kankrej	50
Himachal Pradesh	Hamirpur	Goat	Beetal	45
Jharkhand	Chatra	Goat	Black Bengal	42
		Pig	Jharsukh	44
	Gumla	Pig	Tamworth with local indigenous (Desi)	4
Karnataka	Davanagere	Cattle	Gir	1
	Kalaburgai	Cattle	Deoni	5
Madhya Pradesh	Datia	Buffalo	Murrah	12
	Satna	Goat	Lalitpuri	26
Maharashtra	Ratnagiri	Goat	Konkan Kanyal	8
Nagaland	Dimapur	Pig	Hampshire Cross	8
	Dimapur	Rabbit	Soviet Chinchilla & New Zealand White	15
Odisha	Jharsuguda	Goat	Black Bengal	2
Rajasthan	Barmer	Goat	Sirohi	2
	Jodhpur	Cattle	Tharparker	1
		Goat	Sirohi	3
		Sheep	Marwari	3
Tamil Nadu	Villupuram	Goat	Tellicherry	4
Uttar Pradesh	Chitrakoot	Pig	Large White Yorkshire	2
West Bengal	Coochbehar	Goat	Black Bengal	26
		Pig	Ghungro	16

Table 3.3.9: Poultry breeds introduced in different NICRA villages

State	NICRA village	Breed	No. of farmers
Andaman & Nicobar	Port Blair	Nicobari	14
Andhra Pradesh	Chittoor	Rajasri	50
	Kurnool	Rajasri	42
Arunachal Pradesh	West Siang	Vanaraja	20
	Tirap	Kuroiler	10
Assam	Dibrugarh	Vanaraja	55
Bihar	Banka	Vanaraja	21
	Jehanabad	Jharsim	25
Chhattisgarh	Bilaspur	Vanraja & Giriraja	23
	Dantewada	Kadaknath	50
Jammu & Kashmir	Phulwama	Vanaraja	100
	Bandipora	Vanaraja	15
		Golden Key Stone	15
		Kuroiler	15
Jharkhand	Chatra	Jharsim	42
	East Singhbhum	Jharsim	16
	Koderma	Jharsim	20
Karnataka	Gadag	Giriraja	10
	Chickballapur	Kadaknath	72
Madhya Pradesh	Jhabua	Kadaknath	14
	Bharatapara	Kadaknath	30
	Chhattarpur	Kadaknath	10
Maharashtra	Ratnagiri	Giriraja	14
		Kaveri	14
		Kadaknath	12
	Ahmednagar	Shrinidhi	22
	Aurangabad	Gramapriya	50
	Jalna	Rhode Island Red	30
Manipur	senapati	Gramapriya	10
Meghalaya	West Garo Hills	Kuroiler	20
	Ri Bhoi	Vanaraja	20
Mizoram	Lunglei	Vanaraja	10
Nagaland	Dimapur	Vanaraja	13
Odisha	Jharsuguda	Rainbow rooster	10
	Sonepur	Pallishree	15
	Kendrapara	Kadaknath	10
Sikkim	East Sikkim	Vanaraja	10
Tamil Nadu	Thiruvarur	Aseel	10
	Villupuram	Gramapriya	16
	Ramanathapuram	Namakkal Desi	50
Telangana	Khammam	Rajasri	20
West Bengal	Coochbehar	Vanaraja	15

3.3.2 Composite fish culture:

Composite fish culture with Indian major carps - Catla, Rohu and Mrigal (3:4:3 ratio) at 5000 yearlings ha^{-1} was demonstrated at NICRA village Chopara in Ganjam district of Odisha with harvested water in community pond. With proper water quality management and floating fish feed farmers recorded higher income from composite yearlings compared to stocking of fry.

Table 3.3.10: Details of composite fish culture at Ganjam district of Odisha

Treatments	Survival rate (%)	Yield (kg ha^{-1})	Cost of rearing (Rs. ha^{-1})	Gross income (Rs. ha^{-1})	Net income (Rs. ha^{-1})	B:C ratio
Farmers practice-Stocking of fry	62	2720	140000	258400	118400	1.85
Improved practice-Stocking of yearling with floating fish feed	86	3980	190500	398000	207500	2.09

Release of yearlings of Catla, Rohu and Mrigal at Ganjam district of Odisha and fingerlings of common carp at Hiranar in Dantewada district of Chattisgarh

Fish farming (Aquaculture) is one of the major activities in NICRA village of Malda district in West Bengal, but the productivity is low due to the poor feeding management. Fourteen farmers were trained and initiated the composite fish culture in pond with proper commercial feeding management. This intervention resulted in increase in fish production from 24.75 q ha^{-1} to 48.75 q ha^{-1} with increased net income of Rs. 20,000 ha^{-1}. Similarly, after training, farmers released 9000 fingerlings of common carp in seven farm ponds present in the village as secondary source of income in Hiranar NICRA village of Dantewada district. From each 0.4 ha farm pond farmers harvested about 4.5 q of fish in a season with B:C ratio of 2.6.

Mono fish culture in farm pond is a common practice to generate additional income by the farmers, but exploring composite fish culture with different species in a common pond will certainly results in better yields and income. Each carp occupies a specific layer in the pond thus utilizing the available resources efficiently. Composite fish culture (Rohu, Mrigal, Silver carp, Common carp and Catla) was demonstrated in community farm ponds and farm ponds at Rayapuram village of Thiruvarur to efficiently utilize the natural feed sources available in different layers of the pond. On an average, 58 per cent survival rate was observed with composite fish culture. This resulted in 30 per cent higher net income compared to mono culture.

Table 3.3.11: Production and economics of rearing fish in farm pond at Thiruvarur district

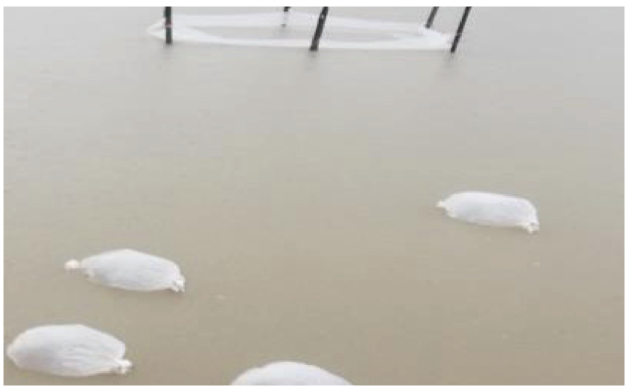
Treatments	Yield in kg/ pond	Cost of production (Rs. / pond)	Gross income (Rs. / pond)	Net income (Rs. / pond)	B:C ratio
Farmers' practice: Tilapia	122	9531	12200	2668	1.28
Improved practice: Composite fish culture	165	13508	23100	9591	1.71


Demonstration of composite fish culture at Thiruvarur district

Polyculture with fish and shrimp has been introduced in 10 ha of land with 5 farmers at NICRA village in West Godavari district for higher income and effective utilisation of feed resources available at different layers of pond replacing traditional monoculture. A stocking density of 2500 fish and 50000 Vannamei per acre were released in the pond and continuously monitored for survivability of vannamei and water quality parameters. Poly culture plots recorded Rs. 53,000 ha^{-1} additional income compared to monoculture.

Table 3.3.12: Production and economics of polyculture (fish and shrimp) at West Godavari district of Andhra Pradesh

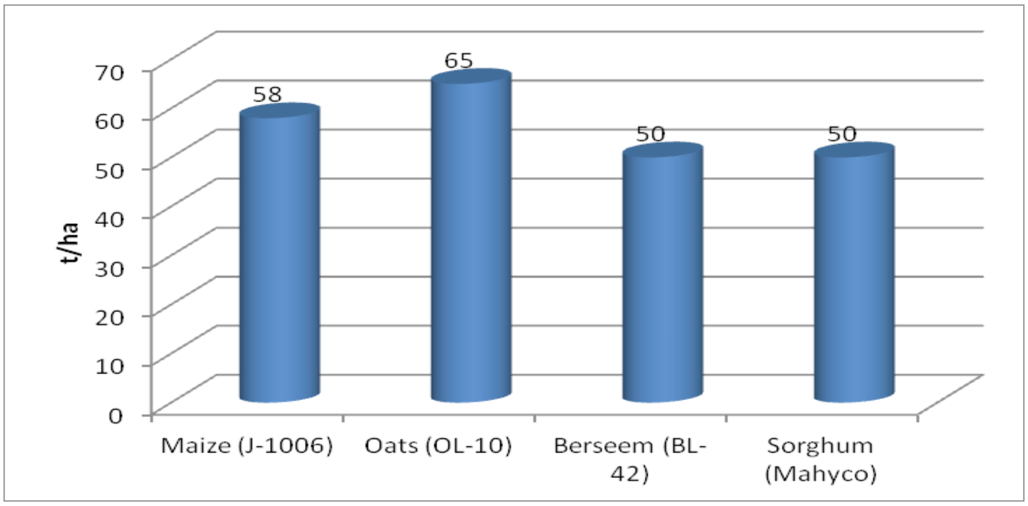
Treatments	Yield (Kg ha^{-1})	Cost of cultivation (Rs. ha^{-1})	Gross income (Rs. ha^{-1})	Net income (Rs. ha^{-1})	B:C ratio
Farmer's practice: Monoculture	4100 kg	255800	328000	72000	1.28
Demonstration: Polyculture	4000 + 1000kg	300000	(300000 + 125000) 425000	125000	1.41




Polyculture of fish and shrimp at West Godavari district of Andhra Pradesh

3.3.3 Mitigation of fodder scarcity: Green fodder production through improved fodder cultivars

Dairying is one of the main component in existing farming system of Faridkot district in Punjab and availability of green fodder throughout the year is the main limiting factor for sustainable milk production from milch animals. In order to mitigate this endemic problem, high yielding green fodder cultivars of Maize (J-1006), Berseem (BL-42), Oats (OL-10), Sorghum (Mahyco multi cut hybrid) were demonstrated during different seasons. About 141 families adopted and benefited in NICRA village with high yielding fodder cultivars and this resulted in increase in fodder base both at village and individual household level for better feeding the milch animals.



Fodder yield of improved cultivars in Faridkot district of Punjab

Table 3.3.13: Milk yield with and without feeding green fodder from improved cultivars at Faridkot district of Punjab

Fodder crop	Variety	Milk yield (litres day^{-1})	
		With improved cultivars	Without improved cultivars
Maize	J-1006	12-13	10-11
Oats	OL-10	14-15	12-13
Berseem	BL-42	11-12	9-10
Sorghum	Mahyco hybrid	16-18	13-15


Demonstration of improved fodder cultivars of maize and berseem at Faridkot district of Punjab

Green fodder production - Chittoor

Dairying was one of the key enterprises for the farmers and cultivating APBN-1 fodder variety as green fodder for feeding milch animals. KVK introduced Hybrid Napier CO-4 variety, which is a multi cut perennial grass with profuse tillering (30-40 tillers per clump) and very good production potential (375-400 t ha^{-1} per year) throughout the year. It is more palatable and having high nutritive value and suitable to varying climatic and soil conditions. Besides, it also supplies green fodder for at least for five years once established. The fodder yield of CO-4 variety recorded at farmer level was 102.3 t ha^{-1} when compared to 83.5 tonnes with APBN-1. KVK supplied slips of Hybrid Napier Co-4 fodder variety to ten dairy farmers initially and it spread to the whole village and all the livestock farmers are now cultivating. This substantially enhanced the fodder base both at household and village level and resulted in sustainable milk production in the village.

Cultivation of fodder crops were demonstrated in the community lands of NICRA village Bahuwan Madar Majha in Gonda district of Uttar Pradesh for nutritious fodder supply during the entire season. Improved varieties of oats, berseem, sudan grass and hybrid napier were demonstrated. Improved fodder varieties have increased fodder yield by 40 per cent and feeding of harvested green fodder enhanced milk productivity of dairy animals.

Table 3.3.14: Fodder and milk yield at Gonda district of Uttar Pradesh

Fodder crop	Variety	Season of cultivation	Fodder yield (t ha^{-1} $season^{-1}$)	Milk yield (litres day^{-1})	
				With intervention	Without intervention
Oats	Local variety	*Rabi*	33.50	-	6.75
Oats	JHO-99-2	*Rabi*	46.60	7.25	6.75
Berseem	Mascavi	*Rabi*	43.15	7.75	6.75
Sudan grass	MFSH-4	Summer	52.25	7.50	6.85
Hybrid napier	NB-21	Throughout the year	53.40	6.00	5.75

Cultivation of berseem and distribution of sudan grass seeds to farmers at Gonda district of Uttar Pradesh

Azolla cultivation was demonstrated in dry regions of the Banaskantha district of Gujarat to mitigate the shortage of green fodder during lean period for sustaining the milk productivity in crossbred cows. Milk productivity has been increased by one litre per day (13.1 to 14.2 litres) and fat content from 3.8 to 4.4 per cent with supplementation of *azolla* at 500 g per day per cow.

Demonstration of azolla cultivation and supplementation at Banaskantha district of Gujarat

Perennial fodder (multi-cut) hybrid napier (BNH-10) having broad green leaves, profuse tillering, anti-lodging, high crude protein and less oxalate content slips were distributed to 10 farmers at NICRA village of Kadegaon in Jalna district for continuous supply of green fodder to milch cattle. Cultivation of hybrid napier resulted in higher green fodder production (80.5 t ha^{-1}) and supplementation of green fodder in milch animals increased milk production compared to feeding of traditional fodder bajra.

Table 3.3.15: Yield and economics of hybrid napier cultivation at Jalna, Maharashtra

Fodder crop	Fodder yield (t ha^{-1}season^{-1})	Cost of rearing (Rs. ha^{-1})	Gross income (Rs. ha^{-1})	Net income (Rs. ha^{-1})	B:C ratio
Farmers practice-Bajra	27.0	34360	47250	12890	1.37
Improved practice-Hybrid napier (BNH-10)	80.5	84600	161000	76400	1.90

Demonstration of hybrid napier (BNH-10) at Jalna district of Maharashtra

Long dry spells and early withdrawal of monsoon were the main constrains for non-availability of green fodder in the villages. To have continuous supply of green fodder and to meet the year round fodder requirement of high yielding milch animals, hybrid Napier (CO-1) and Berseem (JB-1) fodders were promoted in 10 farmer's fields in NICRA village and harvested about 560 and 650 tonnes of fodder, respectively. This resulted in better feeding of milch animals and subsequent higher milk yield of 3.75 litres compared to 2.75 litres per day per animal with significantly higher net returns (Rs. 32,750 ha^{-1}) and B:C ratio (2.2).

Davanagere district of Karnataka faces frequent drought and because of which green fodder scarcity prevails on regular basis and productivity of milch cows is very low. Therefore, improved fodder sorghum variety (COFS-29) was demonstrated in 10 ha area benefitting 100 farmers during drought season. Drought tolerant sorghum cultivar (COFS-29) produced 121 tons of green fodder per hectare per annum. Supplementation of the harvested fodder resulted in milk yield increase by 17 per cent and improved net returns (Rs. 62,050 per annum per animal). Similarly, enrichment of poor-quality dry roughages with brolyatone liquid and enzyme powder has been demonstrated for feeding dairy animals during summer for higher milk productivity.

Table 3.3.16: Milk yield and economics of feeding improved fodder sorghum variety (COFS-29) at Davanagere, Karnataka

Feeding management	Milk yield (L. day^{-1})	Cost of production (Rs. day^{-1})	Gross returns (Rs. day^{-1})	Net returns (Rs. day^{-1})	B:C ratio
Farmer's practice-Locally available fodder	9.9	120	248	128	2.06
Improved practice: HYV Fodder Sorghum (COFS-29)	11.6	120	290	170	2.41
Farmers practice-Dry fodder	7.6	120	190	70	1.58
Improved practice: Enriched dry fodder	9.3	120	234	113	1.95


Demonstration of Fodder Sorghum (COFS-29) and enrichment of dry fodder at Davanagere, Karnataka

For the availability of green fodder throughout the year in frequently drought prone regions of Chittoor and Namakkal districts, growing of fodder sorghum variety COFS-31has been demonstrated in both summer and *rabi* seasons. Fodder sorghum variety COFS-31 has shown higher fodder yield (185.0 t ha^{-1} annum^{-1}) compared to farmers variety (157.0 t ha^{-1} annum^{-1}) at Chittoor district, feeding of fodder from sorghum variety COFS-29 resulted in 27 per cent improvement in milk production at Namakkal.

Table 3.3.17: Fodder yield and economics of fodder sorghum variety COFS-31 at Chittoor, Andhra Pradesh

Treatments	Fodder Yield (t ha^{-1} annum^{-1})	Cost of cultivation (Rs. ha^{-1})	Gross income (Rs. ha^{-1})	Net income (Rs. ha^{-1})	B:C ratio
Local variety fodder	157.0	38425	54000	15575	1.41
Improved variety	185.0	39740	70000	30260	1.76


Demonstration of Fodder Sorghum (CoFS-31) and (CoFS-29) at Chittoor and Namakkal districts

Intercropping of Berseem (BL-42) and Rye grass (PRG-1) has been demonstrated in Ropar district of Punjab to enhance nutritious fodder supply for milch cattle. Intercropping resulted in 10 tons higher productivity compared to farmer's practice of berseem alone (BL-42). Improved fodder production with oats (Sabazar) at Phulwama district helped to overcome the fodder shortage during winter and improved the milk yield from 6.0 to 7.5 litres per day in milch animals.

Demonstration of oats (Sabazar) at Phulwama district of Jammu and Kashmir

Table 3.3.18: Improved fodder varieties demonstrated and adopted in NICRA villages

State	KVK	Crop	No. of farmers	Area Covered (ha)
Andaman & Nicobar	Port Blair	Hybrid Napier (CO-4)	2	0.3
Andhra Pradesh	Chittoor, Ananatapuram	Hybrid Napier (CO-4), Sorghum (COFS-31)	120	21.2
Bihar	Banka, Nawadah, Buxar, Saran Jehanabad	Sorghum (PC-23, SX17, MP Chari) Bajra, Guar (Local), Maize (J-1006), and Napier grass, Oats (Kent), Sudan grass	81	26.6
Chhattisgarh	Bilaspur	Sorghum (MP Chari) + Maize (African Tall), Berseem (Mescavi)	5	1.3
Gujarat	Amreli	Sorghum (GFS-5, Jumbo gold), Lucerne (GAL-2, Anand-2), Hybrid Napier (CO-4)	235	33.0
Himachal Pradesh	Chamba, Kinnaur, Kullu	White clover, Sorghum (Kanchan Hybrid), Fodder Maize (Kanchan 988), Sorghum + Bajra, Oats (Sabzar)	92	5.1
Jammu & Kashmir	Phulwama, Bandipora	Oats (Sabzar), Fodder Maize (African Tall)	68	16.0
Jharkhand	Godda, Gumla, Koderma	Subabul (K-636), Hybrid Napier (CO-4), Drumstick (PKM-2)	46	251.0
Karnataka	Davanagere, Gadag, Tumkur Chickballapur,	Sorghum (COFS-29), Signal Grass, Guinea Grass, Rhodes Grass, Hedge Lucerne, Moringa, Neem (*Melia dubia*)	269	21.6
Madhya Pradesh	Guna, Balaghat, Datia, Guna, Jhabua, Tikamgarh	Berseem (JB-5, JB-1, BL-180), Napier bajra hybrid, Sorghum, Fodder Maize (Makka cholam), Hybrid Napier (KKM-1), Subabul, Spineless Cactus	98	24.5
Maharashtra	Nandurbar, Jalna	Lucerne (Anand-2), Hybrid Napier (BNH-10)	23	0.6
Mizoram	Lunglei	Hybrid Napier (CO-4)	5	2.5
Odisha	Sonepur,Kalahandi, Kendrapara	Hybrid Napier (CO-4), Maize	33	5.1
Punjab	Fatehgarh sahib, Ropar	Berseem +Rye grass (BL-10 + PBRG-1), Fodder Maize (J-1006)	155	27.2
Rajasthan	Jhunjhunu, Barmer, Kota	Bajra (AVKB-19), Oats (JHO-822, Kent), Lucerne (Anand-2), Berseem (BB-2)	130	19.0
Sikkim	East Sikkim	Oats (Kent)	15	0.8
Tamil Nadu	Villupuram	Sorghum (COFS-29), Cumbu Napier Grass (COBN-5), Guinea Grass (GG-3), Stylosanthes (TNAU)	130	2.2
Telangana	Khammam	Sorghum (COFS-29), Hybrid Napier (Super Napier)	50	50.0
Uttar Pradesh	Bahraich, Jhansi, Chitrakoot, Gonda, Pratapgarh, Hamirpur, Baghpat, Muzaffarnagar, Kushinagar	Sorghum (Sudan chari, M.P.Chari), Berseem (Mascavi, BB-2, MFSH-4, Wardan), Oats (JHO-822), Maize (African tall, J-1006), Makhhan Grass, Sudan grass (MFSH-4)	367	44.5
Uttarakhand	Uttarkashi, Tehri Garhwal	Fodder Maize (African tall), Hybrid Napier (CO-3)	146	7.0

3.3.4 Enhancing off season availability of nutritious green fodder: Silage making

Silage preparation was demonstrated at NICRA village of Fatehgarh sahib for continuous supply of nutritious fodder during lean winter season. Feeding of silage prepared in bags with maize fodder during October-November months resulted in increase in milk production from 8.00 litres day^{-1} to 9.2 litres day^{-1} in cows.


Demonstration of silage preparation at Fatheghar shaib district of Punjab



Silage preparation and feeding to cattle at Ahmednagar district of Maharashtra

Green fodder availability during summer was the real problem at Nirmal Pimpri village of Ahmednagar, Maharashtra due to less water availability for fodder crop cultivation. KVK demonstrated and trained silage preparation for 75 farmers with 65 quintals of maize and sorghum green fodder. Farmers fed the silage to cattle during February to June months and it has been adopted by 95 per cent of the farmers in the village. The daily milk production in the village increased from 3000 to 6200 litres per week with the practice of silage supplementation to the milch animals. Net returns for single cow had increased from Rs. 1,925 to 3,208 per month as a result of higher milk and fat content due to silage supplementation.

Mineral mixture and concentrate mixture supplementation to mitigate deficiency of nutrients in general and calcium in particular in milch animals have been demonstrated for increasing milk production. Concentrate feed with more than 60 per cent total digestible nutrients (T.D.N), 18 per cent protein and 2 per cent fat supplementation improved milk production from 4.68 to 5.52 litres day^{-1} at Amreli district. Rumen protected amino acids along with mineral mixture supplementation to high yielding dairy animals has been demonstrated in the same village, which improved the milk productivity by 13 per cent.

The rainfall was mostly erratic in the Yagantipalle village of the Kurnool district and the availability of green fodder was an endemic problem for milch animals. Even water is not available to grow crops during *rabi* and summer season. Under these circumstances, low cost hydroponics fodder production unit has been established and demonstrated the production of green fodder at NICRA village Yagantipalle so as to increase availability of nutritious feed during lean season to overcome the green fodder scarcity with available limited source of water. The production capacity of unit is 25 kg day^{-1} and unit cost of Rs. 13,000. This intervention increased the fat percent in milk (4.4) and daily milk yield (18.9), 6% FCM (22.6) and resulted in Rs.52/- more income per animal.

Low cost hydroponic fodder production unit at Kurnool district of Andhra Pradesh

Table 3.3.19: Milk yield and economics of feeding hydroponic fodder for milch animals

Treatments	Milk yield in Ltrs (60 days period)	Fat % in milk	6 per cent fat corrected milk/day	B:C ratio
Demonstration: Dry fodder + Hydroponic fodder	390.8	7.08	7.32	4.86
Farmers practice: Dry fodder + concentrates	328.8	6.78	5.97	3.83

3.3.5 Controlling endemic disease epidemics: Animal health camps

Animal health camps were organised at Mehra village of Banka district in Bihar to prevent the endemic disease epidemics in livestock and poultry. About 685 cattle were immunized against Foot and Mouth diseases (FMD) and about 356 for Peste des Petits Ruminants (PPR). It resulted in very low morbidity (7%) and mortality (<3%) in calves and goats.

Animal health camp at Mehra village of Banka district in Bihar

Animal health camps and diagnostic visits were organised at NICRA and adjoining villages of East Sikkim for identification and treatment of subclinical of mastitis and babesiosis in cows. Vaccination for Ranikhet also carried for poultry. Trained the dairy farmers on scientific feeding management of cattle using locally available feed ingredients, feeds and fodder.

Animal health camps at Thanka Martam and Timpyem villages of East Sikkim district

Endoparacites especially helminthes such as roundworm, flukes and tapeworm seems to be a chronic problem at buldana district of Maharashtra. Hence, deworming and animal health camps were being conducted at regular intervals where in about 172 cattle and calves were dewormed. Deworming of calves enhanced average daily growth and improved milk production in cows and buffaloes.

Animal health camp and preventive vaccination at buldana district of Maharashtra

Foot and mouth disease in cattle was endemic and wide spread in three NICRA villages (Kanti, Hasgora and Nandanpur) of Tikamagarh district. Hence, preventive vaccination against foot and mouth disease was carried in two animal health camps for 312 animals benefitting 124 farmers. With these preventive vaccinations, mortality was reduced from 15 to 7 per cent and also incidence of diseases.

Animal health camp and preventive vaccination camp at Tikamgarh district of Madhya Pradesh

To educate the farmers about scientific practices in calf rearing "Calf registration and healthy calf programme" was initiated during 2011-12 under NICRA project in Yagantipalle village. The farmer has to register his calf immediately after birth and calf health cards being issued to the farmers for filling the initial data about the calf. The registered calves were provided with scientific feeding and medication up to six months age for maintaining good health and reduce mortality in calves.

Table 3.3.20: Body weight gain and mortality of calves at Kurnool district of Andhra Pradesh

Treatments	Initial body weight (kg)	Final body weight (Kg)	Per cent increase in body weight gain	Mortality (number)	Mortality (%)
Farmers Practice	23.4	62.6	39.2	7	14
Demonstration- Calf registration	24.3	71.6	47.6	1	0.5

Calves registration programme at Kurnool district of Andhra Pradesh

Ranikhet in poultry, blue tongue and PPR in sheep and goats are epidemic diseases in Vadavathur, Jambumadai and Thipramadevi villages of Namakkal district. Preventive vaccination against these diseases helped to reduce not only mortality but also morbidity.

Table 3.3.21: Details of number of animals vaccinated

Name of the village	Disease epidemics recorded during last decade	No of animals vaccinated
Vadavathur	Ranikhet	908
	Blue tongue	241
	PPR	212
Jambumadai	Ranikhet	824
	Blue tongue	173
	PPR	276
Thipramadevi	Ranikhet	215
	Blue tongue	68
	PPR	47

Animal health and preventive vaccination camps at Namakkal district of Tamil Nadu

3.3.6 Mitigation of heat stress: Improved housing

High temperature and heat waves during summer severely impact milk production and many times the calves and aged animals succumbs to severe morbidity in Kota district of Rajasthan. Loose housing made of sheet covered with locally available straw costing Rs. 20,000 and can accommodate 8-10 cattle was demonstrated. With this intervention milk yield of cows and buffaloes were increased by 30 per cent and also reduced calf mortality.

Poor growth and high incidence of diseases were observed in pigs under traditional housing at Sipni village of Tirap district in Arunachal Pradesh. Hence, improved pig sty/housing was demonstrated in the village for reducing the heat stress and disease spread. Improved housing helped in attaining higher body weight and profitability. Similarly, low cost pig sty demonstrated at Imphal east district of Manipur to facilitate the pigs to get enough air, sunlight and space for movement. This facility helped for quick attainment of body weight and reduced the mortality by 40 per cent.

Table 3.3.22: Productivity and economics of improved housing for pigs at Tirap district of Arunachal Pradesh

Treatment	Body weight and pork production (at 10 months in kg)	Disease incidence (%)	Cost of rearing (Rs. ha^{-1})	Gross income (Rs. ha^{-1})	Net income (Rs. ha^{-1})	B:C ratio
Traditional housing	46.8 & 34.2 kg/ pig	22	10290	18527	8237	1.80
Low cost scientific pig sty at Tirap	68 & 51.5 kg/ pig	5	12000	23530	11530	1.96

Low cost scientific pig sty housing at Tirap district of Arunachal Pradesh and Pigsty with wallowing tank at Imphal east district

Improved housing

Piggery/pig farming is very important activity in North East India. Pork is the part of the stable diet of the region. Appropriate housing system is very important for higher productivity and lower incidence of diseases in pigs. Deep litter housing is a type of pig housing where the floor is filled with sawdust of 2 - 3 feet, which is well suited for high rainfall and high altitude areas. Improved housing for pigs was demonstrated in Dibrugarh, Tirap, East Singhbhum and Ri-bhoi NICRA villages of Assam, Arunachal Pradesh and Tripura states benefitting 36 farmers during 2018 year. Construction of the shed was demonstrated with locally available bamboo and other wood materials. Similarly raised poultry sheds with bamboo were also introduced to prevent inundation of flood water in traditional poultry houses. Zero mortality was observed in pig and poultry with demonstrated housing. Improved housing also lead to higher body weight gain by 20-30 per cent at NICRA village of Ri-Bhoi district of Meghalaya.

In NICRA village Chittecherla of Chittoor district, temperature reaches to as high as 45^0C during summer which results in low milk productivity in high yielding crossbred cattle (especially H.F). To overcome the adverse effects of heat stress, foggers were installed in animal sheds to spray minute droplets of water so as to reduce temperature in summer. By installing foggers led to an average increase of 3 litres per animal and an additional income of Rs. 31,050 per annum when compared to no foggers in the shed.

Table 3.3.23: Impact of housing with foggers on milk productivity of crossbred cattle at Chittoor district

Treatments	Farmers practice (without foggers)	Improved technology (with foggers)
Milk yield (litre/day/ animal)	9	12
Milk production (litres/3 months)	810	1080
Total Milk yield /5 animals	4050	5400
Expenditure (Rs. / 5 animals/3 months)	36000	41800
Total Income (Rs. / 5 animals/3 months)	93150	124200
B:C ratio	2.58	2.97


Housing with foggers to reduce heat stress at Chittoor district of Andhra Pradesh

Floods and water logging are the major causes of mortality in goat and poultry at Muttar village of Alappuzha district in Kerala. Further, lower height of traditionally built cages can spread diseases faster. Therefore, modified as elevated cage for poultry and demonstrated against flooding conditions during monsoon. This helped to reduce mortality in chicks from 50 to 10 per cent with increased egg production of 2522 per unit of 15 birds compared to local practice (1528 eggs/ unit of 15 birds/annum). Similarly, fabricated shelter with slated floor has been demonstrated to overcome flooding conditions for goats and which reduced mortality and disease spread.

Table 3.3.24: Mortality rate and economics of modified shelter for poultry and goats

Treatment	Mortality (%)	Production	Cost of rearing (Rs. ha^{-1})	Gross income (Rs. ha^{-1})	Net income (Rs. ha^{-1})	B:C ratio
Farmers practice-Traditional housing of poultry	50	1528 eggs /annum	9125	9668	543	1.05
Demonstration-Raised poultry cage	10	2522 eggs / annum	15025	17632	2607	1.17
Farmers practice-Traditional housing for goats	40	4 kids /annum	15100	18000	2900	1.19
Demonstration-Improved housing of goats	00	11 kids /annum	44300	57100	12800	1.28

Improved housing for poultry and goats at Muttar village of Alappuzha district in Kerala

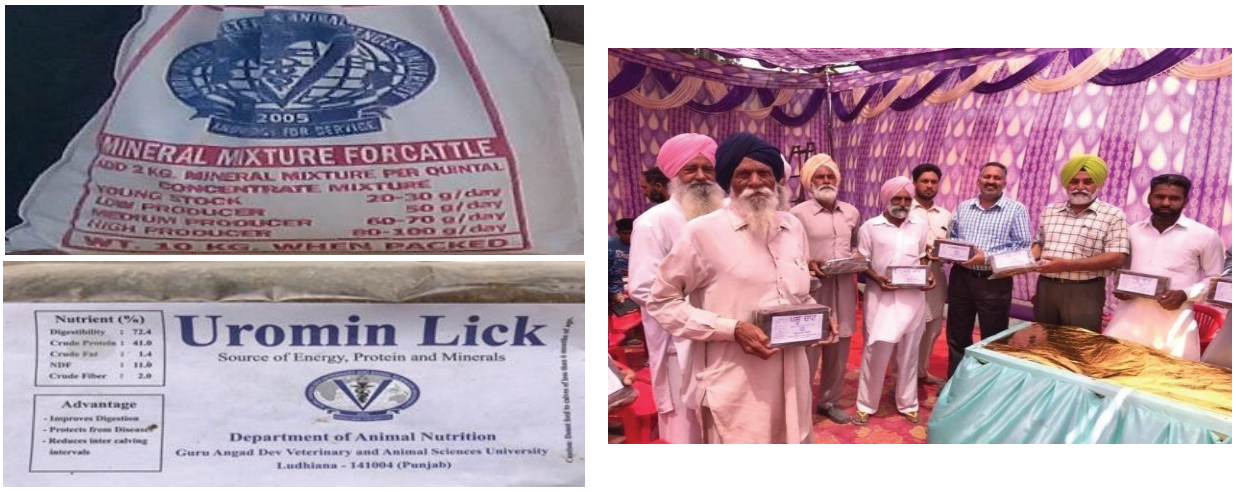
Table 3.3.25: Improved shelter introduced in NICRA villages

State	KVK	Species	Intervention	No. of farmers
Andaman & Nicobar	Port Blair	Poultry	Improved shelters for reducing heat stress	2
Arunchal Pradesh	Tirap	Pig	Low cost pigsty	8
	West Siang	Poultry	Nest box to prevent scattered laying of eggs	10

Assam	Dhubri	Poultry	Cost of Bamboo, shelter etc	10
	Dibrugarh	Poultry	Improved poultry cage	9
		Pig	Improved shelter	15
Bihar	Jehanabad	Cattle	Mud based Shelter Bamboo+Paddystraw+mud+one side brick wall for cattle	16
		Poultry	Mud based Shelter Bamboo+Paddystraw+mud+one side brick wall for cattle	2
	Saran	Cattle	Bamboo made shelters	4
Chhattisgarh	Bilaspur	Cattle and poultry	Surface of cattle and poultry house covered by litter, Restriction of movement of chicks nearer the heat sources	31
	Dantewada	Goat	Locally available forest leaves, polythene sheets(NICRA), Cement cover (DMF) goat breeds(Black Bengal & Sirohi)	54
Himachal Pradesh	Kullu	Cattle	Rubber cow mats	25
Jharkhand	East Singhbhum	Pig	Semi Intensive structure	5
Kerala	Alleppey	Goat	Materials to fabricate improved shelter	5
		Poultry	Improved poultry cage	20
Madhya Pradesh	Morena	Cattle	Grooming and bathing (with plastic brush for 15 min. 2 times a day)	40
	Satna	Goat	Local material	10
Maharashtra	Nandurbar	Goat	Gunny bags for goats for protection from severe cold	10
		Cattle	Shadenet	10
	Ratnagiri	Poultry	Low cost improved poultry housing system	10
		Goat	Improved shelter	8
Manipur	Imphal East	Pig	Construction of improved pigsty with wallowing tank for reducing heat stress	4
Meghalaya	Ri Bhoi	Pig	Deep litter housing of pigs	4
		Poultry	Climate Resilient Raised Floor Poultry Housing	4
Mizoram	Lunglei and Serchhip	Poultry	GI sheet with bamboo ceiling and Machang type Housing in Poultry	12
Odisha	Sonepur	Cattle and poultry	Improved shelter	11
	Ganjam	Cattle	Cement, sand, stone, mosquito repellent net	4
	Kendrapara	Goat	Low cost improved Goat housing system	8
		Poultry	Low cost improved poultry housing system	2
	Kalahandi	Goat	Low cost goat shed	8
Sikkim	East Sikkim	Poultry	Standard low cost brooder house	40
Tamil Nadu	Villupuram and Ramanathapuram	Poultry	Poultry cages and Shelter for backyard poultry	15
Telangana	Khammam	Poultry	Introduction of poultry housing units	10

3.3.7 Supplementation of essential nutrients: Area specific mineral mixture for improved productivity in cattle

Area specific mineral mixture and uromin licks were supplied to livestock farmers at Bathinda district of Punjab to mitigate repeat breeding, and ensure regular calving in dairy animals. Mineral mixture supplementation also increased milk yield by12-15 per cent. A total of 190 farmers adapted this practice and enhanced the resilience of livestock to heat stress.



Demonstration of area specific mineral mixture and uromin licks to dairy cattle at Bathinda district of Punjab

In chopnadih village of Koderma district, feeding with additional minerals, vitamins along with urea molasses mineral block increased the milk production of cattle with 5.3-6.4% and improved general health of the cattle.

Table 3.3.26: Milk production and economics of supplementation of mineral mixture, vitamin solution and urea molasses mineral block at Koderma, Jharkhand

Kind of mineral/ vitamin mixture used	Quantity used per day per animal (kg)	Milk production (Litres)	
		With supplementation	Without supplementation
Minfa gold	50 g	6.4	4.5
Vit.AD3 +E Liver tonic	20 ml	7.3	4.5
Urea molasses mineral block	300g	5.3	4.4

Demonstration of urea molasses mineral block to cattle at Koderma, Jharkhand

Infertility and low milk yield in buffaloes due to high temperatures were observed in Ata village in Morena district of Madhya Pradesh. Feeding with area specific mineral mixture (50 g/ animal/day) to milch buffaloes and supplementation of liquid calcium and phosphorus (100 ml/animal/day) after calving improved general health during September and October months. These interventions increased milk production upto 23-30 per cent and also 38 per cent increase in conception rate.

Feeding of area specific mineral mixture and liquid calcium and phosphorus to cattle at Morena district in Madhya Pradesh

In villages Vadavathur and Jambumadai of Namakkal demonstrated TNUAS mineral mixture to the dairy farmers to overcome the mineral deficiency and increase milk production in milch animals. Mineral mixture supplementation enhanced milk production and reduced calving interval. About 115 progressive dairy farmers adopted UMMB supplementation at 30-40 g per day during milking stage and which resulted in increased milk production from 165 to 210 litres/animal/month.

Demonstration of TNUAS mineral mixture to the dairy farmers in villages Vadavathur and Jambumadai of Namakkal district

3.3.8 Integrated Farming Systems (IFS): Enhancing resilience and income

Integrated farming systems were demonstrated in Nilapur village of Karbi Anglong district of Assam. Duckery with improved breed of Indian runner was introduced in farm ponds with fisheries as additional component. Integration of duck and fish helped in effective resource utilisation and low cost of production compared to monoculture. Farmers harvested 3.5 q of fish with additional 102 kg of duck meat and 2000 number of eggs from single pond per annum compared to monoculture of fish, where 2.8 q of fish was harvested. Farmer's income was doubled due to integrating duckery with fish production in farm ponds.

Table 3.3.27: Yield and economics of duck cum fish integrated farming system at Karbi Anglong district of Assam

Farming system	Yield (q)	Yield (q)	Cost of rearing (Rs. ha^{-1})	Gross income (Rs. ha^{-1})	Net income (Rs. ha^{-1})	B:C ratio
Farmers practice-Fish culture	Fish-2.8 q	Nil	25000	40120	15120	1.60
Duck-cum fish culture	Fish-3.5 q	Duck - 102kg Eggs - 2000	66850	127180	60330	1.90

Demonstration of Duck cum fish farming at Karbi Anglong district of Assam

Pig-Fish-Poultry-Dairy-Mushroom-Vegetables farming system was demonstrated in West Siang district of Arunachal Pradesh for multiple income from a single land. Cross bred pigs, Vanaraja poultry, HF cows, Oyster mushroom, Cabbage and Cauliflower as vegetables are the components of the system. Poultry and pig housing and mushroom beds were established on the pond bunds. Vegetables were grown on nearby fields with harvested water from ponds. The total net income and B:C ratio of the farming system was doubled compared to traditional monoculture of single enterprise.

Demonstration of integrated farming system at West Siang district of Arunachal Pradesh

To overcome the low income from traditional paddy fields, rearing of fishes as a component in trenches at Jaintia Hills district of Meghalaya was demonstrated. Common carp and Amur carp fingerlings were released after the transplanting of paddy. Fish yield of 3.6 q was harvested in addition to the paddy yield of 44 q ha^{-1}. Benefit cost ratio has raised from 1.6 to 3.3 due to additional returns from selling of integrated fish production. Similarly, pond based fish + pig + vegetable farming system was demonstrated replacing mono pisiculture to reduce the risk. Tomato, cabbage and piggery units were established on bunds of farm pond and surrounding area. Total returns were multi fold compared to fish culture alone with B:C ratio of 2.00.

Table 3.3.28: Yield and economics of paddy cum fish and pond based integrated farming systems at Jaintia hills district of Meghalaya

Farming system	Yield (q)	Cost of rearing (Rs. ha^{-1})	Gross income (Rs. ha^{-1})	Net income (Rs. ha^{-1})	B:C ratio
Farmers practice-Paddy crop	Paddy- 34q	49600	85000	35400	1.71
Paddy cum fish culture	Paddy- 44q Fish- 3.6q	171200	560000	388800	3.27
Farmers practice-Pisiculture	Fish- 5q	60000	100000	40000	1.67
Pond based system (fish + pig + vegetable farming)	Fish- 19.5q Pork- 4.2q Cabbage- 180q Tomato- 245q	318000	636000	318000	2:00

Demonstration of paddy cum fish farming system at Jaintia hills district of Meghalaya

Demonstration of pond based fish + pig + vegetable farming system at Jaintia hills district of Meghalaya.

Poultry cum fish integrated farming system was demonstrated in Kyrdem village of Ri-Bhoi district of Meghalaya for higher returns. Vanaraja poultry chicks were introduced along with traditional fisheries component in 0.1 ha pond. Fish, poultry birds, eggs and vegetables gave stable returns to the farmer compared to single monoculture of fish.

Table 3.3.29: Yield and economics of Integrated Farming System in Ri-Bhoi district of Meghalaya

Farming system	Yield (kg) per 0.1 ha unit	Cost of rearing (Rs. /unit)	Gross income (Rs. /unit)	Net income (Rs. /unit)	B:C ratio
Pisiculture	Fish-85kg	6800	13800	7000	2.02
Poultry cum Fish culture	Fish-165kg Eggs-400 Chicken-87kg	42825	70465	27640	2.52

3.4 Institutional Interventions

Institutions were established at the village to guide the implementation of climate resilient technologies and for their long lasting impact. The community based institutional structures foster group action among the communities, mobilize individual resources for addressing community problems, generate understanding among the community and harness synergies, effective management of resources based on shared utilization and promotes collective action. Progress of the institutions established at the village during the year is presented in this section.

3.4.1 Village Climate Risk Management Committee (VCRMC)

Village Climate Risk Management Committee known as VCRMCs are the village level institutions under project which established supporting systems for planning and implementation of technological interventions at grassroot level. Village Climate Risk Management Committee (VCRMC) was conceptualized as a nodal point for organization of activities of climate resilient villages. The activities of institutional structures like community seed bank, fodder bank, custom hiring centre for farm machinery etc. which were established under NICRA are coordinated by VCRMCs. Action plan for the crop season would be discussed with farming community based on the climate variability and the related issues are addressed though VCRMC meetings.

Table 3.4.1: ATARI wise VCRMC meetings held during 2018-19

ATARI	No. of KVKs under NICRA programme	No. of VCRMC meetings held
ATARI I Ludhiana	13	87
ATARI II Jodhpur	7	49
ATARI III Kanpur	11	35
ATARI IV Patna	12	98
ATARI V Kolkata	9	85
ATARI VI Guwahati	9	32
ATARI VII Barapani	14	67
ATARI VIII Pune	13	58
ATARI IX Jabalpur	12	48
ATARI X Hyderabad	11	73
ATARI XI Bengaluru	7	42
Total	**118**	**674**

VCRMC meetings conducted at Sirusuwada village, Srikakulam district, Andhra Pradesh

3.4.2 Custom Hiring Centers (CHCs)

Timely agricultural operations are crucial for better performance of crops and more important in the context of climatic variability, especially with sowing, intercultural operations, crop harvesting and also in soil management. Keeping this in view, custom hiring centers (CHCs) were established in all the NICRA villages to meet farm machinery needs of the local farming communities and to support various natural resources management (NRM) interventions like *in-situ* soil moisture conservation, mulching, residue incorporation into the soil instead of burning, zero tillage operation and water saving irrigation technologies like drip, sprinkler, rain gun, etc. Most popular farm implements were supplied and used by the farmers from the CHCs are rotavator, power tiller, furrow irrigated raised bed planter, happy seeder, multi crop planter, zero till drill, seed cum fertilizer drill, drum seeder, *etc.* The revenue generated from the CHCs is used for the maintenance of these implements and to purchase new implement based on the availability of revenue and needs of the farming community.

Table 3.4.2: Details of ATARI wise revenue generated for CHCs during 2018-19

ATARI	No. of KVKs under NICRA programme	Total revenue generated through CHCs (Rs.)
ATARI I Ludhiana	13	390118
ATARI II Jodhpur	7	160139
ATARI III Kanpur	10	74214
ATARI IV Patna	13	265207
ATARI V Kolkata	8	97790
ATARI VI Guwahati	8	40401
ATARI VII Barapani	13	267941
ATARI VIII Pune	14	159276
ATARI IX Jabalpur	13	88137
ATARI X Hyderabad	10	233260
ATARI XI Bengaluru	6	26855
Total	**115**	**1803338**

Impact of Custom Hiring Centers during 2018-19: Experiences of successfull CHCs

In the NICRA village Melakunda (B) of Kalaburagi district of Karnataka, seed cum fertilizer drill, ridger planter and power operated sprayer were made available to farmers through custom hiring centre established in the village. Pigeonpea crop was sown using both seed cum fertilizer drill and ridger planter in 20 and 10 ha area respectively, which helped in timely sowing and crop performed better when compared to farmers practice with traditional method of sowing. Power operated sprayer was used for both pigeon pea and chick pea crops in 15 and 8 ha area respectively that helped to save time and energy compared to conventional knapsack sprayers. The details of performance are given below.

Table 3.4.3: Comparison of demo and local plot yields of pigeonpea and chickpea with CHC farm equipments

Treatments	Area (ha)	Improved practice yield (q ha^{-1}) (Demo)	Conventional practice yield (q ha^{-1}) (Local)
Seed cum fertilizer drill-Pigeonpea	20	14.50	12.20
Ridger planter-Pigeonpea	10	14.10	12.30
Power operated sprayer-Pigeonpea	15	13.80	11.50
Power operated sprayer-Chickpea	8	12.60	10.30

Pigeonpea sown with ridge planter and usage of power sprayer in chickpea at Kalaburagi, Karnataka

At Nandyalavari Gudem and Boring Thanda villages of Nalgonda district of Telangana, three row planter, six row planter, rotavator, power weeder, maize sheller, drum seeder and other equipment were made available to farmers through custom hiring centre established in the village. BBF planter was used for cotton and pigeon pea crops in 1 and 4 ha areas respectively, which helped for moisture conservation and enhance the productivity under rain fed condition. The details of performance are as follows.

Table 3.4.4: Effect of sowing in cotton and pigeonpea crops by broad bed planter

Treatments	Area (ha)	Demo farmer yield (q ha^{-1})	Local farmer yield (q ha^{-1})
BBF- Cotton	1	20.25	17.50
BBF-Pigeon pea	4	8.57	6.87

Broad bed furrow planter in both cotton and pigeon pea crop at Nandyalavari gudem, Nalgonda, Telangana

At Bhalot village of Kutch district of Gujarat, rotavator, automatic seed cum fertilizer drill, castor mini thresher, power sprayer and thresher were made available to farmers through custom hiring centre provides access to small and marginal farmers to costly farm machinery, facilitates timeliness in farm operations and efficient use of inputs in the village. This farm equipment helped for 87 ha area benefitted 45 farmers in the village and revenue generated during the year 2018-19 from the CHC was Rs. 26325.

Farm equipment usage during the year 2018-19 from CHC at Kutch in Gujarat

At Magharvada village of Rajkot district of Gujarat, cotton stalk shredder, rotavator, manual drawn automatic seed drill, battery operated knapsack sprayer, chaff cutter and bullock drawn automatic seed drill were made available to farmers through custom hiring centre provided access to small and marginal farmers to costly farm machinery, facilitated timeliness in farm operations and efficient use of inputs in the village. This farm equipment used for 156.3 ha area benefitted 186 farmers in the village and revenue available during the year 2018-19 from the CHC was Rs. 5,170.

Farm equipment usage during the year 2018-19 from CHC at Rajkot in Gujarat

At Chhapri village of Jhabua district, thresher, cultivator, seed cum fertilizer drill, chaff cutter, power sprayer, disc harrow and bund former were made available to farmers through custom hiring centre, provided access to small and marginal farmers to costly farm machinery, facilitated timeliness in farm operations and efficient use of inputs in the village. Due to the facilities provided from CHC 39.5 ha area savings of labour work by an average 57 per cent per ha and average cost saved Rs. 1,500 per ha. The total revenue available during the year 2018-19 was Rs. 7,300 from CHC.

Farm equipment usage during the year 2018-19 from CHC at* Jhabua *in Madhya Pradesh

In the NICRA village Jitender Singh from Faridkot district of Punjab, demonstrations on happy seeder were conducted to create awareness on paddy residue management, and conserving the natural resources of soil and moisture. During the year 2018-19, a total of 30 farmers have utilized the happy seeder and conducted zero till sowing of wheat in the harvested paddy fields in an area of 27 hectares. The paddy residue burning, which was a serious cause for air pollution has been drastically reduced with the introduction of happy seeder in these villages. The soil health status has also improved with the reduced burning.

Happy seeder usage during the year 2018-19 from CHC at Faridkot in Punjab

Success story of Custom Hiring centre of Namakkal

Before NICRA intervention in the Vadavathur village of Namakkal district, farmers were hiring agricultural instruments from private persons and from long distance in high cost, hence the instruments were not available in time for agricultural purpose. Keeping this in view, custom hiring center (CHC) was established in the NICRA village to meet farm machinery needs of the local farming communities. After NICRA intervention all necessary machineries are available in the same village itself and farmers are hiring implements in time at an affordable cost. Most popular farm implements used by the farmers from the CHCs are spring cultivator, rotavator, seed cum fertilizer driller, bund farmer, chain block and weighing balance, *etc.* The Custom hiring farm implements unit is successfully operating in the village where it is managed by Village Climate Risk Management Committee (Thalamalayan Pasumai Iyakkam) with 19 members, who have jointly purchased the tractor. So far 1385 numbers of farmers were benefited by the usage of this farm implements. The total gross income through the custom hiring was Rs.871591 from the year 2011 to 2017.

3.4.3 Seed bank

Seed is a critical input in the arid and semi-arid areas. Ensuring the right seed at the right time is important for enhancing resilience to climate risks. Farmer groups were encouraged to multiply seeds of varieties particularly short duration, drought and flood tolerant varieties at the village level for self reliance in seed at the local level for timely and affordable access.

Table 3.4.5: Details of crops/variety wise seed produced at various seed banks during 2018-19

KVK	Crop and Variety
Hamirpur-HP	Wheat (HPW-368)
Ropar	Wheat (Unnat PBW- 343, PBW – 725)
Jhunjhunu	Cow pea (RC-19), Green gram (IPM-02-3), Cluster bean (RGC-1066), Chickpea (GNG-1581)
Jhansi	Wheat (Raj-4120), Groundnut (K-6), Chickpea (JG-14)
Banka	Paddy (Sahbhagi), Chickpea (PG-186), Lentil (HUL-57), Pigeon pea (Malviya -13), Green gram (HUM-16)
Buxar	Paddy (RajendraSweta, Naveen, JaldiDhan 13, Madhuri, Shusksmrat, Sahbhagi), Wheat (HD 2967, Sabour Nirjal, WR-544), Chickpea (BGM-547, GNG-1581 Pusa-372)
Chatra	Paddy(Anjali, Vandana, Abhishek)
Balaghat	Paddy (MTU-1010, JRH-5, JRH-19)
Tikamgarh	Soybean (JS 95-60), Black gram (IPU-94-1), Mustard (Rohani), Chickpea (JG-16), Wheat (GW-322), Sesame (TKG-308)
Satna	Paddy (MTU-1010), Sesame (JT-21), Mustard (Pusa Tarak), Wheat (JW-3288), Barley (JB-58)
Cooch Behar	Lentil (WB-77), Paddy (MTU 7029, GB-1, Patiksha, Dhiren, Chireang sub-1, Dhiren, DRR Dhan-42)
Ganjam	Paddy (Sahabhagidhan)
South 24 Parganas	Paddy (Swarna sub I, Jarava)
Cachar	Paddy (Ranjit)
Dhubri	Paddy (Joymati, Gitesh, Swarna Sub-1), Toria (TS-67)
Dibrugarh	Paddy (Dishang), Toria (TS-36), Potato (KufriPukhraj)
Mon	Maize (PC-4)
Serchhip	French bean (Arka Arjun), Maize (RCM-76)

Ukhrul	Paddy (RCM-13), Maize (RCM -76), Toria (TS-38), Soybean (JS-335), Groundnut (ICGS-76), Ginger (Nadia)
Aurangabad-MH	Soybean (MAUS -15162), Wheat (Netrawati/Phulesamadhan), Pigeon Pea (BDN-711)
Pune (Baramati)	Rabi sorghum (Vasudha, Revati, Anuradha)
Jalna	Bengal gram (Akash)
Kutch	Lucerne (Anand - 2)
Chittoor	Groundnut (Dharani)

Impact of some successful seed banks during 2018-19

In Bhalot village of Kutch district of Gujarat, established one seed bank unit of Lucerne managed by VCRMC of the village. The total seed produced during the year was 12 quintal and unit cost of seed is Rs. 250 per kg. VCRMCs also facilitated seed bank activities like production of seed by the farmers in NICRA villages and their good storage until the next crop season.

Lucerne seed production at Bhalot village of Kutch district of Gujarat

At Sanora village of Datia district of Madhya Pradesh, one seed bank unit of black gram (Pratap Urd-1) managed by VCRMC of the village. The total seed produced during the year was 8 quintal and unit cost of seed is Rs. 300 per quintal.

Black gram seed production variety of Pratap Urd-1 at Datia district of Madhya Pradesh

In Udmari IV village of Dhubri district of Assam, seed bank units of paddy for varieties (Joymati, Gitesh and Swarna Sub-1) and toria (TS-67) are managed by VCRMC of the village. The paddy seeds of different varieties Joymati, Gitesh and Swarna Sub-1 produced 40, 40.2 and 36.5 q/ha respectively and Toria TS-67 produced was 17.86 q/ha during the year 2018-19.

Paddy seed production (Swarna Sub 1 and Gitesh) and Toria (TS-67) at Dhubri, Assam

3.4.4 Fodder bank

Availability of fodder is a challenge, especially during summer or drought. To overcome the scarcity, farmers restore to year round fodder production systems of multi-cut sorghum and Lucerne for availability of both green and dry fodder resources in NICRA villages

At Kadegaon village of Jalna district in Maharashtra, multi cut fodder hybrid napier of BNH-10 having profuse tillering, anti-lodging, high crude protein, broad green leaves, less water requirement and less oxalate content fodder slips are distributed to 30 farmers during the year 2018-19. They were also trained about the importance of balance fodder to livestock's using proper ratio of green and dry fodder. With the introduction of these varieties, the average milk yield also increased by half litre per day per animal. The net income of Rs. 20,000 was generated from cultivation of fodder and these farmers could sell their seed to 20 other farmers.

Hybrid Napier of BNH-10 production at Kadegaon village of Jalna district, Maharashtra

In Hnahthial village of Lunglei district in Mizoram, multi cut fodder hybrid napier of HFBA having profuse tillering, anti-lodging, high crude protein, broad green leaves, less water requirement and less oxalate content fodder slips are distributed to 10 farmers during the year 2018-19. With the introduction of these varieties, the average milk yield also increased by 2 litres per day per animal. The net income of Rs. 4,800 per cow per month was generated from cultivation of fodder.

3.4.5 Agromet advisories

The information was used by farmers to plan the crops, choice of cultivars, enhance input use efficiency, timely and cost effective management of pests and diseases and harvesting operations.

Table 3.4.6: Number of Agromet advisories issued by various NICRA KVKs during 2018-19

KVK / District	Number of Agromet advisories issued	KVK / District	Number of Agromet advisories issued
Jhunjhunu	32	Ukhrul	26
Kota	124	Senapati	42
Sirsa	8	Ri-Bhoi	56
Yamunanagar	68	Dhalai	6
Bathinda	68	Nandurbar	19
Banka	29	Ratnagiri	480 (60 per month)
East Singhbhum	32	South 24 Paraganas	63
Gumla	64	Chittoor	70
Nawadah	29	Khammam	15
Buxar	39	Belgaum	21
Jehanabad	29	Davanagere	7
Ratlam	11	Chikkaballapura	200
Morena	48	Tumkuru	48
Jhabua	104	Tirap	179
Satna	17	Dibrugarh	8
West Siang	70	Cachar	15

Agro advisories were issued during the cropping season to enable farmers to a take timely decisions. The established partnerships and strengthened institutions in the NICRA villages have contributed towards the spread of the resilient practices among farmers and contributing towards enhancement of the adaptive capacity of farmers and resilience in the fragile and stressed agro-ecosystems of the arid and semi-arid regions.

4. Extreme Events-Coping Interventions

During 2018-19, extreme events were witnessed severely impacting crop growth and yields. The preparedness measures demonstrated and adopted by farmers minimized the impact to a great extent. Timely advisories were given in the affected regions to further minimize the damage and demonstrated contingency measures. These measures further minimized the damage due to the extreme events. The details of extreme events witnessed during the season are as follows.

Table 4.1: Extreme events occurred in different states during 2018-19

Extreme events	State impacted	Date of occurrence	Major crops affected
Titli cyclone	Andhra Pradesh, Odisha	10-14 October, 2018	Paddy
Gaja cyclone	Tamil Nadu, Kerala and Puducherry	10-14 November, 2018	Paddy
Pethai cyclone	Andhra Pradesh, Jharkhand	13-18 December, 2018	Paddy
Cold Wave	Uttar Pradesh, Bihar, Himachal Pradesh	2-14 January, 2019	Apple
Heat wave	Rajasthan, Uttar Pradesh	15 March to 15 April, 2019	Wheat and Mustard

In Sirusuwada NICRA village of Srikakulam district, Andhra Pradesh, *titli* cyclone adversely affected paddy crop which is at panicle initiation and flowering stage and caused complete inundation (3-5 days) due to heavy rain which is about 90 mm in three days and due to the over flow of vamsadhara canal. The *pethai* cyclone impacted the crop at maturity. Demonstration of flood tolerant paddy cultivars taken up during the last six years led to adoption of flood tolerant cultivars such as MTU 1061, MTU- 1075 and RGL-2537 by 147 farmers covering an area of 83 ha in the NICRA village. These varieties could tolerate the water stagnation and withstood the heavy wind with little lodging where as the traditional varieties grown by farmers got impacted severely resulting in severe yield loss. Farmers were advised to drain out excess water from the inundated fields, advised for application of booster doses of fertilizer (urea 25 Kg, potash 15 kg per acre), advised to monitor the BPH population, blast and sheath blight prevalence. Adoption of the flood tolerant cultivars and the contingency measures further minimised the damage due to cyclone and helped to realise 80% of the normal yields.

Inundated paddy fields at sirusuwada village (*3rd day of inundation)

Crop inundated at grain maturity stage

Application of pesticides for control of BPH- Post cyclone measure

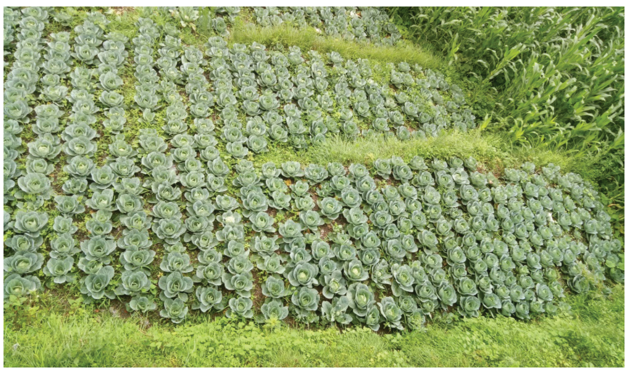
Nutrient management (Booster dose application)-Post cyclone measure

Heat waves were observed during 15th March to 15th April in Rajasthan and Uttar Pradesh affecting crops such as mustard, wheat and beet root. Preparedness measures such as timely sowing of *rabi* crops by way of happy seeder, planting by providing presowing irrigation, adoption of heat and drought tolerant varieties in mustard crop (Variety-CS-56) minimized the impact to a significant extent. Contingency measures such as providing irrigation where ever possible were suggested to farmers in the villages to minimize the impact. Use of zero till seed drill for timely wheat sowing helped to escape the heat stress and reduced the heat stress at maturity and helped to increase the production by 15-20 per cent as compared to late sown wheat.

Use of Zero till seed Drill for timely wheat Sowing

Drought tolerant Mustard crop (Variety-CS-56)

Cold wave with minimum temperatures of -6 to -8^{0}C were observed in chamba district. Many crops were affected due to the cold wave. Protected cultivation in poly houses is one of the interventions demonstrated to minimize the impact of cold stress, which was adopted by several farmers in the village. Protected cultivation of capsicum and crop diversification with cabbage and cauliflower (23.5 ha) resulted in significant returns in spite of cold stress. About 56 farmers in the NICRA village have adopted protected cultivation which have contributed towards reducing the impact of cold stress and helped to realize returns from high value crops.



Protected cultivation of capsicum

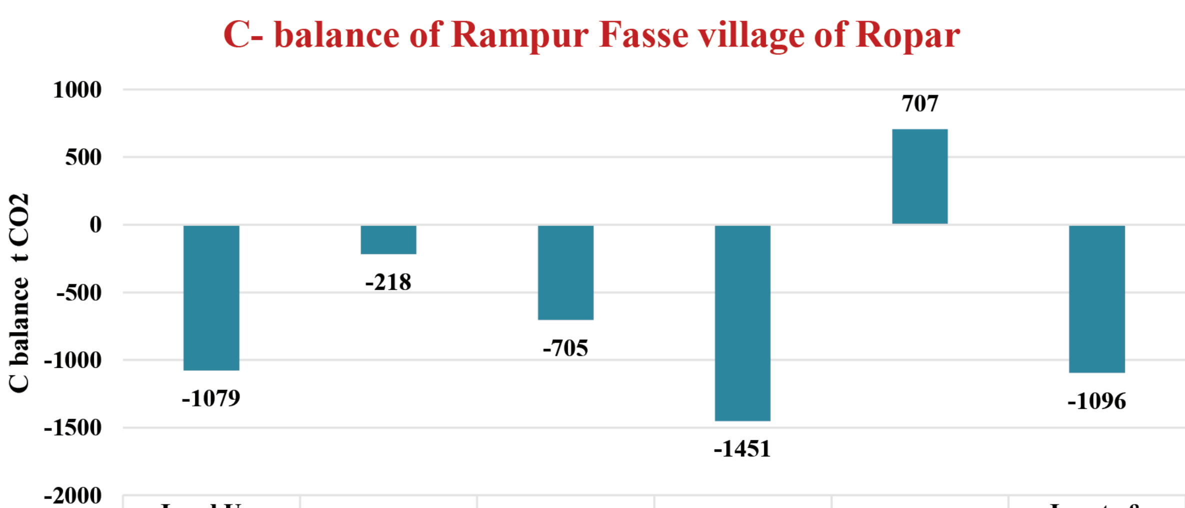
Crop diversification with vegetables

In Kinnaur during *kharif* 2018, deficient rainfall was observed and affected horticultural crops such as apple. Stress tolerant apple root stocks, mulching in apple to conserve the moisture and resilient intercropping system of apple + rajmash crops benefiting 26 farmers were demonstrated. Agro-advisories for dry spells and effective utilization of harvested water were also provided to the farmers to overcome the deficit rainfall situation.

5. Village Level Carbon Balance Studies

Several of climatic resilient technologies demonstrated in NICRA villages contributed towards mitigation of greenhouse gases and contributed positively towards carbon balance at the village. Quantification of the carbon balance at village level was done by the Ex-Ante Carbon balance tool developed by FAO. Ex-ACT model compares the impact of interventions, between 'with project' and 'without project' scenarios, followed in the Agriculture, Forestry and Other Land Use Changes (AFOLU) sector. The input components to run the model includes forestry (deforestation, afforestation and reforestation), agriculture (annual crops, perennial crops and irrigated rice), livestock (large and small ruminants), and inputs (fertilizers, manures and crop residues). The output is given in terms of tons of carbon equivalents (t CO_2-eq).Carbon balance study with EX-ACT model was done for fifty four villages so far from different parts of the country and the final carbon balance values for the 54 villages from fifteen states (Andhra Pradesh, Telangana, Maharashtra, Gujarat, Rajasthan, Karnataka, Tamil Nadu, Kerala, Bihar, Jharkhand, West Bengal, A&N Islands, Arunachal Pradesh, Assam and Sikkim) were computed.

During the year, carbon balance of villages from the states of Punjab, Haryana, Uttarakhand, Himachal Pradesh and Jammu and Kashmir is computed. Carbon balance study conducted for Rampur Fasse village in Ropar district of Punjab revealed that the overall carbon balance of the village was -3842 t CO_2 eq. due to the adoption of climatic resilient technologies demonstrated at the village, which has significantly contributed towards higher carbon sequestration and carbon balance. The negative sign indicates the sink, while positive sign indicates the source of carbon emissions. Among various components contributed for the sink were land use change of flooded paddy to annual crops (-1079t CO_2 eq.), improved agronomic practices in paddy cultivation (-1451t CO_2 eq.), soil test based use of inputs to crops (-1096t CO_2 eq.) while livestock contributed for the positive net emissions of 707 t CO_2 eq. due to the increase in the number of animals of large ruminants for milk production. Improved practices in annual and perennial crops resulted in the carbon balance of -218 and -705 t CO_2 eq. respectively.



	Land Use Changes	Annuals	Perennials	Rice	Livestock	Inputs & Investments
Series1	-1079	-218	-705	-1451	707	-1096

Carbon balance study at Rampur Fasse village of Ropar district in Punjab

6. Resilience Indicators for Adaptation Interventions

Bonghri, a village adjoining Sunderban's mangrove ecosystem is a low lying area situated close to brackish water river 'Matla'. Soils of the village are predominantly clay and silty clay with poor infiltration capacity. High and intense rainfall (annual rainfall of 1800-2000mm) in this area often leads to water-logging. Standing water even after harvesting does not permit the farmers to grow *rabi* crops. Groundwater of the village is saline on account of neighboring brackish water river 'Matla'.

Land shaping is a major intervention introduced by NICRA wherein new ponds were constructed in low lying fields of farmers and ponds of some farmers were renovated. The soil obtained through pond digging / desilting was used to raise the ground level of rest of the farm and to broaden the field bunds. Raised ground level of the farm is ensuring easy and quick depletion of stagnant water in the *kharif* paddy by the time the crop is harvested and permitting the farmer to go for *rabi* season crops. Farmers, with elevated ground level, are now able to grow high yielding dwarf varieties of paddy. Broadened field bunds are allowing the farmers to do Ail cultivation where in farmers are using edges of the bund to grow vegetables. Desilting of ponds increased the storage capacity of ponds and thereby water availability for raising vegetables during *rabi* season. The ponds constructed created new and most profitable livelihood option *i.e.* rearing of fish. Many farmers are adopting this practice even without financial support from NICRA, as they found it more profitable.

Field where land shaping was taken up along with ail cultivation on bunds

Impact of land shaping and desilting intervention in *kharif* paddy can be seen in Table 6.1. Yield resilience of farmers practice in stress year is 97% (100*SN/NN) with 42 kg/ha (3%) loss due to stress (impact potential). Though there is some loss in yield, income resilience of farmers' practice was 110% due to better price received in stress year compared to normal year. Yield resilience with intervention is 114% (100*SI/NN). Yield resilience induced by the intervention is 17% (114-97). It means the intervention is found to have added advantage over and above countering the stress. Gain in income resilience is 149%. Resilience may also be assessed from the perspective of impact potential countered by an intervention as [100*(SI-SN)/(NN-SN)]. Yield gain due to intervention in stress year is 230 kg/ha which is 5.48 times of impact potential *i.e.* 42 kg/ha. Significant impact of the intervention is due to cultivation of vegetables during the *rabi* season and rearing of fish in desilted ponds. It suggests that the intervention works well in normal years too.

Table 6.1: Impact of land shaping and desilting in *kharif* paddy

Particulars	Yield (kg/ha)	Net returns (Rs. /ha)	Yield resilience	Income resilience	Impact potential of stress (kg/ha)	% Impact potential countered
Stress year & with intervention (SI)	1488	8316	114	259	42	548
Stress year & with no intervention (SN)	1258	3510	97	110		
Normal year & No intervention (NN)	1300	3205				

Cultivation of *rabi* green gram resulted in a yield resilience gain of 32% and income resilience gain of 180% (Table 6.2 2). Yield gain due to intervention in stress year is 123 kg/ha which is 6.83 times of impact potential i.e. 18 kg/ha.

Table 6.2: Impact of cultivation of green gram in *rabi* season

Particulars	Yield (kg/ha)	Net returns (Rs. /ha)	Yield resilience	Income resilience	Impact potential of stress (kg/ha)	% Impact potential countered
Stress year & with intervention (SI)	494	17290	127	280	18	683
Stress year & with no intervention (SN)	371	6175	95	100		
Normal year & No intervention (NN)	389	6175				

Ridge and furrow system of cultivation is another intervention introduced by NICRA, which was found to have good adoption rate for cultivation of vegetables. Impact of land shaping & desilting, ridge and furrow, ail cultivation in potato led to a yield resilience gain of 5% and income resilience gain of 14%. Yield gain due to intervention in stress year is 240 kg/ha which is 81% of impact potential *i.e.* 296 kg/ha. Income from crops (Rs./ha) was compared between beneficiaries of NICRA interventions and others in the village (Table 6.3). The impact of NICRA interventions on income from crops from both *kharif* and *rabi* seasons together was substantially high especially in stress year with Rs. 19,142 per for NICRA beneficiaries compared to Rs. 4,069 per ha for others.

Table 6.3: Income from crops with NICRA Interventions (Rs. /ha)

Particulars	Normal year	Stress year
NICRA beneficiaries	17167	19142
Others	3792	4069

7. Spread of Climate Resilient Technologies through Convergence

Spread of the proven resilient technologies, *viz.,* improved varieties, water harvesting structures, micro irrigation systems, land shaping, improved breeds and back yard poultry was ensured by establishing convergence with the relevant state departments. Important natural resource management interventions, such as construction of farm pond, desilting of check dams was taken up in the adjoining villages by fostering convergence with programmes like MGNREGA, ATMA, NABARD, RKVY, IWMP, State agricultural department, NHM, NFSM and other development programs of departments. Spread of climatic resilient crop varieties was ensured by integrating them in the district agriculture plans and in association with Cluster Frontline Demonstrations (CFLD) of Pulses and Oilseeds projects. Micro irrigation was spread by establishing convergence with NHM, PMKSY and state horticultural departments. Fostered convergence with department of animal husbandry and veterinary services for the large scale vaccination and livestock services at the village level. Improved shelter, mineral mixture supplement and backyard poultry are other important technologies which were scaled in association with other line departments.

Table 7.1: Spread of resilient technologies through convergence with development programs in NICRA clusters

KVK	Name of the programme or department	Activity/ Intervention
For NRM Interventions Banka, Chittoor, Aurangabad_UP, Hamirpur_UP, Gumla, Coochbehar, Dhalai, Anantapuram, East Singhbhum, Dibrugarh, Yamunanagar, Pratapgarh, Jehanabad, Kathua, Aurangabad_MH, Chikkaballapura, Chatra, Gadag, Godda, Jalna, Jhunjhunu, Kalaburgai, Koderma, Davanagere, Nandurbar, Kota, Lunglei, Nawadah, Palamu, Pune, Ratnagiri, Baramati, Ri-Bhoi, Saran, Serchhip, Sirsa, Supaul, Tikamgarh	Rashtriya Krishi Vikas Yojana (RKVY); Integrated Watershed Management Programme (IWMP); Krishi Bhagya Yojane of Karnataka State; Agricultural Technology Management Agency (ATMA); Paani Foundation, Mumbai. Integrated Tribal Development (ITDA); Mumbai; Mahatma Ghandi Rural Employment Guarantee Act (MGNREGA); Tribal Development Fund; Jalyukt Shivar Abhiyan-Maharashtra; National Bank for Agriculture and Rural Development (NABARD); Pradhan Mantri Awas Yojona Gramin (PMAY-G); Department of Agriculture, rural development and Horticulture Minor irrigation dept. Gumla	Construction of Biogas plants, poly houses, compost units, desilting of community tanks, construction and renovation of check dams, farm ponds, jalkunds and farm tanks; Distribution of micro irrigation systems; Afforestation and agroforestry development; soil and water conservation practices like nala desilting, bench terracing etc.
Crop Related Interventions Davanagere, Gumla, Cachar, Khowai, Anantapuram, Ahmednagar_MH, Tikamgarh, Dhalai, Chikkaballapura, Chittoor, Pratapgarh, Lunglei, Coochbehar, Dantewada, South 24-Paraganas, Ratnagiri, Kinnaur, Jalna, Saran, East Singhbhum, Nandurbar, Aurangabad_UP, Kota, Alleppey, Koderma	Department of agriculture and Horticulture, National Horticulture Mission (NHM); Cluster Frontline Demonstrations (CFLD) of Pulses and Oilseeds; National Food Security Mission (NFSM); Integrated Watershed Management Programme (IWMP); Assam Agribusiness and Rural Transformation Project (APART), Directorate of Research, AAU, Jorhat	Cultivation of tissue culture banana, dragon fruit, High yielding varieties of paddy soybean, chick pea, sorghum, maize, wheat, pulses, oil seeds; Demonstration of SRI, drought tolerant varieties of groundnut, redgram and cotton for FPO's; Demonstration of flood tolerant varieties on swarna sub-1 etc., Land shaping and Ail cultivation in the South-24 paraganas district; Construction of poly houses, onion storage structures; organic farming and production of organic inputs

Livestock related interventions Belgaum, Coochbehar, Chikkaballapura, Kinnaur, Saran, Ahmednagar, Nandurbar, Kota, Ratnagiri, Phulwama, Banka, Supaul, Godda, Aurangabad, Jhunjhunu, Dantewada, Lunglei, Baramati_Pune, Hamirpur, Ri-Bhoi	Dept. of Animal husbandry and Veterinary services, Integrated Tribal Development Project (ITDP); Mega Seed project, SKUAST-K; Gavyavikas Yojna (Banka); District Dairy Development, Godda; Mahatma Ghandi Rural Employment Guarantee Act (MGNREGA); Saansad Adrash Dairy Gram Yojna	Animal health checkup and vaccination camps, Back yard poultry; Dairy farming; Deworming of animals; Distribution of improved cow breeds; improved shelter to cows and goats; Kadaknath poultry farms; Low cost pig sty; Mineral mixture supplement; *Azolla* production
Training and capacity building Karbianglong, Nandurbar, Dibrugarh, Anantapuram, Pratapgarh, Chamba, Nawadah, Godda, Kinnaur, Aurangabad, Davanagere, Coochbehar.	National Bank for Agriculture and Rural Development (NABARD); Swachh Bharat Mission-Gramin; Agricultural Technology Management Agency (ATMA); Department of Rural Development and Department of Horticulture – Rastriya Krishi Vikash Yojna (RKVY)	Exposure visits and trainings on climate resilient practices, crops; Training on improved practices, protected cultivation

Land shaping and Ail cultivation-South 24 parganas mobilized 2.1 crores benefitting 300 farmers in 70 ha.

Canal renovation-KVK Gumla mobilised 1.86 crores of money through minor irrigation dept. and MGNREGA

Construction of farm ponds-KVK Davanagere mobilized 25 lakhs from Krishi Bhayga scheme of Karnataka

Micro irrigation system-KVK Kutch mobilised 20.25 lakhs from GGRC and horticulture department of Gujarat

8. Monitoring of NICRA Villages

Zonal monitoring teams was constituted to review the technical progress of different modules like NRM, Crop production, Livestock & Fishery and Institutional Interventions in NICRA villages and for making appropriate suggestions for improvement. The teams visited 32 KVKs during the year to assess field performance of interventions interacted with communities and submitted their recommendations which were communicated to the KVKs for compliance. The details of zone-wise visits made by the committee for the year 2018-19 are as follows.

Table 8.1: NICRA KVKs monitored by Zonal Monitoring Committees (ZMCs) for the 2018-19

Name of the ATARI	Name of the participated KVK	Date of visits
Guwahati	Tirap and Sonitpur	3-5 July, 2018
Barapani	Khowai and Dhalai	24-25 July, 2018
Kolkata	Malda and Coochbehar	28-29 August, 2018
Jodhpur	Barmer and Jodhpur	27-28 September, 2018
Jabalpur	Bhatapara, Dantewada and Bilaspur	9-12 October, 2018
Guwahati	East Sikkim and Dhubri	25-26 October, 2018
Bengaluru	Davanagere and Tumakuru	5-6 November, 2018
Barapani	Dimapur and Mokokchung	12-14 November, 2018
Hyderabad	West Godavari and Srikakulam	16-17 November, 2018
Barapani	Serchhip and Lunglei	21-23 January, 2019
Pune	Ahmednagar and Nandurbar	8-10 January, 2019
Bengaluru	Belagavi	14 January, 2019
Hyderabad	Kurnool and Anantapur	17-18 January, 2019
Jodhpur	Bharatpur, Jhunjhunuand Kota	3-7 February, 2019
Pune	Baramati	9 March, 2019
Jabalpur	Guna and Morena	13-14 March, 2019

Zonal Monitoring Committee, visit to KVKs Jhunjhunu, Bharatpur and Kota, Rajasthan

Zonal Monitoring Committee, visit to KVKs Tirap, Arunachal Pradesh and Sonitpur, Assam

Zonal Monitoring Committee, visit to KVKs Bhatapara, Dantewada and Bilaspur, Chattisgarh

Zonal Monitoring Committee, visit to KVKs Tumkur and Davanagere, Karnataka

9. Review cum Action Plan Preparation Workshop

Three day Annual Review Workshop of KVKs under Technology Demonstration Component of NICRA was held at ICAR-CRIDA, Hyderabad from 4-6th June, 2019. Two special sessions were conducted for the presentations of award winning best KVKs and to discuss the key issues and way forward of the programme. During the six concurrent technical sessions, progress of KVK during the year and the action plan for the subsequent year was thoroughly discussed and suggestions were made. Twenty two best performing KVKs were awarded in view of their performance and the spread of climate resilient practices. The recommendations emerged during the workshop was communicated to all KVKs for inclusion in the action plan of the KVKs and for compliance.

Dr. A. K. Singh, DDG (Agricultural Extension)

Dr. S. Bhaskar ADG (Agronomy, Agroforestry and Climate Change)

Dr. Lalmuanzovi, PC Lunglei receiving the best KVK award for the year 2018-19

Dr. Akila, PC Namakkal receiving the best KVK award for the year 2018-19

Review cum Action Plan Preparation Workshop at CRIDA

10. Capacity Building Activities

Trainings were conducted on various aspects of climate change and resilient technologies aiming at enhancing the adaptive capacity of the communities and skill upgradation. During 2018-19, a total of 2303 programmes were organized involving 39135 participants (Table 10.1). Trainings were conducted on various aspects of climatic change, impacts of climate change, adaptation of climate change, natural resource management for enhancing the adaptive capacity, efficient cultivars and cropping systems, nutrient management, breed improvement, feed and fodder management, fish and goat farming, poultry, horticulture, kitchen gardening, nursery raising, vermicompost preparation, value addition, *etc.,* in NICRA villages.

Table 10.1: Training programmes conducted by ATARIs

Zone	ATARI	No. of programs	No. of participants
I	Ludhiana	313	4847
II	Jodhpur	92	2557
III	Kanpur	171	3993
IV	Patna	795	7193
V	Kolkata	57	1350
VI	Guwahati	65	1576
VII	Barapani	115	2857
VIII	Pune	155	5687
IX	Jabalpur	172	4849
X	Hyderabad	295	1875
XI	Bengaluru	73	2351
	Total	**2303**	**39135**

Training Programme at Tehri Garhwal, Uttarakhand


Training Programme at Aurangabad, Maharashtra


Training Programme at Cachar, Assam

Training Programme at Villupuram, Tamil Nadu

11. Awards and Recognitions

Five farmers were recognized and awarded from TDC-NICRA villages in recognition of their efforts in implementing climate resilient practices and towards their spread in the NICRA villages on ICAR-CRIDA Foundation Day (12th April, 2019). Farmers from NICRA-KVKs such as Gonda, Kendrapara, Ratlam, Villupuram and Chittoor were felicitated. Besides, several NICRA farmers received awards for the adoption and spread of climate resilient practices.

Shri. Subash Chandra Mohanty, Kendrapara, Odisha has been awarded as innovative farmer

Smt. Mittapalli Sudha Rani, Chittoor, A.P. has been awarded as innovative women farmer

Shri. Mangal Debbarma from NICRA village Khowai, Tripura has been awarded as innovative farmer by ICAR-RCNEH, Meghalaya

Shri. Charan Debbarma, KVK Khowai has been presented Pandit Deendayal Upadhyay Antyodaya Krishi Puraskar-2018

Shri. Mantu Debbarma, from NICRA village Khowai, Tripura has been awarded as innovative rice farmer by ICAR-RCNEH, Tripura

Farmers were awarded during ICAR-CRIDA Foundation Day, 2019

12. Distinguished Visitors to NICRA Villages

Visit of Hon'ble Shri. Ramnath Kovind, President of India and Ex. CM Dr. Raman Singh to NICRA village of Dantewada, Chhattisgarh

Visit of Hon'ble Dr. Trilochan Mohapatra, Secretary (DARE) & Director General (ICAR) to NICRA village Chitrakoot, Uttar Pradesh

Visit of Hon'ble Union Minister of Tribal Affairs, Sj. Jual Oram to NICRA village of Jharsuguda, Odisha

Visit of Dr. Atul Debbarma, MLA Tripura visited NICRA village Khowai, West Tripura

Hon'ble V.C. Prof. A. K. Singh, BAU Sabour visited NICRA village of Banka, Bihar

Hon'ble V.C. Prof. P.S. Rathore, SKNAU visited NICRA village of Bharatpur, Rajasthan

Visit of secretary Vikas Bharti, Padma Shri Dr. Ashok Bhagat to NICRA village Gumla, Jharkhand

Visit of Mrs. Kamala Devi, Deputy Director, NITI Ayog. Govt. of India to NICRA village Baramati, Maharashtra

13. Publications

1. Prasad, Y.G., Singh, A.K., Himabindu, T., Reddy, G.R., Prasad, J.V., Dhanalakshmi, G., Hemantha Kumar, J., Srinivasulu, S., Chinnam Naidu, D., Lakshmi Reddy, P., Sonune, S.V., Zade, K.K., Sudhakar, M., Yadagiri Reddy, T., Deborah Messiana, N., Uttarwar, J.N., Jayle, P.S. and Shailesh Deshmukh. 2017. Towards Climate Resilient Villages-Evidences from participatory technology demonstrations. ICAR-ATARI, Hyderabad. 109 pp.

2. Gautam, U.S., Atar Singh, Dubey, S.K., Singh, N.K., Yemul, S.N. and Rajeev Singh. 2018. Adaptation of climate resilient technologies in Uttar Pradesh. Experiences of KVKs. ICAR-ATARI, Kanpur. 56pp.

3. ICAR-Krishi Vigyan Kendra, Namakkal. 2017. Smart practices and technological interventions for climate resilient agriculture demonstrated at Namakkal district. Research highlights 2011-2016. 82pp.

4. ShobhaRani. 2018. Enhancing Resilience in Agriculture & Adaptive Capacity to Climate Vulnerability, Experience of NICRA-2018-TDC-ATARI, Kolkata, ICAR.

5. Patel, G.J., Pawar, Y.D., Malve, S.H., Sadarasaniya, D.A. and Dobariya, U.D. 2017-18. Climate Resilient Agriculture Technology Demonstrations. Technical bulletin-Banaskantha.

6. Sachan, V.K., Nautiyal, P., Papnai G., Arya M., Joshi, K., Chauhan, H.S., and Prasad, H. 2018. Impact of Technology Demonstrations on Farmers' Socio Economic Status under NICRA project. Technical bulletin-Uttarkashi.

14. Budget Utilization

Year: 2018-19

(Rupees in lakhs)

ATARI Zone	Sanctioned Budget	Expenditure
ATARI I, Ludhiana	131.00	127.88
ATARI II, Jodhpur	68.13	59.25
ATARI III, Kanpur	104.28	94.21
ATARI IV, Patna	117.06	113.83
ATARI V, Kolkata	94.86	87.31
ATARI VI, Guwahati	95.40	94.70
ATARI VII, Barapani	67.50	64.54
ATARI VIII, Pune	108.16	108.14
ATARI IX, Jabalpur	107.28	98.82
ATARI X, Hyderabad	99.44	98.46
ATARI XI, Bengaluru	65.89	64.73
Total	**1059.00**	**1011.86**

15. Contributors NICRA-KVKs

S. No.	Name of the KVK, ATARI Zone wise	State	Climatic vulnerability addressed	Programme Coordinator
	ATARI I	**LUDHIANA**		
1	Bandipora	Jammu & Kashmir	Frost / cold stress	Peerzada Shafaat
2	Kathua	Jammu & Kashmir	Drought	Vishal Mahajan
3	Phulwama	Jammu & Kashmir	Frost/cold wave	Arshad. H Mughal
4	Chamba	Himachal Pradesh	Cold wave / frost / moisture stress	Rajeev Raina
5	Hamirpur	Himachal Pradesh	Moisture stress / drought	Praveen Kumar Sharma
6	Kinnaur	Himachal Pradesh	Cold wave / drought	Shashi Kumar Sharma
7	Kullu	Himachal Pradesh	Drought / cold wave	K.C. Sharma
8	Bathinda	Punjab	Heat wave	Jitender Singh Brar
9	Faridkot	Punjab	High temperature	Jagdish Grover
10	Fatehgarh Sahib	Punjab	Frost/ cold wave	Vipan Kumar Rampal
11	Ropar	Punjab	Frost/ cold wave	Makkad
12	Tehri Garhwal	Uttarkhand	Cold wave, hail storm	Alok Gulabrao Yewle
13	Uttarkashi	Uttarkhand	Cold wave, hailstorm	Pankaj Nautiyal
	ATARI II	**JODHPUR**		
14	Sirsa	Haryana	Salinity / heat wave	Sardul Mann
15	Yamunanagar	Haryana	Frost in winter	N.K. Goyal
16	Barmer	Rajasthan	Drought	Shyam Das
17	Bharatpur	Rajasthan	Moisture stress & poor quality ground water	Dhanraj Sharma
18	Jhunjhunu	Rajasthan	Frost & heat stress	Dayanand
19	Jodhpur	Rajasthan	Low & erratic rainfall, high temperature	B.S Rathore
20	Kota	Rajasthan	Erratic rainfall & dry spell	Mahendra Choudhary
	ATARI III	**KANPUR**		
21	Baghpat	Uttar Pradesh	Water stress	Gajendra Pal
22	Bahraich	Uttar Pradesh	Flood	M.P. Singh
23	Chitrakoot	Uttar Pradesh	Drought & Heat Wave	Chandramani Tripathi
24	Gonda	Uttar Pradesh	Flood	Upendra Nath Singh
25	Gorakhpur	Uttar Pradesh	Flood	S.K. Tomar
26	Hamirpur	Uttar Pradesh	Drought & Heat wave	Md. Mustafa
27	Jhansi	Uttar Pradesh	Drought & Heat wave	Nishi Roy
28	Kaushambi	Uttar Pradesh	Salt stress	Ajay Kumar
29	Kushinagar	Uttar Pradesh	Flood	Vikas Singh
30	Mahrajganj	Uttar Pradesh	Flood	D.P. Singh
31	Muzaffarnagar	Uttar Pradesh	Ground water depletion	Praveen Kumar Singh
32	Pratapgarh	Uttar Pradesh	Salt stress	A.K. Srivastava
33	Sonbhadra	Uttar Pradesh	Drought heat wave	P.K. Singh

S. No.	Name of the KVK, ATARI Zone wise	State	Climatic vulnerability addressed	Programme Coordinator
	ATARI IV	**PATNA**		
34	Aurangabad	Bihar	Drought	Nityanand
35	Banka	Bihar	Drought	Muneshwar Prasad
36	Buxar	Bihar	Drought & flood	V. Dwivedi
37	Jehanabad	Bihar	Drought	Shobha Rani
38	Nawadah	Bihar	Drought	Ranjan Kumar Singh
39	Saran	Bihar	Flood & drought	Abhay Kumar
40	Supaul	Bihar	Drought & flood	Bipul Kumar Manda
41	Chatra	Jharkhand	Drought/ heat wave	Ranjay Kumar Singh
42	East Singhbhum	Jharkhand	Drought/heat wave	Artibeena Ekka
43	Godda	Jharkhand	Drought	Ravi Shankar
44	Gumla	Jharkhand	Drought/ heat wave	Sanjay Kumar
45	Koderma	Jharkhand	Drought	Sudhanshu Shekhar
46	Palamu	Jharkhand	Drought/ heat wave	Rajiv Kumar
	ATARI V	**KOLKATA**		
47	Coochbehar	West Bengal	Heavy rainfall	Bikash Roy
48	Malda	West Bengal	Flood	Rakesh Roy
49	South 24 Parganas	West Bengal	Cyclone & flood	Prabir Kumar Garain
50	Ganjam	Odisha	Drought	Swagatika Sahu
51	Jharsuguda	Odisha	Drought & flood	Jyotimayee Udgata
52	Kalahandi	Odisha	Drought	Amitabh Panda
53	Kendrapara	Odisha	Flood & cyclone	Surya Narayan Mishra
54	Sonepur	Odisha	Drought & flood	Jibanjit Sen
55	Port Blair	A & N Islands	Cyclone	L. Brojendra Singh
	ATARI VI	**GUWAHATI**		
56	Tirap	Arunachal Pradesh	Erratic rainfall & water stress	D.S Chhonkar
57	West Kameng	Arunachal Pradesh	Cold stress	Narender Deo Singh
58	West Siang	Arunachal Pradesh	Water stress	Chitrangad Singh Raghav
59	East Sikkim	Sikkim	Hailstorm, frost and long dry spells	P.K. Pathak
60	Cachar	Assam	Flood	Pulakabha Chowdhury
61	Dhubri	Assam	Flash-Flood & terminal drought	Chandan Kumar Deka
62	Dibrugarh	Assam	Flood/drought	H.K. Bhattacharya
63	Karbi-Anglong	Assam	Drought / Flood	Subal Maibangsa
64	Sonitpur	Assam	Flood & drought	Pramod Chandra Deka
	ATARI VII	**BARAPANI**		
65	Dimapur	Nagaland	Water stress/ Prolonged dry spells	Ebibeni Ngullie
66	Mokokchung	Nagaland	Water stress	Pijush Kanti Biswas
67	Mon	Nagaland	Water scarcity	Ruokuovilie Mezhatsu
68	Phek	Nagaland	Heavy rainfall, frost	T. Esther Longkumer
69	Jaintia Hills	Meghalaya	Dry spells	Dodo Pasweth
70	Umiam/Ri-bhoi	Meghalaya	Water stress	M. Mokidul Islam

S. No.	Name of the KVK, ATARI Zone wise	State	Climatic vulnerability addressed	Programme Coordinator
71	West Garo Hills	Meghalaya	Water stress	Joyshree Mahanta
72	Imphal East	Manipur	Flood & Drought	S. Molibala Devi
73	Senapati	Manipur	Drought	N. Jyotsna
74	Ukhrul	Manipur	Frost	Y. Ramakrishna
75	Lunglei	Mizoram	Water Stress	Lalmuanzovi
76	Serchhip	Mizoram	Water scarcity	T. Vanlalngurzauva
77	Dhalai	Tripura	Flood/ Water stress	Pradeep Kumar Das
78	West Tripura/ Khowai	Tripura	Water stress	Dipankey Dey
	ATARI VIII	**PUNE**		
79	Amreli	Gujarat	Drought / Salinity	N.S. Joshi
80	Banasakanta	Gujarat	Drought	V.V. Prajapati
81	Kutch	Gujarat	Erratic rainfall/cyclone	U.N. Tank
82	Rajkot	Gujarat	Erratic rainfall	B.B Kabaria
83	Valsad	Gujarat	Heavy rainfall/flood	R.F. Thakor
84	Ahmednagar	Maharashtra	Drought, heat waves	Sambhaji Nalkar
85	Aurangabad	Maharashtra	Drought	D. C. Patgaonkar
86	Amravati (Durgapur)	Maharashtra	Drought, water stress and heat wave	K. A. Dhapke
87	Buldana	Maharashtra	Drought	C.P. Jayabhaye
88	Jalna	Maharashtra	Drought	K.V. Sonune
89	Nandurbar	Maharashtra	Soil erosion, Drought	R.S. Dahatonde
90	Baramati (Pune)	Maharashtra	Drought, long dry spell	Syed Shakir Ali
91	Ratnagiri	Maharashtra	Flood	Anand A. Hanmante
	ATARI IX	**JABALPUR**		
92	Balaghat	Madhya Pradesh	Drought	R.L. Raut
93	Chhatarpur	Madhya Pradesh	Drought	Veena Pani Shrivastava
94	Datia	Madhya Pradesh	Drought	Puneet Kumar
95	Guna	Madhya Pradesh	Drought	Sunita Mishra
96	Jhabua	Madhya Pradesh	Drought	I. S. Tomar
97	Morena	Madhya Pradesh	Terminal heat, Drought, frost	S.P. Singh
98	Ratlam	Madhya Pradesh	Drought	Sarvesh Tripathy
99	Satna	Madhya Pradesh	Drought & heat stress	Rajendra Singh Negi
100	Tikamgarh	Madhya Pradesh	Drought	B.S. Kirar
101	Bilaspur	Chhattisgarh	Drought	R.K. Swarnkar
102	Dantewada	Chhattisgarh	Drought, flood, heat wave and cold wave	Narayan Sahu
103	Raipur/Bhatapara	Chhattisgarh	Drought	A.S. Rajput
	ATARI X	**HYDERABAD**		
104	Anantapur	Andhra Pradesh	Drought	G. Narayana Swamy

S. No.	Name of the KVK, ATARI Zone wise	State	Climatic vulnerability addressed	Programme Coordinator
105	Chittoor	Andhra Pradesh	Drought	S. Sreenivasulu
106	Kurnool	Andhra Pradesh	Drought	G. Dhanalakshmi
107	Srikakulam	Andhra Pradesh	Flood	D. Chinnam Naidu
108	West Godavari	Andhra Pradesh	Flood	N. Mallikarjuna Rao
109	Khammam	Telangana	Drought, heat stress	J. Hemantha Kumar
110	Nalgonda	Telangana	Drought, erratic rainfall	Narasimha Reddy
111	Namakkal	Tamil Nadu	Drought	N. Akhila
112	Ramanathapuram	Tamil Nadu	Drought, Salinity	S. Kavitha
113	Thiruvarur	Tamil Nadu	Drought, Floods, cyclones	M. Ramasubramanian
114	Villupuram	Tamil Nadu	Drought	V.K. Satya
	ATARI XI	**BENGALURU**		
115	Belgaum	Karnataka	Drought, Heat wave	D.C. Chougala
116	Davanagere	Karnataka	Drought	Devaraja TN
117	Gadag	Karnataka	Drought	L.G. Hiregoudar
118	Kalaburgai (Gulbarga)	Karnataka	Drought	Raju Teggelli
119	Chikkaballapura/ Kolar	Karnataka	Drought	R. Manjunatha Gowda
120	Tumkur	Karnataka	Drought	N. Loganandhan
121	Alleppey	Kerala	Salinity, Water logging	P. Muralidharan

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