

Highlights  
2015-16

# Technology Demonstrations

Enhancing resilience and adaptive capacity of  
farmers to climate variability



NICRA- TDC



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

# Technology Demonstrations

Enhancing resilience and adaptive capacity of farmers to climate variability

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त्रिलोचन महापात्र, पीएच.डी.  
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## Foreword

Changing and increasingly variable climate is one of the global challenges to ensure food and livelihood security and India is no exception. The Indian Council of Agricultural Research (ICAR) is addressing this issue by enhancing the adaptive capacity and building resilience of the farming communities through Technology Demonstration Component (TDC) of National Innovations in Climate Resilient Agriculture (NICRA) project across the country. TDC aims at demonstration of proven location specific technologies that can help farmers cope with weather variability in 121 climatically vulnerable districts through Krishi Vigyan Kendras (KVKs) of ICAR.

The 2015 Monsoon season was below normal and the country received 760 mm rainfall as against 887 mm with a negative departure of 14%. Most of the regions recorded deficiency in rainfall ranging from 6% in the central region to 17% in North West Region. About 272 districts of the country received deficient rainfall thus adversely affecting the crop growth during vegetative and reproductive stages. Several NICRA villages received aberrant rainfall which was both a challenge and an opportunity to test the resilience potential of proven technologies under TDC component of NICRA project.

Location specific resilient practices identified at the village level were implemented in NICRA villages. This involved introduction of drought tolerant and short duration varieties, resilient intercropping systems and *in-situ* soil moisture conservation practices at the time of sowing which enabled mitigation of drought effectively. The water harvesting potential created in these villages was made use for supplemental irrigation during dry spells which led to improved performance of rainfed crops at several locations during *kharif*. The surplus harvested water contributed to enhancing the area under *rabi* cropping and thus facilitated compensatory production during the *rabi*. Emphasis was laid on enhancing the green fodder production and its storage to overcome the fodder shortage during the lean season in deficit rainfall districts of Maharashtra, Andhra Pradesh, Karnataka and Gujarat. Timely advisories enabled in minimizing the damage during extreme weather events. Zero till sown wheat in rice residue was promoted in Punjab and Haryana which was not damaged due to unseasonal rains experienced in March, 2016 compared to conventional method of sowing.

I congratulate the team at ICAR-CRIDA and Agricultural Technology Application Research Institutes (ATARIs) and compliment all the participating farmers and KVKs for bringing out the highlights of technology demonstrations and lessons learnt. I am sure that this publication will bridge the knowledge gap and will contribute towards horizontal spread of these technologies in the similar farming situations through several Central and State Government initiatives.

(T. MOHAPATRA)

Date the 18<sup>th</sup> November, 2016  
Place : New Delhi



## PREFACE

Enhancing the adaptive capacity and building resilience of the farming communities is important in the context of climate variability and to cope with these extreme events effectively. As part of the Technology Demonstration Component (TDC) of NICRA, proven technologies are being demonstrated in climatically vulnerable districts of the country. The objective is to impart resilience under variable climates and consequently enhance the pace of adoption of these resilient technologies by stakeholders. On-farm participatory demonstrations were taken up in 121 climatically vulnerable districts across the country through KVKs.

The southwest monsoon rainfall during 2015 was deficient by 14%. The distribution of the rainfall was erratic, rainfall during June was normal while July and August were deficient at several NICRA villages in the country thus impacting the growth and yield of several crops in the states of Maharashtra, Gujarat, Madhya Pradesh, Karnataka, Uttar Pradesh, etc. Heavy rains were witnessed during October, November in the states of TamilNadu and Andhra Pradesh and unseasonal rains during February and March in the states of Punjab, Haryana, Jammu and Kashmir severely impacting the wheat, mustard and other *rabi* crops. The interventions mitigated the impact and contributed to the resilience are being documented in this publication.

Capacity development programs for scientists from all participating KVKs was undertaken. About 1568 courses in different thematic areas of climate resilience were taken up for awareness and building capacity of participating farmers. About 13366 soil health cards were prepared and distributed across 121 NICRA KVKs. On CRIDA Foundation Day, around 14 farmers were recognized and awarded. Meetings were organized to assess the progress and review the action plans thoroughly for the coming year. Emphasis was laid on scaling up of the proven resilient interventions in NICRA villages for lateral spread and greater impact.

We take this opportunity to gratefully acknowledge the constant guidance and support from Dr. Trilochan Mohapatra, Secretary (DARE) & Director General (ICAR), Dr. A.K.Sikka, former DDG (NRM), ICAR, members of the HLMC, we do place on record and appreciate the valuable contribution of network partners including farmers, VCRMC members, Scientists, Department Officials and all other stakeholders.

**Authors**



## Executive Summary

Technology Demonstration Component (TDC) of NICRA is being implemented in a farmer participatory mode in 121 vulnerable districts of the country through 121 Krishi Vigyan Kendras (KVKs) spread across the country in 28 states and 1 Union Territory. Demonstrations of proven location-specific technologies related to natural resource management, crop production, livestock and fisheries are being taken up for enhancing adaptation gains and imparting resilience against drought, flood, cyclone, heat stress coastal salinity, etc.

Interventions include site specific rainwater harvesting structures (RWH) in drought affected areas; efficient use of harvested water through supplemental irrigation to alleviate moisture stress during mid-season drought, improved drainage in flood-prone areas, artificial groundwater recharge and efficient irrigation systems. Through NRM interventions, about 2236 ha of area covered involving 2845 farmers during 2015-16. About 760 demonstrations on improved planting methods in several *kharif* and *rabi* crops were carried out during the year. About 594 demonstrations on zero till and DSR cultivation indicated its high potential as a sustainable alternative to conventional planting of wheat, paddy, mustard, maize and vegetable crops. In the north Eastern states, the focus has been on sustainable intensification in rice fallows and zero till sowing, raised and sunken bed planting method for cultivation of grain legumes and vegetable crops. Efficient use of harvested water through micro-irrigation systems to provide critical irrigations to *kharif* crops during dry spells resulted in higher yields and net returns under deficit rainfall conditions in NICRA villages in cotton (Telangana, Gujarat), soybean (Madhya Pradesh and Maharashtra), groundnut (Gujarat), maize (Karnataka) and paddy (Jharkhand, Odisha and Chhattisgarh). Harvested water was used for increasing the cropping intensity by bringing more area under *rabi* crops with increase in yield and returns in several crops such as wheat (Bihar, Jharkhand, Chhattisgarh, Madhya Pradesh, Rajasthan), mustard (Madhya Pradesh, Rajasthan, Jharkhand), chickpea (Uttar Pradesh, Maharashtra) and vegetable crops (Nagaland, Sikkim, Jharkhand, Bihar, Uttar Pradesh, Himachal Pradesh, Tamil Nadu).

In drought affected districts, soil moisture and nutrient management measures were demonstrated in standing crops experiencing dry spells. Contingency crops such as horsegram, castor, foxtail millet, pearl millet, cluster bean, toria and blackgram were adopted by farmers at different locations. Under the crop production module emphasis was on drought and flood tolerant varieties, timely planting, community nurseries for delayed monsoon, water saving paddy cultivation methods (SRI, aerobic, direct seeding), green manuring, nitrogen management, advancement of planting dates of *rabi* crops in areas with terminal heat stress, frost management in horticulture through fumigation. About 4134 demonstrations were taken up covering 1306 ha area of short duration and

drought tolerant varieties across different districts during 2015-16. Resilient intercropping systems in place of sole crops contributed in stabilizing productivity under variable climatic stresses.

Demonstration of location specific fodder production and its storage by silage making addressed fodder needs during the lean season in several districts in Maharashtra, Andhra Pradesh, Gujarat, Karnataka, Himachal Pradesh, Punjab and Bihar. In districts affected by extreme events (high rainfall during November month), timely advisories to minimize damage were issued and demonstrated. Widespread unseasonal rains over an extended period during the second week of March 2016 adversely impacted wheat, mustard and chickpea crops. Timely sown wheat with happy seeder in combined harvested rice fields in Punjab (Fatehgarh Sahib, Ropar, Faridkot and Bathinda) and Haryana (Yamunanagar) escaped crop damage due to lodging and water stagnation. About 13,366 soil health cards were distributed to the community in the NICRA villages during 2015-16 and emphasis was laid on site and crop specific nutrient management.

Custom hiring centers (CHCs) generated a revenue ranging from Rs. 0.24 to Rs.16 lakhs during the year 2015-16. About 1568 courses in different thematic areas of climate change were taken up for awareness and capacity building of participating farmers. Village level carbon balance studies were completed for Tamil Nadu, Karnataka and Kerala. KVKs were monitored by Zonal Monitoring Committees to review the technical progress and suggested improvements in action plan and its implementation. Workshops on *kharif* review and *rabi* progress were organized at zonal level during April to June, 2016 in eight zones.

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# 1. Introduction

The National Initiative on Climate Resilient Agriculture (NICRA) is a network project of the Indian Council of Agricultural Research (ICAR) launched during February, 2011 in the XI Plan Period. 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 climatic 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 building of scientists and other stakeholders in climate resilient agricultural research and its application.

The Technology Demonstration Component (TDC) is a participatory field based and action oriented activity and hence it is the most visible face of NICRA project. TDC is being implemented in 121 vulnerable villages belonging to 28 states and one union territory. TDC of NICRA aims at involving about one-lakh farm families across the country during the project period. The specific objectives of technology demonstration component are:

- To demonstrate site-specific technology interventions 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 the 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, farmers' experiences and perceptions following a bottom-up approach. The districts selected and their climate vulnerability are depicted in Figure 1. One village or a cluster of villages from each of the 121 selected districts was selected for this purpose by the respective Krishi Vigyan Kendra (KVK) in the district (Table 1). Planning, coordination and monitoring of the program at the national level is the responsibility of CRIDA. Eight Agricultural Technology Application Research Institute (ATARIs) are involved in coordinating the project in their respective zones. At the district level, the selected KVK is responsible for implementing the project through farmer participatory approach.

The technology demonstration component addresses climatic vulnerabilities such as droughts, floods, cyclone, heat wave, high temperature stress, cold wave, frost and the like. To address the climate vulnerabilities of the selected village's, technology interventions are planned and implemented under the four modules ensuring that these are appropriate to the local context in the village/district. Prioritization of interventions is based on extent of exposure to climate vulnerability of the different farming situations prevalent in the village and takes into account building resilience of different categories of farmers and communities. Creation of enabling conditions through village level institutional interventions and to promote adoption of climate resilient practices and technologies by farmers to enhance their adaptive capacity and coping ability to climate risks is an important aspect of TDC.

**Table 1. Zone-wise distribution of KVKs taking part in Technology Demonstrations under NICRA**

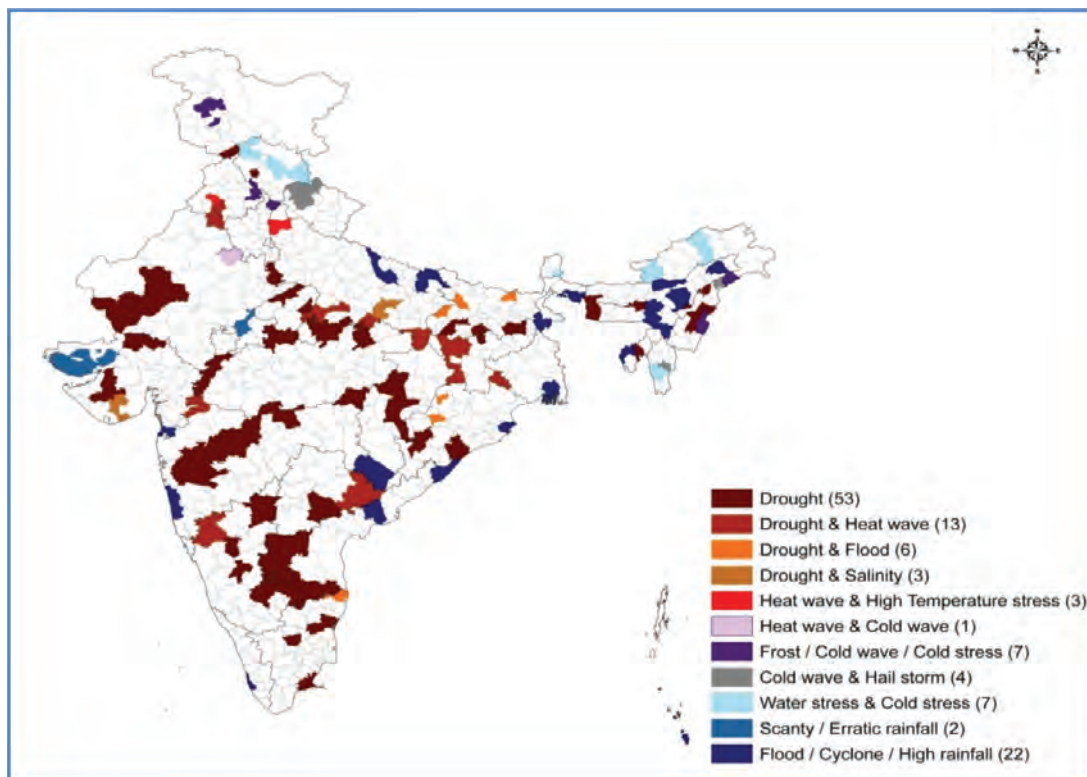
ATARIs	States	NICRA KVKs
I : Ludhiana	Haryana (2), Himachal Pradesh (4), Jammu & Kashmir (3), Punjab (4)	13
II : Kolkata	A & N Islands (1), Bihar (7), Jharkand (6), West Bangal (3)	17
III : Barapani	Arunachal Pradesh (3), Assam (5), Manipur (5), Meghalaya (3), Nagaland (4), Sikkim (1), Tripura (2), Mizoram (2)	23
IV : Kanpur	Uttar Pradesh (13), Uttarakhand (2)	15
V : Hyderabad	Andhra Pradesh (5), Telangana (2), Maharashtra (8)	15
VI : Jodhpur	Rajasthan (5), Gujarat (5)	10
VII : Jabalpur	Chhattisgarh (3), Madhya Pradesh (9), Odisha (5)	17
VIII : Bengaluru	Tamilnadu (4), Karnataka (6), Kerala (1)	11
Total	28 + 1 UT	121

## Technology Modules and Interventions

Climate resilient practices and technologies implemented can be categorized under four modules: natural resource management, crop production systems, livestock & fisheries production systems and institutional mechanisms.

### Module I: Natural Resource Management

This module consists of interventions related to *in-situ* moisture conservation, biomass mulching, residue incorporation instead of burning, brown and green manuring, water



**Figure 1. Map of 121 NICRA-KVK sites, climate vulnerabilities addressed along with number of districts covered**

harvesting and recycling for supplemental irrigation, improved drainage in flood prone areas, conservation tillage where appropriate, artificial ground water recharge and water saving irrigation methods.

## **Module II: Crop Production**

This module consists of 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, custom hiring centers for timely completion of farm operations, location specific intercropping systems with high sustainable yield index.

## **Module III: Livestock and Fisheries**

Use of community lands for fodder production 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.

#### **Module IV: Institutional Interventions**

This module consist of institutional interventions either by strengthening the existing ones or initiating new ones relating to community seed bank, fodder bank, commodity groups, custom hiring centre, collective marketing group, introduction of weather index based insurance and climate literacy through a village weather station. The program also aims at development of an enabling mechanism at the village level for continued adoption of such practices in a sustainable manner.

## 2. Rainfall Analysis

Several NICRA project sties experienced deficit rainfall situations in 2015 during the South West Monsoon season (Table 2). Though the onset of monsoon is timely, deficit rainfall was observed in the month of July, August and Septmber (Table 3), which adversely affected the growth and yields of crops, especially soybean, cotton, groundnut, short duration pulses, rice, maize, millets (sorghum and pearl millet) in rainfed states and districts.

**Table 2. Deficit seasonal rainfall in NICRA villages**

STATE	Name of the KVK	Actual RF (mm)	Normal RF (mm)	Deficit over normal (mm)	Departure from normal (%)
Andhra Pradesh	Kurnool	330	460	-130	-28
Arunchal Pradesh	Tirap	1362	2385	-1012	-43
Bihar	Nawadah	632	897	-265	-30
Bihar	Saran	600	973	-374	-38
Bihar	Supaul	724	1056	-331	-31
Chattisgarh	Raipur	828	1047	-219	-21
Gujarat	Valsad	1435	1951	-517	-26
Haryana	Sirsa	177	242	-66	-27
Haryana	Yamunanagar	608	892	-284	-32
Himachal Pradesh	Chamba	764	1406	-643	-46
Himachal Pradesh	Kinnaur	140	264	-124	-47
Jharkhand	Chatra	713	1031	-318	-31
Jharkhand	Koderma	716	930	-214	-23
Jharkhand	Palamau	729	974	-245	-25
Karnataka	Belgaum	353	574	-221	-38
Karnataka	Gadag	289	368	-79	-21
Karnataka	Kalaburgai (Gulbarga)	411	620	-209	-34
Kerala	Alleppey	1137	1746	-609	-35
Madhya Pradesh	Balaghat	889	1335	-446	-33
Madhya Pradesh	Chhatapur	621	985	-364	-37
Madhya Pradesh	Datia	537	776	-239	-31

STATE	Name of the KVK	Actual RF (mm)	Normal RF (mm)	Deficit over normal (mm)	Departure from normal (%)
Madhya Pradesh	Morena	423	708	-285	-40
Madhya Pradesh	Tikamgarh	540	853	-313	-37
Maharashtra	Ahmednagar	334	438	-104	-24
Maharashtra	Pune	582	861	-279	-32
Maharashtra	Ratnagiri	2143	3261	-1119	-34
Maharashtra	Jalna	444	606	-162	-27
Manipur	Senapati	573	1281	-708	-55
Meghalaya	Jaintia Hills	2982	4667	-1686	-36
Mizoram	Lunglei	673	1866	-1193	-64
Nagaland	Mokokchung	555	1676	-1121	-67
Nagaland	Phek	349	1308	-959	-73
Odissa	Sonepur	877	1243	-366	-29
Punjab	Bathinda	252	321	-69	-21
Punjab	Ropar	570	728	-159	-22
Rajasthan	Bharatpur	396	558	-161	-29
Tamil nadu	Thiruvavur	218	296	-78	-26
Tamil nadu	Villupuram	289	408	-120	-29
Uttar Pradesh	Baghpat	327	545	-219	-40
Uttar Pradesh	Bahraich	740	994	-254	-26
Uttar Pradesh	Chitrakoot	289	769	-479	-62
Uttar Pradesh	Gonda	515	1027	-512	-50
Uttar Pradesh	Gorakhpur	564	1175	-612	-52
Uttar Pradesh	Hamirpur_UP	324	797	-473	-59
Uttar Pradesh	Jhansi	390	838	-448	-53
Uttar Pradesh	Kushinagar	246	1158	-913	-79
Uttar Pradesh	Mahrajganj	435	1214	-779	-64
Uttar Pradesh	Muzaffarnagar	593	737	-144	-20
Uttar Pradesh	Sonbhadra	498	865	-367	-42
Uttar Pradesh	Kaushambi	142	766	-624	-82
Uttar Pradesh	Pratapgarh	488	852	-364	-43

STATE	Name of the KVK	Actual RF (mm)	Normal RF (mm)	Deficit over normal (mm)	Departure from normal (%)
Uttarakhand	Tehri Garhwal	562	1047	-485	-46
Uttarakhand	Uttarkhashi	861	1149	-287	-25
West bengal	Coochbehar	2087	2738	-650	-24

**Table 3. Percent departure in monthly rainfall from normal at NICRA villages**

State	Name of the KVK	Departure from normal (%)			
		June	July	August	September
Andhra Pradesh	Kurnool	-56	-29	-30	53
Arunchal Pradesh	Tirap	-31	-61	-33	-61
Bihar	Nawadah	-39	-29	3	-72
Bihar	Saran	-45	-35	1	-92
Bihar	Supaul	-45	-51	-13	-7
Chattisgarh	Raipur	21	-46	-36	9
Gujarat	Valsad	-36	-57	-39	-1
Haryana	Sirsa	-40	-65	-52	-53
Haryana	Yamunanagar	-65	-36	-32	-19
Himachal Pradesh	Chamba	-18	-46	-60	-33
Himachal Pradesh	Kinnaur	28	-60	-71	-47
Jharkhand	Chatra	-14	-5	-28	-82
Jharkhand	Koderma	-16	9	-19	-71
Jharkhand	Palamu	-33	28	-35	-77
Karnataka	Belgaum	21	-72	-54	-35
Karnataka	Gadag	3	-86	19	-26
Karnataka	Kalaburagi	-49	-60	-29	-7
Kerala	Alleppey	-23	-54	-45	-14
Madhya Pradesh	Balaghat	17	-57	-29	-39
Madhya Pradesh	Chhatarpur	80	-31	-55	-75
Madhya Pradesh	Datia	-38	7	-32	-79
Madhya Pradesh	Morena	70	-21	-52	-94
Madhya Pradesh	Tikamgarh	-29	-14	-37	-80
Maharashtra	Ahmednagar	-46	-56	-35	14

State	Name of the KVK	Departure from normal (%)			
		June	July	August	September
Maharashtra	Pune	39	-54	-76	-6
Maharashtra	Ratnagiri	30	-62	-48	-22
Maharashtra	Jalna	-11	-92	-13	16
Manipur	Senapati	-50	-12	-27	-82
Meghalaya	Jaintia Hills	-50	-74	53	-42
Mizoram	Lunglei	-85	-12	-3	-27
Nagaland	Mokokchung	-51	-48	-30	-64
Nagaland	Phek	-39	-53	34	-48
Nagaland	Mon	-100	-100	204	-100
Odissa	Sonepur	43	-42	-43	-46
Punjab	Bathinda	-41	-11	-36	1
Punjab	Ropar	-27	-16	-19	-39
Rajasthan	Bharatpur	24	-11	-30	-82
Tamil nadu	Thiruvarur	51	-32	-35	-45
Tamil nadu	Villupuram	-71	-7	-13	-42
Uttar Pradesh	Baghpat	54	-50	-37	-85
Uttar Pradesh	Bahraich	15	-37	10	-91
Uttar Pradesh	Chitrakoot	-88	-52	-62	-70
Uttar Pradesh	Gonda	-18	-54	-27	-96
Uttar Pradesh	Gorakhpur	-28	-63	-29	-89
Uttar Pradesh	Hamirpur	-81	-24	-67	-86
Uttar Pradesh	Jhansi	-76	-15	-60	-88
Uttar Pradesh	Kushinagar	-71	-74	-76	-95
Uttar Pradesh	Mahrajganj	-59	-61	-56	-87
Uttar Pradesh	Muzaffarnagar	31	-57	-71	-68
Uttar Pradesh	Sonbhadra	-17	-25	-16	-95
Uttar Pradesh	Kaushambi	-32	2	-23	-70
Uttar Pradesh	Pratapgarh	-31	-24	-44	-73
Uttarkhand	Tehri Garhwal	-31	-12	-59	-98
Uttarkhand	Uttarkhashi	-37	-14	-63	-98
West Bengal	Coochbehar	-5	-69	4	-13

## 3. Highlights of Technology Demonstrations

### 3.1 Natural Resource Management

Rainwater management is the critical component of rainfed farming. The successful production of rainfed crops largely depends on how efficiently soil moisture is conserved *in-situ* and the surplus runoff is harvested, stored and recycled for supplemental irrigation. Interventions related to *in-situ* moisture conservation, water harvesting and recycling for supplemental irrigation, recharge structure for open well, zero till cultivation, direct seeded rice, field bunding, improved drainage in flood prone areas, minimum tillage where appropriate, artificial ground water recharge and efficient water management methods were demonstrated. This has led to increased availability of water for agricultural purposes leading to higher production. The Village Climate Risk Management Committee (VCRMC) in NICRA villages played an important role for taking up the interventions on natural resource management in the village. The impact of interventions in NICRA villages during 2015-16 is highlighted below:

#### Rainwater harvesting and efficient use to enhance resilience of farms

In Bhalot village of Kutch, renovation of 10 old check dams and 4 ponds benefitted 97 farmers, which covered an area of 153 ha. Water level in open wells increased significantly by 10 to 15 ft after renovation. Supplemental irrigation through drip became possible due to recharge of open wells and the yield of Bt. Cotton increased by 3.0q/ha and higher income of Rs. 12000/ha was realized.



Use of recharged water for critical irrigation from wells in Kutch, Gujarat

In Magharvada village in Rajkot, 5 farm ponds of (30×30×7 ft) were constructed each having a capacity to store 1,80,000 liters of water and lined with 425 gsm plastic to prevent percolation of water. This harvested water enabled farmers' to protect their crop during mid season drought of about 25 days after first rain. The harvested rainwater was used for providing life saving irrigation to paddy and vegetable crops like bittergourd and bottlegourd. This enhanced the crop yield by 10-12 per cent. Growing of short

duration crops of coriander and fenugreek gave an additional return of Rs. 8,000 to 10,000/ha which was not possible earlier.

In Takali village of Amravati district, renovation of 13 check dams of different water storage capacity was undertaken by farmers and this helped in recharging the surrounding 62 open wells during kharif 2015-16. Desilting of these structures led to increase in water table for supplemental irrigation (2-3 times) through drip (27 ha) and sprinkler (63 ha) to crops such as soybean and chickpea resulted in realising soybean yield of 6.85 q/ha as compared to farmers' practice of rain dependent cultivation (3.85 q/ha). Renovation of rainwater harvesting structures since inception of NICRA project could expand the area under irrigation to 131.7 ha in the village during rabi season for wheat and chickpea resulting the enhancing the cropping intensity up to 15%.



**Use of harvested water from check dam for supplemental irrigation in Amravati, MH**

Umarani village of Nandurbar district, is situated in the Satpura range having an undulating topography with red and medium black soils. During 2015, there were two dry spells of 33 and 37 days during crop growth period. Two protective irrigations were given at the critical stage of maize crop which benefitted 10 farmers in 4 ha area. The yield increase observed was up to 73.1% (30.3q/ha).



**Two protective irrigations provided to maize through sprinkler in Nandurbar, MH**

Demonstrated low cost Konkan Vijay Bandhara (checkdam) in NICRA village Haral, Ratnagiri district to conserve water at field level covering 11 ha area involving 95 farmers. Results showed that, water stored per checkdam was up to 2,70,000 lit and there was availability of water in the nearby wells upto April which enhanced area (3.4 ha) under cultivation of crops like cowpea, groundnut and dolichus bean in *rabi* season. The stored water was utilized through drip in cashew plantation in 2 ha area resulting in higher income by Rs. 37,000.



**Supplemental irrigations to cowpea from harvested rainwater in Ratnagiri, MH**

In Nirmal Pimpri village in Ahmednagar, to minimize the evaporation losses from farm ponds, KVK demonstrated use of water evaporation retardant (Cetyl stearyl fatty acid alcoholic emulsion) @ 3kg per month for 1000 m<sup>3</sup> farm pond during March to May. This technology was demonstrated on 20 farm ponds in village during the year 2015-16. Water evaporation retardant was observed to be useful and saved one lakh liter of water per month from farm pond of size 1000 m<sup>3</sup>. It was observed that total water saving during three months (March, April, and May) was found to be 300000 lit. from 1000 m<sup>3</sup> farm pond amounting to 27% of stored water.

Cement bhandara was constructed in Shekta village of Aurangabad district during 2014-2015 with 500 m length, 8 m width and 3 m deep. During 2015-2016, the check dam was filled with 5 TCM of rainwater, two times during June and September 2015; totaling 10 TCM. The water level in the open wells (9) and bore well (6) was raised by 10 feet. The available water was used for different crops covering an additional area of 17 ha than normal irrigated area during *kharif* and *rabi* season. Similarly, Seven farm ponds were constructed during 2011-2012, filled with rainwater two times during June & September 2015, which resulted in increase in water level up to 5 feet in 5 open wells and 7 bore wells in the village. The available water was used for irrigating 2-3 times: soybean, cotton, pigeonpea and greengram through drip and sprinkler irrigation systems during the season. Due to the increased water availability the yield increased by 18-20% in chickpea and *rabi* sorghum during *rabi*.



**Supplemental irrigation of cotton using harvested rainwater in Aurangabad, Maharashtra**

In S. Raghutthalli village in Chikkaballapur eight farm ponds, thirteen percolation ponds, two nala bunds and two check dams were constructed and desilting of existing tanks to an extent of 11,375 cu m was carried out over a period of five years. During 2015-16, rainfall of 1163 mm was received which was 97% excess over normal. As a result, 312.85 lakh litres of rainwater was harvested in the water storage structures. The impact of water storage reflected in increased water table depth of 79 borewells in the village of which 53 bore wells were defunct since 2011. The average water yield of bore wells increased from 1320 gallon/ hr to 2250 gallon/ hr during 2015-16. In addition, the water stored in farm ponds have been utilized for providing irrigation to cereals, vegetables, fodder and fruit crops at critical crop stage as detailed below (Table 4).

**Table 4. Protective irrigation taken up using farm ponds water during 2015-16 in Chikkaballapura, Karnataka**

Farm pond	Crop	Area (ha)	No. of Irrigation (Drip)	Stage of the crop
1	SRI paddy	0.4	2	Panicle initiation/milking stage
2	Cucumber	0.2	4	Vegetative/flowering/ fruiting
3	Jamun seedling	0.4	6	Vegetative stage
4	Cashew	0.6	3	Flowering stage
5	Tomato	0.2	4	Vegetative/flowering
6	Brinjal	0.2	5	Vegetative/flowering
7	Groundnut	0.4	1	Harvesting stage
8	Fodder	0.2	6	Vegetative/ pruning



**Protective irrigation to foxtail millet from harvested rainwater in Chikkaballapura, Karnataka in 2015 kharif**

In Siddanuru village of Davanagere district, six farm ponds were constructed during 2014-15 which got filled during 2015 September with the receipt of 211 mm of rainfall in 5 rainy days (65, 78, 31, 20 and 17 mm). During the month of October, 20 day's dry spell was observed. Protective irrigation was taken up for ragi during grain filling stage. The farmers who were having farm ponds harvested the rainwater and used for protective irrigation and the yield increased by 53% (Table 5).

**Table 5. Improvement in crop yields with supplemental irrigation from farm pond in Davanagere, Karnataka**

Crop	Supplemental Irrigation	Yield (q/ha)	Net Returns (Rs/ha)	B:C ratio
Finger millet	Two Irrigation at grain filling stage	29.5	43,950	2.82
Finger millet	No irrigation	19.3	24,450	2.04



**Supplemental irrigation to finger millet using harvested rainwater in Davanagere, Karnataka**

In village of D.Nagenahalli, Tumakuru farm ponds were constructed in the fields with a dual-purpose, viz., firstly to help farmers provide supplemental irrigation to crops whenever required and secondly to allow seepage of water to recharge the underground aquifer. In a period of five years from 2010-11 to 2015-16, about 72 farm ponds of various capacities were constructed under NICRA. The total storage capacity of these farm ponds is about 18,000 cu. m. After the interventions, farmers could take up three crops by utilizing harvested rainwater from dug out farm pond and recharged wells. A farmer used portable 1hp motor and sprinkler to irrigate groundnut crop produced 6-quintal from 0.4 ha and earned Rs. 20000 during *kharif* and Rs.12000 by producing 10-quintal paddy in *rabi*. During summer, cultivation of groundnut in 0.3 ha, Chrysanthemum in 0.2 ha and fodder maize in 0.2 ha was taken up and earned Rs.45000. Farmers utilized the water for vegetable cultivation like tomato, brinjal and aster and their income got doubled after the construction of farm ponds.

In Yagantipalle village, Kurnool desilting of Burrakunta was taken up during July 2012 and 1260 m<sup>3</sup> of silt was excavated. The silt was applied in 6 ha areas covering 10 farmers and transportation cost was borne by the farmers. The average pH and EC of tank silt was 7.95 and 0.35 dSm<sup>-1</sup> respectively, which were under normal range. During 2015-16, recharge of ground water increased water table of nearby 2 open wells and 160 bore wells in the month of July to November. The area irrigated was 107 ha in *kharif* and 96 ha in *rabi* season that resulted in increase in average in yields of sorghum (24.5 q/ha) and maize (47 q/ha) in the village by 28%.



**Recharging of borewells from desilted tank in Kurnool, AP**

During the year 2015-16, two check dams were desilted in NICRA village of Anantapur with a water storage capacity of 6000 cu.m. Nearly 8 bore wells and 3 open wells were recharged in the vicinity of check dams benefiting 21 ha area and 25 farmers in the village. Water was utilized for irrigating (2-3 times) sweet orange, pomegranate, Lilly flowers and growing of fodder crops and drinking water for livestock.

NICRA village Sirusuwada, Srikakulam is prone to floods during monsoon season as it is located in low-lying area near to Jagannadha Naidu tank. The drainage channel of 800 m was dug, which is meant to let off the excess water, due to either floods or rainfall from the fields in order to reduce the period of water stagnation from medium and high

inundation. After taking up the drainage channel excavation work over a length of 800 m, the threat of complete inundation due to excess rainwater in area of 45 acres was overcome and the period of complete inundation got reduced by 1-2 days during August 2015 (109 mm received in one day).

Desilting of village tank at Nandyalagudem village, Nalgonda was taken up under convergence with State Government. The silt was applied in 36 ha area in 34 farmers fields to improve the drought tolerance, moisture conservation and for improving the productivity of cotton. With the result, the farmers realized an additional yield of 2.8 q/ha. Introduced micro irrigation (drip) in order to increase the water use efficiency as against furrow irrigation in chillies (2.0 ha) benefitting 5 farmers and Mulberry (11.2 ha) benefitting 14 farmers. Because of the drip irrigation system, the farmers could able to irrigate an additional area of 0.4-0.6 ha. Chilly farmers got an extra yield of 12.5 q/ha.

Demonstration of 3-poly bag check dams in Sanora and Barodi villages of Datia district resulted in enhancing the water storage capacity by 7500 cu.m. Harvested rainwater was used for providing two supplemental irrigations to groundnut and black gram crop during vegetative and peg formation stage of the crop. This interevention covered an area of 60 ha benefitting 52 farmers with 60-70% increase in yield of black gram and groundnut crops. These structures recharged 19 near by open wells existed in down stream which remain filled up to the month of January instead of September or October earlier thus enabling farmers to take up *rabi* crops such as mustard, lentil and vegetables successfully in an area of 60 ha.

Renovation of three old water-harvesting structures in Sanora and Barodi villages of Datia district increased the volume of harvested water by 4500 cu.m water. This harvested water was used for supplemental irrigation of kharif crops like soybean and groundnut at vegetative and pod formation phase in 9 ha area with 51% increase in soybean and 46% in yield of groundnut crop. Similarly, four farm ponds having storage capacity of 480 cu.m each was constructed in farmer's fields and water harvested in these farm ponds was used for supplemental irrigation for soybean crop at critical stages in seven ha area. Irrigation was done by either furrow or sprinkler method for efficient utilization. Farmers with these farm ponds got 55% more yield of soybean compared to the other farmers.





**Rainwater harvesting and its efficient utilization through supplemental irrigation to soybean and vegetables in Datia, MP**

In Heeranar village of Dantewada district, three check dams were renovated through NICRA project for water harvesting and nearly 19113 m<sup>3</sup> water was harvested after the renovation of check dam and water was available up to end of February. This water was used to provide supplemental irrigation during grain filling of rice up to 3 ha. Due to water availability, the area of field pea and vegetables increased in *rabi* season up to 1.5 ha. Total 48 farmers were benefited after renovation of stop dam. One farm pond and a percolation tank was constructed to provide the life saving irrigation and to recharge the ground water. Before construction of pond, water was available till this end of December, now got extended up to end of February. With availability of water, farmers cultivated paddy (10.5 ha), maize (2 ha), minor millets (3 ha), pulses & vegetables crops (5 ha) benefitting 84 farmers in the village. These ponds are being used for fish rearing also.



**Renovation of check dam and utilization of harvested water for growing vegetables in Dantewada, Chhattisgarh**

In village Mardanpur, Chatra the potential of the existing water harvesting structures could not be realized due to lack of maintenance and leakage. Renovation of two existing water harvesting structures, pond and check dam were taken up during 2015 in convergence with the district administration. Access to supplemental irrigation increased from 42 ha to 120 ha area which enabled farmers to take up wheat crop during the *rabi* season.

In Lowkeshra village of East Singhbhum, desilting and renovation of two old check dams created an additional storage of 20000 cu.m of runoff water which was used for puddling and transplanting of rice during kharif 2015. The check dam water was helpful in providing critical irrigation to paddy in 55 ha area dry spell in the month of August, September and October (% of deviation was -28, -22 & -18 from normal rainfall). Desilted farm pond opened up scope for second crop during *rabi* season such as wheat, gram & mustard in 13 ha area and got an additional net return of Rs. 15,000 to 22,000/ ha.

In Gunia village of Gumla, Jharkhand, demonstrated sand bag check dam on Masharia river which is 150 meter long and 3 meter wide in harvesting the water. Besides, increasing water table of near by wells (21) and benefititng 200 ha of standing paddy crop of 120 farmers in village, increased area under *rabi* and summer crops cultivation such as wheat and vegetables in 50 ha area. Bora-Bandi initiative has emerged as a boon for livelihood of several farmers by bringing 3500 acres additional area under *rabi* in 70 villages of six adjoining districts in Jharkhand.



**Sand bag check dam enabled irrigations of *rabi* crops in Gumla, Jharkhanad**

In NICRA village of Sakrorha, Jehanabad, rainwater has been harvested and stored in 5 ponds which were renovated previously and used for irrigation in paddy crop in 26.5 ha area benefitting 84 farmers of the village. During 2015, 3 more new check dams were constructed for diverting the water flowing in pynes and 52 farmers got benefitted covering 20.2 ha of paddy area. Five miniature water ponds have been dugout in 5% portion of each plot having 1/3<sup>rd</sup> acre size to harvest and store runoff water for supplemental irrigation during dry spells. The village has a good network of pynes that flows during rainy season but due to their shallow depth, water flows out, resulting in less water availability for irrigation to *kharif* paddy. Pyne renovation work of these channels (10.5 km length) was carried out in convergence with MNREGA providing access to critical irrigation to 38.4 ha area. During *rabi*, the water is utilized for providing irrigation to crops such as wheat and lentil through sprinkler irrigation resulting in average yields of 37 q/ha in wheat and 14 q/ha in lentil.

Majhila village of Nawada district is impacted by dryspells and renovation of farm pond and irrigation channel (2000ft) was taken up in the village. An amount of nearly 20,000

m<sup>3</sup> of water could be collected in the reservoirs/ponds to provide protective irrigation in 40 ha area during dry period of kharif paddy and pigeonpea which increased yield by 35-54%. Drilling of five new shallow tube wells increased the area under wheat by 20 ha during *rabi*. Increase in ground water level through recharge by 2-3 ft and almost all the defunct bore wells became functional. Water is also used for drinking purpose of livestock during April to June.

In North Pulinpur village of West Tripura, rainwater was harvested in ponds and jalkund having total storage capacity of 175000 ft<sup>3</sup>, which was used for providing life saving irrigation for vegetables such as bitter gourd and potato during *kharif* dry spells as well as during *rabi*/summer season covering an area of about 5.0 ha. Water was utilised for cultivating vegetables and farmers' got an additional net returns to the extent of Rs. 14730/ ha.

In village Port Mout & Badmas Pahar, Port Blair during the year 2015-16, constructed two numbers of tank cum well (30 m × 22 m × 2.5 m) system of irrigation in farmer fields of 2 ha area in which fish fingerlings were also introduced. The harvested water from the tank was stored in the well and pumped out to irrigate the crops like maize, cowpea, okra and french beans during the dry spells. A gross return of Rs 75,000/ha was observed from cultivation and sale of vegetables and fish against gross cost of cultivation of Rs 38,000/ha with a net profit of Rs 37,000/ha and B:C ratio of 2.3.

### Rainwater harvesting a boon to farmers in hilly regions

In village Mann, Hamirpur, Himachal Pradesh, earlier farmers faced problem of availability water for irrigation especially during critical crop growth period. In NICRA project, 35 numbers of small rain water harvesting structures were constructed in convergence with MGNREGA from 2011 to 2015, the farmers made use of harvested rain water for irrigation by ridge and furrow method in vegetable crops like, bitter gourd, cucumber, cauliflower and radish. In 2015-16, about 1.2 ha area was brought under vegetable cultivation with net returns of Rs. 98000/ha (Table 6). Hence, there was an increase in irrigated area of the NICRA village as well as enhanced production of crops. The number of vegetable growers has increased in NICRA village as also the area under vegetable cultivation resulting in an additional returns from vegetable cultivation (Table 6).

**Table 6. Improvement in yields and net returns from rainwater harvesting structures in Hamirpur, HP**

Crops grown	Area (ha)	Yield (q)	Net return	BCR
Bitter gourd	0.20	45	27500	2.57
Cucumber	0.24	30	12000	1.66
Cauliflower	0.40	80	39000	2.56
Radish	0.32	56	20000	3.50

Community water storage tanks brought a significant change in the cropping pattern in NICRA village Chhoel- Gadauri, Kullu. Due to drought and erratic rainfall, farmers generally grow non-remunerative cereal crops i.e. maize and wheat. Three community water storage tanks were constructed in 2014 having 110 cu m water storage capacity. Demonstration on tomato cultivation in area of 4.6 ha covering 35 farmers during *kharif* 2015 was taken up. In *rabi* season 2015-16, the cash crop, garlic was demonstrated in an area of 2.52 ha and pea in 1.0 ha. The stored water was utilized for life saving irrigation during the dry spells experienced at different growth stages. In tomato crop 4-5 life saving irrigations were given through pipes. During *rabi* season in garlic 3 and peas 4 numbers of life saving irrigations were given through sprinkler method. The net returns of the farmers increased to Rs 2.97 lakhs/ha from tomato as compared to Rs 25000/ha from maize during *kharif* 2015. Similarly during *rabi* season, the net income of Rs 2.80 lakhs and Rs 1.67 lakhs/ha from garlic and pea respectively was obtained in comparison to only Rs 45000-50000/ha from conventional wheat crops grown under rainfed conditions (Table 7).

**Table 7. Impact of community water storage tank increased the income of farmers in rain fed situation in Kullu, HP**

Crop /season	No. of farmers	Area (ha)	Yield (kg/ha)	Gross cost (Rs./ha)	Gross returns (Rs./ha)	Net returns (Rs./ha)	Benefit cost ratio
<i>Kharif</i> 2015-16							
Tomato	35	4.60	32744	96250	392928	296678	3.98
<i>Rabi</i> 2015-16							
Garlic	23	2.52	11850	74830	355500	280670	4.75
Pea	11	1.0	14100	59119	225600	166481	3.81



**Construction of community water storage tank and cultivation of vegetables in hilly regions, Kullu, HP**

In Sangti village of West Kameng (Arunchal Pradesh), generally farmers face scarcity of water during winter season. A water harvesting tank (12m x 10m x 5m) was constructed which increased the cropping intensity through raising of high value vegetable crops (pea, cabbage and cauliflower) during *rabi* season. Five farmers adopted this technology with 3.0 ha area during 2015-16. Providing irrigation to high value vegetable crops during *rabi* season resulted in additional income (Table 8).

**Table 8. Increase in area under assured irrigation from water harvesting structures in West Kameng, Arunachal Pradesh**

Interventions	Technology demonstrated (Crops)	Variety	Area (ha)	Yield (q/ha)	Gross Cost (Rs)	Gross Return (Rs)	Net Return (Rs)	BCR
Water harvesting and recycling for supplemental irrigation	Pea cultivation using from irrigation water harvesting tank	Pea (VRP -11)	3.0	60	55,000	227000	172000	4.12



**Water storage tanks for cultivation of vegetable in hilly regions at West Kameng, Arunachal Pradesh**

Though Imphal East district of Manipur receives high rainfall (>1500 mm), prolonged dryspells during the cropping season is affecting crop production and limiting crop yields. Water harvesting has become one of the most important practices and prerequisite for any successful agriculture and allied sectors under such erratic rainfall situation. The issue is more serious with small land holdings along the mild hill slopes due to presence of undulated areas and unavailability of site for bigger size pond construction.

Demonstration of Jalkund in the mild hill slope area of Chingtha village, Imphal East was taken up during 2015-16 and 32 numbers of farmers were benefitted from 13 numbers of farm pond and 10 farmers from 10 jalkund. Harvested water was utilized for vegetable crop cultivation during *rabi* season. An area of 0.25 ha was irrigated by each farmer giving 5 cm protective irrigation resulting in net income of Rs. 77,992.

The farmers of the NICRA village Marapara, West Garo Hills of Meghalaya grow vegetables on rainfed condition. The annual rainfall is more than 2500 mm per year, however, the farmers are facing problem for cultivating winter vegetables due to shortage of water. To overcome the problem, jalkunds using silpaulin of 300 GSM with size 5×4×1.5 m having 30,000 lit of storage water capacity were constructed in four farmers' fields. Harvested rainwater during rainy season was used for critical irrigation during dry spells in winter vegetable crops (tomato, pea, cabbage) in 0.24 ha area and realized a total income of Rs.1, 82,690/- with benefit cost ratio of 3.2.



**Cultivation of vegetables using harvested water in Jalkund in West Garo Hills, Meghalaya**

In village Aboi, Mon district of Nagaland, demonstration of low-cost water harvesting structure was taken up for harvesting flowing water, which is 4 m length, 2 m width, and 1m deep with storage capacity of 8000 litres of water. Plastic lining material of 250 GSM was used as lining material supported by pole. The harvested water was utilized for vegetables and fish production during post-rainy season. Twenty-eight farmers were benefitted from this technology. The cost of construction of jalkund was Rs. 1, 05,000/- which an average net return of Rs. 95,000 with a B: C Ratio of 1.9 was obtained.

Five numbers of farm pond with size (10 × 30 × 2 m) and six numbers of *Jalkund* (5 x 4 x 1.5 m) for life saving irrigation having capacity of 30,000 litres of water were constructed in the NICRA village Ramva, Ukhrul of Manipur. The water was collected from rain and from small stream, and the water storing capacity ranged from 30,000 L (5 ×4 ×1.5 m) to 60,000 L (12 × 6 × 1.5 m). Hill district suffers from extreme water scarcity during October

to February. Net return from Cabbage cultivation from Jalkund size (5 × 4 × 1.5 m) was Rs. 3600 and Rs. 8400 from bigger size. Water was applied through gravitational force without any extra energy application by constructing Jalkund at ridge point of catchments.



**Cultivation of vegetable using harvested water from *Jalkund* at Ukhrul, Manipur**

Farmers of N. Vanlaiphai NICRA village, Serchhip of Mizoram don't practice cultivation of *rabi* crops after paddy and leave the land fallow due to scarcity of water. Shallow open well was introduced at individual farm level for water harvesting and for providing supplemental irrigation during critical periods of crop growth stage and for providing pre-sowing irrigation to *rabi* crop. The recharge water from shallow open well was collected and lifted for irrigation with the help of pumpset (petrol start/kerosene run of 1.5 HP) provided to farmer. The intervention was introduced in the year 2015-16 in which four farmers were benefitted and covered an area of 1.6 ha. An average yield of 25q was obtained from the farmer field with a net return of Rs. 50,000/- and B: C ratio of 2.0 providing supplemental irrigation to field pea during *rabi* season. Additional income earned from the vegetable cultivation has attracted more farmers to cultivate *rabi* crops after harvesting of paddy crop.

NICRA village of Hnahthial, Lunglei of Mizoram is characterized by warm and humid climate. Although the village receives an annual rainfall of about 2200 mm, there is still a shortage of irrigation water particularly during winter season. Hence, priority was given to renovate the defunct water harvesting structure in order to harvest the rainwater for providing irrigation to different crops during winter season and to enhance the cropping intensity. Two numbers of RCC structures and one farm pond were renovated during 2015-16. With this intervention, farmers could irrigate their farm land during post *kharif* and *rabi* season for cabbage and broccoli in an area of 4.5 ha. The increase in availability of water in winter season resulted in higher production of cabbage (125 q/ha) and Broccoli (79 q/ha) with net returns of Rs. 30345/-.



**Cultivation of vegetables using harvested water in *Jalkund* at Lunglie, Mizoram**

The NICRA Village of Dunda, Uttarkashi district has lack of irrigation facilities and erratic distribution of rainfall is common in the area. In this village, a total 20 multi layered cross-linked silpaulin based tanks were developed in farmer's fields, with a capacity of about 25 m<sup>3</sup> each. Based on normative assumption, about 6 Nali (0.12 ha) of land can be irrigated by these tanks. Demonstrations on high-yielding varieties in crops like cabbage, cauliflower in *rabi* season, French bean and summer squash in jayad while tomato, capsicum, brinjal and okra in kharif season was carried out in 5.12 ha area of 20 farmers' field. Significant increase in area under off-season vegetable cultivation was observed, from 1.1 to 14 ha during *rabi* season, Cultivation of off-season vegetables utilizing the water harvested and collected in these poly-tanks resulted in net return of Rs 5,000 to 7,000 per year by each farmer.



***Jalkund* promotes cultivation of winter vegetables in Uttarkashi, Uttarakhand**

**Table 9. Summary of rainwater harvesting structures across districts in 2015-16**

Structure	State	Districts	Crop	No. of farmers benefitted	Area irrigated (ha)
Farm pond	Jharkhand	East Singhbhum	Paddy, Wheat, Mustard, Vegetable	42	11.5
	Bihar	Aurangabad	Wheat, Lentil, Gram	8	9.3
	Jharkhand	Godda	Paddy	25	35
	Bihar	Jehanabad	Paddy	84	26
	Bihar	Nawadah	Wheat, Potato		20
	Andaman & Nicobar	Port-blair	Leafy vegetables	2	2
	Manipur	Imphal East	Water melon, Cole crops and Other seasonal Vegetables	8	8
	Uttar Pradesh	Sonbhadra	Wheat	2	5
	Andhra Pradesh	Kurnool	Pigeonpea, Sorghum	4	3.4
	Maharashtra	Ahmednagar	Pomegranate	15	6
	Maharashtra	Amravati	Soybean	31	6.5
	Maharashtra	Aurangabad	Cotton, pigeonpea	40	41
	Gujarat	Valsad	Paddy	5	2.5
	Rajasthan	Kota	Mustard	1	2
	Chhattisgarh	Dantewada	Rice, Field pea and Vegetables	24	5
	Madhya Pradesh	Datia	Soybean	4	7
	Odisha	Ganjam	Paddy	7	3
	Odisha	Kalahandi	Vegetables	50	75
	Madhya Pradesh	Morena	Soybean	3	8
	Karnataka	Chickballapura	Paddy, Groundnut, Vegetables	8	2.5

Structure	State	Districts	Crop	No. of farmers benefitted	Area irrigated (ha)
	Karnataka	Davanagere	Finger millet	7	8
	Karnataka	Tumakuru	Pigeonpea	6	6
Jalkund	Manipur	Dhalai	Cabbage, Cauliflower	18	3.6
	Nagaland	Dimapur	Vegetables	1	5
	Sikkim	East Sikkim	Vegetables	15	1.25
	Manipur	Imphal East	Vegetables	10	10
			Jainita Hills	Vegetables	4
	Mizoram	Lunglei	Vegetables	2	4.5
	Nagaland	Mon	Broccoli, Pea	8	1.25
	Meghalaya	Ri- Bhoi	Vegetables	10	1
	Arunachal Pradesh	Tirap	Potato, Rape seed, French bean	49	7.5
	Manipur	Ukhrul	Groundnut	15	3
	Meghalaya	West Garo Hills	Vegetables	4	1.5
	Uttarakhand	Uttarkashi	French bean, Okra, Vegetable Pea	130	5
Check dam	Jharkhand	East Singhbhum	Paddy, Wheat, Mustard, Vegetable	110	132
	Bihar	Buxar	Paddy	63	65
	Bihar	Jehanabad	Paddy, Wheat	52	20
	Uttar Pradesh	Chitrakoot	Paddy, Maize, Pigeonpea	23	65
	Andhra Pradesh	Anantapur	Leafy vegetables	25	21
	Maharashtra	Amravati	Soybean	218	131
	Maharashtra	Aurangabad	Cotton, Pigeonpea, Rabi Sorghum, Chickpea	20	8
	Gujarat	Kutch	Cotton	97	153

Structure	State	Districts	Crop	No. of farmers benefitted	Area irrigated (ha)
	Chhattisgarh	Dantewada	Rice, Field pea and Vegetables	24	4.5
	MP	Datia	Soybean, Groundnut	14	9
	Odisha	Ganjam	Paddy, Vegetables	32	14
	MP	Jhabua	Vegetables	43	9
	Odisha	Sonepur	Paddy	3	4
	Karnataka	Tumakuru	Cowpea	4	2
Sand bag check dam	Jharkhand	Gumla	Wheat, Finger millet and Vegetables	155	70
	Maharashtra	Ratnagiri	Cowpea	28	3.2
Drainage channel treatment	Telangana	Khammam	Paddy	14	20
	Maharashtra	Ratnagiri	Cowpea	28	3.2
	Chhattisgarh	Balaghat	Paddy	5	2
	MP	Datia	Blackgram, Groundnut	98	60
	Jammu & Kashmir	Bandipora	Paddy	4	10
	Jharkhand	Chatra	Paddy	15	5
	Bihar	Nawadah	Paddy	122	110
	Assam	Dhubri	Paddy	56	310m
	Andhra Pradesh	Chittoor	Paddy	32	10.8
	Andhra Pradesh	Srikakulam	Paddy	40	20
	Maharashtra	Jalna	Cotton, Soybean	22	36
	Maharashtra	Amravati	Soybean	24	45.5
	Chhattisgarh	Balaghat	Paddy	12	6.2
	Chhattisgarh	Bilaspur	Wheat	37	50
	Karnataka	Belagavi	Pigeonpea, Groundnut	25	29
Tamil Nadu	Namakkal	Onion and Jasmine	230	60	
Karnataka	Tumkur	Paddy	4	4	
Percolation tank	Jharkhand	Chatra	Paddy, Wheat	152	580

Structure	State	Districts	Crop	No. of farmers benefitted	Area irrigated (ha)
Well recharge	AP	Chittoor	Paddy	37	16.8
	Odisha	Ganjam	Paddy	5	13
	MP	Guna	Wheat	1	4
	Jharkhand	Chatra	Wheat	12	15
	Jharkhand	East Singhbhum	Leafy vegetable, Mustard & Tomato	11	1.5
	Jharkhand	Gumla	Cabbage	5	2
	Bihar	Nawadah	Wheat, Potato		6
	Maharashtra	Amravati	Cotton, Pigeonpea, Chickpea	12	33
	Maharashtra	Aurangabad	Cotton, Pigeonpea	20	20
	Gujarat	Kutch	Wheat, Cumin	12	22
Rajasthan	Bharatpur	Wheat	60	54	
Chhattisgarh	Dantewada	Vegetables	2	1	
MP	Morena	Wheat, Greengram	4	12	
Community Tank	Himachal Pradesh	Kullu	Cabbage and Cauliflower	28	4.5
	Himachal Pradesh	Kullu	Tomato, Garlic, Pea	69	8.12
	Arunachal Pradesh	West Kameng	Cauliflower	7	5
	Uttarakhand	Tehri Gharwal	Paddy, Onion	45	5
	Rajasthan	Jhunjhunu	Cluster bean, Green gram	2	1
	Tamil Nadu	Namakkal	Onion, Groundnut, Sorghum and Jasmine	12	74
	Tamil Nadu	Ramananthpuram	Paddy	88	35

## Improved planting methods for *in-situ* moisture conservation measures in different rainfall regions

*In-situ* rainwater harvesting using simple technologies enables greater water infiltration, temporarily impounds water on the surface to increase the opportunity time for infiltration, prolongs the availability of moisture to the crop and enables crop to survive under variable rainfall conditions. *In-situ* measures such as ridge and furrow method, broad bed and furrow method, conservation furrows, bunding, land leveling, compartmental bunding, sowing across the slope, trench cum bunding, contour farming, etc., were demonstrated at various locations. Selection of appropriate soil and water conservation measure for a location depends on the amount and the distribution of rainfall, slope and soil type, depth and texture, especially the clay content and the choice of crop. Adoption of conservation furrows at specified interval improved the soil moisture availability at the root zone (30-40 days) and increased the productivity of crops by 15-20% in dry regions of the country compared to the traditional practice.

In village Choma Kot, Kota, demonstration of furrow irrigated raised bed (FIRB) planting method in wheat saved not only irrigation water to the tune of 25-30% and seed but also contributed to good plant stand and vigorous root growth. The average yield obtained from FIRB was 49.40 q/ha as compared to 47.20 q/ha farmer's practice. FIRB planted wheat suffered less damage due to hail and unseasonal rains compared to conventional method.

In Jalgaon KP village of Pune district, the *kharif* season is uncertain due to delayed monsoon and prolonged dry spells and *rabi* sorghum is generally cultivated on stored soil moisture. Demonstration of *rabi* sorghum (Phule Vasudha) by *in-situ* soil moisture conservation practice of compartmental bunding (10 X 10 m<sup>2</sup>) in 15 farmer's field was taken up. The cultivation of *rabi* sorghum with compartmental bunding gave 53.1% of higher yield than local farmer's practice. The crop yield was 16.7 q/ha as against 11.0 q/ha yields of non- adopted farmers and the net income of demonstration was Rs. 38166/ha against Rs. 19930/ha in farmers' practice.



Sorghum cultivation with compartmental bunding at Baramati, MS

In Jalgaon KP village of Pune district, due to delay of monsoon and deficit moisture in soil, farmers practiced ridge and furrow method for cultivation of chickpea. The implement used for sowing was multi-crop ridger. Chickpea crop experienced moisture stress during long dry spells and suffered terminal moisture stress at pod formation stage. Ridges and furrow sowing using multi crop ridger (45 cm × 15 cm) resulted in an yield increase of 25.62 % compared to conventional sowing (9.95 q/ha).

Demonstration on formation of conservation furrows in *Bt* cotton and pigeonpea (BDN-711) along with no furrows was taken up in Shekta village of district Aurangabad. The demonstrations were taken up in 20 ha area covering 100 farmers during the year 2015-16. Farmers got the yield benefit of 8% and 60% by opening of furrows in alternate rows in *Bt* cotton and pigeonpea, respectively (Table 10).

**Table 10. Impact of conservation furrows over farmers’ practice in cotton and pigeonpea in Aurangabad, MS**

Demonstration	Yield (q/ha)	
	Cotton	Pigeonpea
Improved practice	17.0	12.0
Farmer Practice	15.7	7.5



**Conservation furrow in cotton and pigeonpea cultivation at Aurangabad, MS**

In Takali village of Amravati, due to delayed onset of monsoon and deficit rainfall conditions farmers adopted *in-situ* moisture conservation practices like, sowing cross the slope, ridge & furrow and broad bed furrow method of planting in 187 ha with short duration variety of soybean (JS-9560) which resulted in an yield advantage of 33% (3.8 q/ha), 55% (4.5q/ha) and 81% (5.2 q/ha), respectively over farmers’ practice with no conservation measures (2.9 q/ha).

In Umarani village of Nandurbar district, generally farmers sow the crop behind the plough along the slope resulting in runoff and soil erosion. Ridge furrow planting using short duration maize (var GM-6) in 4 ha area covered 10 farmers and the yield increased

upto 14% (17.50 q/ha) compared to the farmers' practice (15.20 q/ha). Similarly, trench cum bunding was also demonstrated on 27 ha area benefitting 50 farmers. During intense rainfall events, most of the top soil from cultivated fields was trapped in the trenches allowing safe disposal of excess rainwater. The soil trapped due to trench cum bunding was in the range of 4.6 to 8.5 m<sup>3</sup>/ha. The farmers could save the valuable top soil being eroded from their fields with trench cum bunding.

Demonstration of *in-situ* moisture conservation technologies in groundnut and pigeonpea by subsoiling with chisel plough in NICRA village Chamaluru, Anantapur district was taken up. The subsoiling breaks the hard pan and helps in infiltration of the rainwater into the lower layer of soil from where it is not easily lost by evaporation. Subsoiling improved the yields of pod and haulm by 11% and 24%; respectively (Table 11).

**Table 11. Improvement yields of crops through *in-situ* moisture conservation in Anantapur, AP**

Groundnut	Pod yield (kg/ha)	Haulm yield (kg/ha)	Net returns (Rs.)
Subsoiling	1330	2650	46325
Farmers practice	1200	2130	40045



**Subsoiling for *in-situ* moisture conservation in at Anantapur, AP**

In village Sanora, Barodi, Datia adoption of *in-situ* conservation practices, viz., ridge and furrow and broad bed furrow planting method were taken up in soybean to cope with intermittent dry spells during crop growth period and for improved drainage during excess rains. The yield increase was to the tune of 24% and 39% with ridge and furrow and BBF method of planting (Table 12). Similarly, in Sanora and Baroudi village of Datia, a total 80 ha and 500 ha area brought under ridge and furrow method of planting compared to nil before initiation of the NICRA project.

**Table 12. Increment in yield of soybean and net returns from improved planting methods in comparison with farmers practice in Datia, MP**

Demonstartion	Yield (q/ha)	FP (q/ha)	Net benefit (Rs)
Ridge and furrow	9.5	7.2	15900
BBF	11.0	7.9	25590

In village Kanti, Tikamgarh, Madhya Pradesh soybean planting through broadcasting is common resulting in low plant stand. Demonstrations on ridge and furrow method of soybean sowing were conducted on 20 ha involving 12 farmers. This method of sowing gave about 14q/ha yield and an additional income of Rs. 22950 /ha compared to farmers' practice. Presently, significant increase in area was found under line sowing and ridge and furrow method of sowing in soybean.



**Ridge and furrow method of soybean cultivation at Tikamgarh, MP**

In village Sarkho of Guna, Soybean crop suffers from moisture stress during long dry spells and early withdrawal of monsoon. Demonstration of broad bed furrow planting for *in-situ* moisture conservation was taken up in soybean in 20 farmers' field in 8 ha area (Table 13).

**Table 13. Impact of BBF planting over farmer practice in soybean crop in Guna, MP**

Particulars	IP (BBF)	FP (Flat bed)
Yield (q/ha)	16.7	13.2
Net return (Rs/ha)	18019	6400
B:C ratio	1.99	1.35
Soil moisture(%) at 45 DAS	36.23	16.25
RWUE (kg/ha/mm)	2.43	1.76

During 2015-16, in village Bhargawan, Satna, demonstration of *in-situ* soil moisture conservation practice through ridge and furrow planting was taken up in soybean, black gram and green gram in 8 ha area covering 30 farmers. The yield increase observed was upto 22%, 17.6% and 19.5% with ridge and furrow planting over farmers' practice in case of soybean, blackgram and greengram, respectively (Table 14). Similarly, demonstration of *in-situ* moisture conservation through ridge and furrow method was taken up in cowpea and colocassia in village Bhoimunda, Jharsuguda.

**Table 14. Impact of ridge and furrow on crop yields at Jharsuguda, Odisha**

Crop	Cowpea		Colocassia	
	IP	FP	IP	FP
Yield (q/ha)	72.0	58.0	143.0	116.0
Net return (Rs/ha)	74000		126600	
B:C ratio	3.8		4.3	

In Amba village of Ratlam, demonstrated broad bed furrow system for *in-situ* moisture conservation in soybean crop. There were two long dry spells, the first one after ten days of sowing at vegetative growth stage (25-06-15 to 17-07-15) and second at pod formation stage (30-08-15 to 11-09-15) of 21 days and 13 days, respectively. In spite of dry spells, BBF sown soybean variety JS-9560 was not much affected. The average soybean yield in control sown was 11.20 q/ha where as the BBF field produced 15.60q/ha (2.83).



**Ridge and furrow method of soybean cultivation at Ratlam, MP**

In village of Capari Jhabua, demonstration of *in-situ* moisture conservation practice through ridge and furrow method was taken up in soybean to cope with intermittent dry spells during crop growth period and for drainage of excess water. The crop performed



**Table 15. Impact of raised bed planting over farmer's practice in pigeonpea in Gonda district, UP**

Treatments	Crop	Variety	Seed yield (q/ha)	Gross cost (Rs./ha)	Gross returns (Rs./ha)	Net returns (Rs./ha)	BC
Raised bed sowing	Pigeonpea	NA-1	13.15	59460	105200	45740	1.77
Broadcasting sowing	Pigeonpea	NA-1	9.85	60135	78800	18665	1.31

**Table 16. Summary of *in-situ* soil moisture conservation practices across the districts**

State	District	Crop	Cultivars	Intervention	No. of demonstrations	Area (ha)
Madhya Pradesh	Datia Morena Satna Guna Jhabua Tikamgarh	Soybean, Pigeonpea, Wheat, Greengram, Chickpea	JS-95-60 PUSA 992 MP-4010 TJM-3 Samrat PU-35	Ridge and furrow, BBF	224	112
Maharashtra	Ahmednagar Amravati Nandurbar Aurangabad Baramati	Soybean/ pearl millet Cotton Maize Pigeonpea Sorghum Green gram Bengal gram	JS-9305, Ajeet 155, GM-6, Bt.cotton, BDN-711, Phule Vasudha	Conservation furrow, ridges and furrow, Sowing across the slop, BBF, Trench cum bunding Compartmental bunding	338	284
UP	Gonda, Bhagpat	Pigeon pea, Mustard	NA-1, Pusa M-27	Ridge and furrow, Bed planting	57	11
Bihar	Buxar	Wheat	HD 2824	FIRB	6	4
Andhra Pradesh	Kurnool, Anantapur, Chittoor	Pigeonpea Groundnut Tomato	ICPL-87119, K6	Conservation furrows, Plastic mulch	40	4
Telangana	Nalgonda	Cotton, Redgram	PRG-176	Conservation furrow	32	20

State	District	Crop	Cultivars	Intervention	No. of demonstrations	Area (ha)
Rajasthan	Kota	Wheat		FIRB	20	10
Himachal Pradesh	Hamirpur	Bitter Gourd, Cucumber, Bottle Gourd	Aman, Malav, Sharda,	Shambu Ridge and furrow	16	2
West Bengal	Coochbehar	Cucumber	Barsati	Ridge and furrow	5	1
Odisha	Jharsuguda	Cowpea, Colocassia	-	Ridge and furrow	2	6

### Direct Seeded Rice (DSR)

Direct seeding of rice overcomes the problem of dependence on labor for nursery raising and transplanting operations. The direct seeded rice technology has showed potential of improving water productivity by 15–18% (as puddling requires significant quantity of water), and reduced use of labour, usage of energy and cost of cultivation, reduces the methane emissions, and increases the system profitability by 10–15%. Further, a significant improvement in the soil health under the rice-based production systems was also reported. Selection of short duration paddy varieties can contribute to the early harvest of paddy and timely sowing of wheat, thus reducing the possibility of heat stress at maturity in wheat. The impact of paddy sown with direct seeded rice in NICRA villages are highlighted below.

Demonstration of direct seeded rice was taken up in Pindi Balochan village of Faridkot in 50 ha area covering 17 farmers resulting in yield of 46.0 q/ha as compared to farmers' practice of 44.0 q/ha. This method helped in saving of 4-5 irrigations and early maturity of crop by 7-8 days and an additional yield of 2.0 q/ha.

Demonstration of the DSR was taken up in Sadanandpur village in 2 ha area covering 12 farmers. Farmers saved about Rs. 4000/ha on cost of cultivation and yield increased by 18% as compared to farmer's practice (22 q/ha).

In village Chittecherla of Chittoor, demonstration of direct seeding method was taken up in paddy using drum seeder. About 9% yield increase was observed in the demonstration than traditional transplanted method. Farmers opined that crop duration was reduced by 10-15 days and cost of cultivation was reduced by Rs.9723/ha.

In NICRA village Killi Nihal Singh, Bathinda demonstration of direct seeded rice (DSR) with Pusa Basmati (1121) was taken up in 21 farmers field in 42 ha area. Farmers of the

village observed reduction in the labour and energy requirements, earlier crop maturity by 7-10 days, saved irrigation water by 10-15 % and an additional yield of 2.6q/ha. (Table 17).

**Table 17. Performance of DSR over farmers' practice in Bathinda, Punjab**

Variety	No. of farmers	Area (ha)	Yield (q/ha)		% increase	Economics of demonstration (Rs./ha)			
			IP	FP		Gross Cost	Gross Return	Net Return	BCR
Pusa Basmati-1121	31	42	50.8	48.2	5.3	35,550/-	1,06,680/-	71,130/-	3.00

Demonstration of DSR with drum seeder was taken up in village Sonauli Mohammadpur, Gonda. The grain yields, gross returns are higher in comparison to the traditional transplanting method (Table 18 & 19). The area under direct seeded rice is increasing continuously after introduction of the drum seeder. This technology has become very popular in areas where field is levelled and having assured irrigation facility.

**Table 18. Impacts of DSR paddy in comparison with transplanting in Gonda, Uttar Pradesh**

Indicators	Paddy drum seeder	Transplanting
Cost saving in sowing (Rs./ha)	6000	-
No. of tillers/hill	60 - 65	30 - 35
Plant height (cm)	70 - 75	60 - 65
Length of spike (cm)	20 - 22	12 - 15
No. of grain/spike	287	185
Time of maturity	7-8 day before	-

**Table 19. Economics of DSR paddy in comparison with transplanting in Gonda, Uttar Pradesh**

Comparison of Treatments	Crop	Variety	Yield (q/ha)	Gross cost (Rs./ha)	Gross returns (Rs./ha)	Net returns (Rs./ha)	BC ratio
DSR through drum seeder	Paddy	NDR-359	38.54	18120	34686	16566	1.91
Transplanting	Paddy	NDR-359	35.35	23120	31815	8695	1.37

In Hengbung village of Senapati, direct seeded rice (CAU-R1) was introduced in six farmer's paddy fields covering two ha to overcome the problems of water scarcity and delayed rainfall. Seeds were sown directly and gap filling was done 20-30 DAS. The uprooted paddy seedlings were used for transplanting in neighbouring paddy fields. Farmers were able to reap on an average yield of 39.5 q/ha (Table 20).

**Table 20. Impact and economics of DSR in comparison with farmers' practice in Senapati, Manipur**

Intervention	DSR	Farmers practice
Name of crop	Paddy	Paddy
Variety	CAU-R1	CAU-R1
Area (ha) covered	2.0	-
Yield (average) q/ ha	39.5	32.01
Net income (Rs/ha)	32700	18080
B:C ratio	1.70	1.39



**DSR for water saving in Senapati, Manipur**

In village Muttar, Alleppy demonstration of paddy using drum seeder in 44 ha area covering 47 farmers were taken up. The sowing by drum seeder required less quantity of seeds (30 kg/ha) compared to direct sowing (100-120 kg/ha). Seeds were sown in lines at a spacing of 20 x 10 cm to facilitate weeding and other operations. Moreover the plant population was maintained and the crop had enough space for proper growth and development. It was observed that yield obtained with drum seeder was 67q/ha as compared to farmer practice (60q/ha).



**Drum seeding of rice for water saving in Alleppey, Kerala**

In Matsypuri village, West Godavari during 2015-16 in *rabi* season direct seeding of rice with drum seeder was demonstrated in 16 hectares area. Higher yields were obtained with paddy sown with drum seeder (81q/ha) as compared to farmer practice (74 q/ha) with B:C ratio of 2.54. The cost of cultivation reduced in drum seeder sowing method by Rs. 4422/ha than manual transplanting (Table 21). The crop matured one week earlier than manual planting.

**Table 21. Economics of demonstration of paddy through drum seeder in West Godavari, AP**

Treatments	Seed / Grain yield (kg/ha)	Cost of cultivation (Rs/ha)	Gross income (Rs/ha)	Net income (Rs/ha)	B:C ratio	% increase
Drum seeder sowing	8135	39260	99820	60560	2.54	9.41
Manual transplanting	7437	43682	91233	47551	2.08	-



**Drum seeding of paddy for water saving in West Godavari, AP**

In Karnataka, about 55–60 % of the rice is grown under puddled system and the rest is under rainfed situation. Because of increasing water scarcity, aerobic paddy cultivation was demonstrated in D. Nagenahalli village, which requires less water. The main

advantages of an aerobic paddy (MAS 26) are: no need of puddling, water saving up to 30% along with 80% saving on seed. The demonstration of aerobic paddy (MAS-26) was conducted in five farmer's field in 10 ha area. The performance of the aerobic paddy was found to be superior (38 q/ha) compared to the local variety of paddy (29 q/ha). The farmers were benefitted with additional yield of 4.0 q/ha and earned an additional income of Rs.5400 compared to the traditional practice.

**Table 22. Summary of demonstrations conducted on direct seeded rice**

Cultivars	District	State	No. of Demonstration	Area (ha)
Pusa Basmati-1121	Bathinda	Punjab	31	42
	Fatehgarh sahib	Punjab	11	5
	Faridkot	Punjab	17	50
PB 1509	Yamunanagar	Haryana	13	5
Sahbhagi	Aurangabad	Bihar	31	11
	Banka	Bihar	19	7
Sushk Samrat	Buxar	Bihar	4	3
Prabhat	Jehnad	Bihar	12	21
Anjali	Koderma	Jharkhand	22	3
Sahbhagi	Supaul	Bihar	12	2
Sarjoo -52	Kushinagar	Uttar Pradesh	10	6
Swarna Sub-1	Maharajganj	Uttar Pradesh	75	30
PPB-1509	Muzaffarnagar	Uttar Pradesh	17	6
Sahabhagi	Sonbhadra	Uttar Pradesh	8	4
RGL-2537	Srikakulam	Andhra Pradesh	12	4.6
MTU 1061	West Godavari	Andhra Pradesh	30	15
MTU 1010	Balaghat	Madhya Pradesh	5	2
MTU-1010, Mahamaya	Bhatapara	Chhattisgarh	13	4
Indira Rajeshwari	Bilaspur	Chhattisgarh	10	3
Indira Barani Dhan-1, Sahbhagi, MTU-1010	Dantewada	Chhattisgarh	32	13
Pusa-1509	Datia	Madhya Pradesh	10	5
Uma	Alleppy	Kerala	47	44

## Zero till cultivation of wheat

Wheat sowing by conventional method requires number of tillage operations to prepare a fine seed bed after the harvest of paddy. Delay in harvest of paddy and the time needed for land preparation results in delay in wheat sowing which may leads to heat stress at grain formation resulting in poor wheat yields. The zero till wheat sowing in the standing paddy residues provides an alternative to residue burning of paddy also. Demonstrations of zero-till drill was taken up in farmer's fields in NICRA villages in wheat growing states by conventional method.

In Pindi Balochan village of Faridkot, demonstration of timely sowing of wheat (HD-2967) with zero till drill was demonstrated in 59 farmer's fields in 232 ha area. The net return of Rs. 37000 per ha was obtained with zero till method as compared to farmers practice (Rs.34000/ha). This technology helped in paddy straw management, saved Rs. 2000/ha and improved soil health. Wheat sown with happy seeder escaped crop damage due to lodging and water stagnation experienced during heavy rains received in March 2016. The conventionally sown fields suffered water logging up to 7 days, which caused significant damage. Recovery of the lodged plants in happy seeder sown plots was faster due to less water stagnation.

Burning of rice stubbles are widely practiced in NICRA village Badhouchhi Kalan, Fatehgarh Sahib Punjab, as straw burning is a rapid and cheaper option. It has serious effects on human and animal health due to air pollution, results in loss of nutrients and organic matter, and contribute to green house gas emissions. Demonstration of wheat sowing with happy seeder in 20 ha area covering 50 farmers were taken up during 2015-16. The yield obtained with happy seeder was 50.6 q/ha as compared to farmers' practice of (44.8 q/ha), thus realizing an additional yield of 5.8 q/ha.

In Rasidpur village of Ropar, wheat sowing with happy seeder technology provides an alternative to burning rice residues and allows direct drilling of wheat in standing crop residues. Initially the happy seeder in adopted village was demonstrated on 5.8 ha and now it has increased upto 20 ha in 2015-16. A net saving of Rs. 4735 /- per hectare was achieved when wheat was sown with happy seeder over conventional method. (Table 23).

**Table 23. Economic comparison of wheat sown with happy seeder and conventional method in Ropar, Punjab**

Particular	Method of sowing	
	Happy seeder	Conventional
Cost of field preparation (Rs/ha)	2500	6350
Weedicide and labour charges (Rs/ha)	400	1375
Rodenticide (Rs./ha)	90	-
Total (Rs./ha)	2990	7725
Net saving (Rs./ha)	4735	-



**Sowing of wheat with happy seeder after harvest of paddy at Ropar, Punjab**

In village Killi Nihal Singh of Bathinda district, before the starting of the project the farmers of village were not aware about the happy seeder technology, which enables sowing of wheat crop in standing stubbles without burning of the paddy straw. During 2015-16 wheat crop is sown in 32 farmers' field in 24.8 ha area, one week earlier as compared to traditional method of sowing and saving of Rs 2500/ha and cost of labour and diesel costs. Now the farmers of the village are demanding for more number of happy seeder machines as one machine can sow the wheat crop in 2 ha area in a day and sowing window is limited and the area under wheat crop is about 725 ha in the village.

Zero till sowing of wheat is key strategy in flood prone region to avoid terminal heat stress. In NICRA village Jhangha of Gorakhpur district, which is frequently prone to flood, demonstration of zero till sowing of wheat crop (var.HD-2967) was taken up benefitting 15 farmers in 6 ha area. The yield of wheat obtained was 38.65 q/ha with zero till whereas 29.48 q/ha under farmers' practice.

In village Rasalpur Jatan, Muzaffarnagar sowing of wheat delayed due to late harvesting of paddy. Demonstration of wheat with zero till drill in 10 ha area in 25 farmer's field gave a yield of 48 q/ha compared to farmers' practice of 44 q/ha. The timely sowing helped in reducing the effect of terminal heat stress.



**Wheat sown with happy seeder at Bathinda, Punjab**

**Table 24. Extent of zero till cultivation in NICRA villages across states in 2015-16**

Crop	Cultivars	Intervention	District	State	No. of Demonstration	Area (ha)	
Wheat	HD-2967	Zero till	Bathinda	Punjab	2	5	
	WH-1105	Happy seeder	Bathinda	Punjab	32	25	
	HD- 2967	Happy seeder	Fatehgarh sahib	Punjab	50	20	
	HD-2967	Zero till	Faridkot	Punjab	59	232	
	HD-2967	Happy seeder	Ropar	Punjab	16	12	
	HD-2967	Happy seeder	Yamunanagar	Haryana	70	28	
	K 7025	Zero till	Chatra	Jharkhand	30	23	
			Banka	Bihar	3	2	
	WR 544	Happy seeder	Buxar	Bihar	8	2	
	HD2967	Zero till	Buxar	Bihar	36	26	
	K-9107	Zero till	Koderma	Jharkhand	53	11	
	PBW-343	Zero till	Malda	West Bengal	140	19	
	HD2733	Zero till	Nawada	Bihar	20	12	
	PBW-373	Zero till	Baharaich	Uttar Pradesh	60	24	
	K-9533	Zero till	Gonda	Uttar Pradesh	19	17	
	HD 2967	Zero till	Gorakhpur	Uttar Pradesh	15	6	
	HD2329	Zero till	Kaushambi	Uttar Pradesh	10	4	
	HD-2967	Zero till	Maharajganj	Uttar Pradesh	15	6	
	HD-2967	Zero till	Muzaffarnagar	Uttar Pradesh	25	10	
	KRL – 210	Zero till	Pratapgarh	Uttar Pradesh	46	25	
	DBW-550	Zero till	Sonbhadra	Uttar Pradesh	25	5	
	JW-3211	Zero till	Balaghat	Chhattisgarh	5	4	
	Sujata	Zero till	Bhatapara	Chhattisgarh	5	2	
	Ratan	Zero till	Bilaspur	Chhattisgarh	6	12	
	JW- 3020	Zero till	Chhatarpur	Madhya Pradesh	10	4	
	GW-366	Zero till	Datia	Madhya Pradesh	10	5	
	HI 1544	Zero till	Guna	Madhya Pradesh	30	12	
	MP- 4010	Zero till	Tikamgarh	Madhya Pradesh	12	5	
	Lentil	L-4594	Zero till	Maharajganj	Uttar Pradesh	12	5
	Maize	Kaveri 50	Zero till	Srikakulam	Andhra Pradesh	25	8
Rashi-4212		Zero till	Bhatapara	Chhattisgarh	7	2	
Mustard	Pusa Bold	Zero till	Bhatapara	Chhattisgarh	4	1	
Pea	Vikash	Zero till	Jaintia hills	Meghalaya	8	5	
	HUL 57	Zero till	Dhalai	Tripura	35	3	

## Sustainable Intensification in Hilly areas

Farmers of Kyrdem village, Ri-bhoi usually leave the field fallow after the harvest of paddy. Pea variety prakash was demonstrated in raised and sunken beds in rice fallows in 30 farmer's fields in an area of 1.5 ha to increase the cropping intensity and income. In the first year, 30 numbers of farmers cultivated pea in rice fallows covering more than 1.5 ha area. As most of the rice fallows remain uncultivated after paddy cultivation, many of the farmers showed great interest in adopting this technology. After seeing the success of the intervention, nearly 100 farmers from the nearby villages have approached KVK Ri-Bhoi for introducing the technology in their fields. The raised bed technology demonstrated in the farmer's field had shown 46% increase in pod yield, which fetched 10 times higher returns than traditional method. The B:C ratio also increased from 1.42 to 2.9 (Table 25).

**Table 25. Improvement in yields in comparison with local practice in Ri-Bhoi, Meghalaya**

Technology demonstrated	No. of farmers benefitted	Area (ha)	Yield (q/ha)	% increase in yield	Gross Cost	Gross Return	Net Return	BCR
Cultivation of pea in raised and sunken beds var. (Prakash)	30	1.5	25.55	46.0	30,500	89,425	58,925	2.9
Local	30	1.5	17.5		12900	18400	5500	1.42



**Pea cultivation on raised and sunken beds in rice fallows at Ri-Bhoi, Meghalaya**

Normal sown toria varieties cannot be cultivated under rice-toria crop sequence, since harvesting of winter rice occurs only by the end of November or early December in

Assam. Demonstration on toria variety TS-36 and TS-38 was conducted in village Phutahola, Dibrugarh in 15ha area. Seed treatment with Azotobacter and PSB@ 50gm/kg was done. Grain yields of 12.1q/ha was obtained in TS-38 against the local yield of 9.5q/ha. After seeing the successful performances of toria variety TS-36 and TS-38 in 2014-15, 49 farmers collected seed from the adopted farmers and cultivated on their own in more than 50 ha area during 2015-16.

Lowland paddy is the major *kharif* crop in NICRA village Dhansiripar, Dimapur, Nagaland covering about 242.20 hectares with average productivity of 18.20 q/ha, which occupy about 79.40% of the total cropped area during *kharif* season. Generally, this village receives rainfall from second fortnight of May or first fortnight of June but during monsoon 2015 rainfall was uncertain as a result farmer's stopped growing paddy due to water shortage. To compensate the loss, sesame crop (AST-1) was demonstrated in the village as an alternate crop. Sesame performed well in the village as the soil and climatic conditions were favourable for the crop. During the year 2015-16 farmer's could earn an average net return of Rs. 45,000/ha with B: C Ratio of 3.14 with an average yields of 6.6 q/ha. Sesame being a short duration crop provides an opportunity for taking second crop viz., vegetables, pulses and oilseeds subsequently during *rabi* season.



**Sesame cultivation as alternate crop to compensate kharif loss at Dimapur, Nagaland**

In village Umjalasiaw, Jaintia hills, Meghalaya generally farmers keep the land fallow after harvesting of paddy. Demonstration of pea with zero till drill in 8 farmers' field in 5 ha area was taken up. The yield obtained was 26 q/ha with net returns of Rs. 18,265/ha.

In Methrina paschim village of Dhalai, Tripura, leaving the land fallow after paddy harvest is a common practice. Significant area of cultivable land remains uncultivated after harvesting of paddy. Demonstration of lentil with zero till drill in 35 farmers field in 3.2 ha area to utilise the residual moisture was taken up. At about 30-35 DAS, the crops were sprayed with DAP @ 20% followed by boron at 50 DAS. An average yield of 4.6 q/ha was obtained with a net return of Rs. 14000 and B:C ratio of 1.5.

### 3.2 Crop Production System

In view of aberrant monsoon during kharif, 2015 contingency crops were demonstrated in 50 NICRA KVKs in states vulnerable to drought. Contingency crops for late planting including soil moisture and nutrient management measures in standing crops experiencing dry spells were taken up at several locations. The impact of resilient practices and technologies are highlighted below:

#### Contingency Cropping

In village Bhalot, Kutch demonstrations of drought tolerant var. GCH-2 of castor were conducted in 10 ha area benefitting 25 farmers' in the village. The introduced variety of castor recorded 30.2 q/ha, which is 19.4% higher than the farmers' practice.



Drought tolerant castor var. GCH-2 at Kutch, Gujarat

In village Purkhawas, Jodhpur during kharif 2015-16 demonstration of short duration drought tolerant variety of bajra (HHB-67) and CZM-2 of Mothbean were taken up in 125 farmers' fields covering 50 ha area. The average yield of bajra (var. HHB-67) was higher by 44.4% and in mothbean (Var. CZM-2) by 41.7% over local check. An additional net profit of Rs 5,190/ha and Rs.8625/ha in bajra and mothbean, respectively was realized.



Short duration drought tolerant bajra (HHB-67) and moth bean (CZM-2) at Jodhpur, Rajasthan

In Shekta village of Aurangabad district due to frequent drought during crop growth stage, demonstration of drought tolerant variety BDN 711 of pigeonpea was demonstrated in eight ha area covering 20 farmers. The yield of improved variety of pigeonpea was 900 kg/ha as compared to local variety (750 kg/ha). The B:C ratio was observed to be 2.94 (Table 26). The BDN-711 was found to be drought tolerant, shorter in duration by 20-25 days and also resistant to sterility mosaic virus.

**Table 26. Performance of improved crop variety of pigeonpea in comparison to local variety in Aurangabad, MS**

Treatments	Seed yield (kg/ ha)	Cost of cultivation (Rs/ha)	Gross income (Rs/ha)	Net income (Rs/ha)	B:C ratio
Local variety	750	23500	63750	49750	1:2.71
Improved variety (BDN-711)	900	26000	76500	51500	1:2.94

In D. Nagenahalli village, Tumkur BRG-2 variety of pigeonpea was introduced in 25 ha area in 115 farmers' field. BRG 2 variety is a short duration, high yielding and suitable for dryland and late sowing conditions. The yield of the pigeonpea var. BRG 2 was found to be higher (12.6 q/ha) in comparison to the local check (10.2 q/ha) and the farmers recorded an additional income of Rs. 10,440/ ha.



**Drought tolerant short duration pigeonpea (var. BDN-711) at Aurangabad, MS**



**Drought tolerant short duration pigeonpea (var. BRG-2) at Tumakuru, Karnataka**

Frequent droughts and acute moisture stress condition in Chopanadih village of Koderma are common to paddy cultivation during *kharif* in upland situation and impacting the traditional long duration varieties being grown by farmers. Demonstration of short duration drought tolerant rice variety sahbhagi dhan (110-115 days) in 31 farmers fields were taken up in 11 ha area resulting in increase in yield by 43 % over local check (20.68 q/ha) and matured 15 days earlier than local variety.

## Short duration and drought tolerant varieties

Short duration, drought tolerant crop varieties were demonstrated for delayed sowing and deficit rainfall conditions to improve the resilience of farming in the drought prone areas. Farmers adopted short duration varieties when faced with delayed onset of monsoon.

In village Bhalot, Kutch due to low and late onset of monsoon, demonstration of short duration variety of green gram (GM-4) was taken up in 5.7 ha area in 13 farmers' fields. The yield of variety was recorded higher 23.8% with 2.74 BCR as compared to farmers' practice. An additional net income of Rs 8000/ha was realised.

In village Karbala, Amreli, long duration varieties of groundnut are not performing due to erratic rainfall and early withdrawal of monsoon. Demonstration of short duration high yielding variety of groundnut (GJG-9) was taken up in 5 farmers' fields covering 2 ha area resulting in increase in yield by 20.67% over local variety (19.30 q/ha) and net profit of Rs 83085/ha was realised. Farmers were motivated to grow new variety of groundnut in this area because of bold seed size and tolerance to dry spells compared to local variety.



Short duration high yielding groundnut var. GJG-9 at Amreli, Gujarat

In village Sujan Singh Sutaroka Tala, Barmer, demonstration of drought resistance cultivars recommended for arid zone viz. bajra (MPMH17), mothbean (RMO435) green gram (GM4) and cluster bean (RGC1017) were taken up in 200 farmers' fields covering 80 ha area which produced significantly higher yields to the extent of 15-55% as compared to the locally grown crop varieties. Farmers of NICRA village and adjoining surrounding villages also adopted the improved cultivars of above crops indicating horizontal spread.



Drought tolerant cultivars bajra (MPMH-17) and greengram (GM-4) at Barmer, Rajasthan

In village Bharu, Jhunjhunu district, pearl millet, greengram, cluster bean and cowpea are the major kharif season crops. Although there are 84-tube wells and open wells in the village for irrigation, their high salinity level limits their use ( $P^H$  8.5 to 10.2). Farmers gave life saving irrigation only in pearl millet during long dry spell. During the kharif, the total rainfall received was 370 mm against the normal 450 mm with three long dry spells (21 days, 11 days and 30 days from August to October 2015). Keeping the above problems in view, intervention of foliar sprays of agro-chemicals (Thiourea- 0.05% and Thiourea 0.05% + Zinc Sulphate 0.5%) was demonstrated on farmers' field to minimize the effect of long dry spell on greengram crop. Two foliar sprays of Thiourea- 0.05% and Thiourea 0.05% + Zinc Sulphate 0.5% at I/II week of August and during last week of August/first week of September were taken up. The overall increase in yield of greengram was about 14 to 20% (Table 27).

**Table 27. Foliar spray to minimize impact of dry spell in farmers' field**

Intervention	Variety	Critical input	No of farmers	Area (ha)	Yield (q/ha)		% Increase
					IP	FP	
long dry spell	RMG-344	1.Improved seed	10	4.0	6.19	5.50	12.55
		2. Improved seed & foliar spray of Thiourea- 0.05%	07	3.5	6.25	5.50	13.64
			07	3.5	6.60	5.50	20.00
		3.Improved seed &Thiourea 0.05% + Zinc Sulphate 0.5%					



**Effect of foliar spray on greengram (RMG-344) at Jhunjhunu, Rajasthan**

In Shekta village of Aurangabad district, demonstration of improved variety of soybean was carried out on 12 ha area covering 30 farmers. During 2015, it was observed that

improved variety (MAUS-71) of soybean recorded the highest yield (900 Kg/ha) and net returns (13100 Rs/ha) as compared to local variety (JS-335) (700 kg/ha & Rs.7500/ha) (Table 28).

**Table 28. Performance of soybean variety in comparison with local variety in Aurnagabad, MS**

Treatments	Seed yield (kg/ha)	Cost of cultivation (Rs/ha)	Gross income (Rs/ha)	Net income (Rs/ha)	B:C ratio
local Variety (JS-335)	700	20500	28000	7500	1:1.36
Improved variety(MAUS-71)	900	22900	36000	13100	1:1.57

The village Umarani is situated in the Satpura ranges and experiences terminal drought affecting the productivity of maize. Demonstration of short duration variety of maize (GM-6) in 30 farmers in 12 ha area were taken up which escaped the terminal drought. The yield increase was to the tune of 14.14% compared to local.

S. Raghuttahalli village of Chikkballpur district, short duration and early maturing finger millet variety ML-365 against GPU-28 in seven farmers' fields were demonstrated. ML-65 variety gave yield 21.78 q/ha as compared to 15.65 q/ha by GPU-28. Further, it was found to be resistant to blast and ideal for both rainfed and irrigated conditions.



**Short duration ragi cultivars (ML-365 & GPU-28) at Chikkaballapura, Karnataka**

In village Siddanuru, Davanagere after the harvesting of the vegetables in the month of September, usually farmers are going again for the vegetables in the same field with bore well as a source of irrigation. The rainfall throughout the cropping season up to August end was very low (90 mm) and the farmers were convinced to go for millets, which require less water. Introduced the finger millet (ML-365) which is medium duration, drought tolerant and resistant to neck blast in 20 farmers field in eight ha area (Table 29).

**Table 29. Economics of demonstration of HYV of fingermillet in Davanagere, Karnataka**

Intervention	Yield (q/ha)		Cost of cultivation (Rs/ha)	Gross Return (Rs/ha)	Net Return (Rs/ha)	B:C
	Grain	Fodder				
Integrated crop management in HYV Finger millet ML-365	24.5	43.5	24,100	60,640	36,540	2.51
Local Check Integrated crop management in HYV finger millet GPU-28	19.5	39.6	23,500	47,950	24,450	2.04

In village Mahalingapur, Gadag demonstrated foxtail millet crop with high yielding variety DHFt-109-3 to cope with drought situation. The performance of the crop was good and in enhanced the net returns per ha compared to greengram and maize crops even in severe drought condition. The net returns from greengram crop was Rs.620/ha and from maize crop it was Rs.712/ha whereas from Foxtail millet crop, it was Rs.17149/ha (Table 30).

**Table 30. Economics of demonstration of different crops in Gadag, Karnataka**

Crop	Yield (q/ha)	Gross cost (Rs./ha)	Gross return (Rs./ha)	Net return (Rs./ha)	BCR
Greengram	2.33	18020	18640	640	1.03
Maize	21.95	25628	26340	712	1.02
Foxtail millet	16.80	19811	36960	17149	1.86

In village D. Nagenahalli, Tumakuru, finger millet is the staple food crop and farmers are getting low yields due to uneven rainfall (May- June), poor management and due to non-availability of quality seeds. During kharif season, the early season drought occurred due to delay in monsoon rains. Demonstration of finger millet variety ML-365 to cope up with delayed monsoon in 50 ha area covering 120 farmers was taken up (Table 31).

**Table 31. Performance of short duratin finger millet (ML-365) in comparison to local variety in Tumakuru, Karnataka**

Crop	ML-365	Gutte ragi
Yield (q/ha)	38.5	29.5
Increase in yield (%)	30.5%	-
Addiitonal Net return (Rs)	13,500	-



**High yielding drought tolerant variety of finger millet (DHFt-109-3) at Davanagere, Karnataka**



**Short duration finger millet cultivars (ML-365) at Tumakuru, Karnataka**

In Vadavathur and Jambumadai village of Namakkal District, Tamil Nadu community owned onion nursery with low seed rate and drought tolerant variety (CO- 5) was taken up on 1<sup>st</sup> October (1<sup>st</sup> nursery), 15<sup>th</sup> October (2<sup>nd</sup> nursery) and 1<sup>st</sup> November (3<sup>rd</sup> nursery), respectively each in 5 farmers' fields involving 20 farmers. Majority of the farmers could take up transplanting using seedlings from the 1<sup>st</sup> and 2<sup>nd</sup> nursery raised on 1<sup>st</sup> and 15<sup>th</sup> October. These farmers' benefitted with an additional yield of 1.8 to 2 tonnes/ha (25 % increase in yield) compared to farmers who directly sown bulbs during November.



**Onion nursery (30 days seedling) and bulbing stage at Namakkal, Tamil Nadu**

In NICRA village Kattusiviri, Villupuram, demonstration of short duration, drought tolerant paddy variety (Anna 4) during late samba season (November) under direct seeding using drum seeder was taken up. This fine variety was found to be tolerant to dry spell which is common during maturity stage when compared to farmer's variety ADT37. The yield obtained was 42.5 q/ha as compared to farmer's practice (32 q/ha).

In village Chittecherla, Chittoor demonstrations on drought tolerant variety of groundnut Dharani was taken up in 1.4 ha area covering 7 farmers during *rabi* season. The results

showed that about 11.3% increase in yield in Dharani variety over farmer's variety (Kadiri-6). The net returns obtained in the demonstration was Rs.53169/ha as compared to farmers' practice of Rs.41438/ha.

In Nandyalagudem village in Nalgonda district, generally farmers cultivate medium duration pigeonpea varieties which experience terminal moisture stress resulting in low yields. Demonstrations of short duration pigeonpea variety PRG-176 was taken up in 12.0 ha with 30 farmers. This variety yielded 12.36 q/ha while the local variety (LRG-41) yielded only 8.75 q/ha. Demonstration of short duration greengram variety WGG-42 which is tolerant to YMV was taken up in 10 ha area involving 25 farmers. This variety gave a yield of 5.35 q/ha over the local variety LGG-460 (4.37 q/ha).



**Short duration pigeonpea (PRG-176) and greengram (WGG-42) at Nalgonda, Telangana**

Nacharam village of Khammam district in Telangana, frequently experiences erratic rainfall with long dry spells, resulting in low water storage in village tanks affecting paddy cultivation in *rabi* season. Due to water shortage, farmers are keeping paddy fields fallow in *rabi* season. Demonstrated short duration high yielding greengram variety (MGG-295) after kharif paddy in 8 ha area. Farmers could get 9.5q/ha yield with net returns of Rs. 51000/ ha apart from the biomass which was used as cattle feed. More than 80 % of famers in the village have adopted this variety.

In NICRA village Sonara & Barodi, Datia, to escape the water stress due to early withdrawal of monsoon, demonstrations were laid in farmer's fields with short duration varieties of black gram (IPU – 94-1), soybean (JS-95-60), groundnut (GG-20) and sesame (TKG-306) during kharif 2015-16 season. Short duration varieties of these crops escaped early drought and early withdrawal of monsoon and performed better over existing varieties due to early maturity and efficient rainwater use. (Table 32).

**Table 32. Performance of short duration crop varieties in Datia, MP**

Crop	Variety	Yield (q/ha)		Additional Yield (Kg/ha)	Maturity days		
		Demo	Local check		Improved Variety	Local Variety	Decrease days in maturity
Black Gram	IPU – 94-1	5.04	3.50	1.54	70	85	15
Soybean	JS-95-60	9.50	7.12	4.61	85	105	20
Sesame	TKG- 306	4.65	2.55	2.11	78	95	17
Groundnut	GG-20	12.51	8.50	4.01	122	138	16

In village Sonara & Barodi, Datia during rabi season early maturing variety RVM-2 of mustard was demonstrated in farmers field to escape the frost and aphid attack at grain formation stage. This variety produced 18.12 q/ha, 22.59 % more yield than the farmers practice (14.78 q/ha).



**Demonstration of short duration crop varieties at Datia, MP**

Choukhada village of Chhattarpur district under Bundelkhand agroclimatic zone, short duration varieties of crop like sesame (TKG-55) and black gram (Azad-1) were demonstrated in 24 farmers fields in 9.6 ha area to meet the challenge from the water stress condition. It was observed that sesame and blackgram proved economically superior over soybean. These crops had least insect/disease incidence as compared to soybean resulting in low cost of cultivation and higher income (Table 33).

**Table 33. Performance short duration crop varieties in Chhattarpur, MP**

Technology demonstrated	No. of farmers	Area (ha)	Yield (q/ha)		Economics of demonstration (Rs./ha)				Economics of Local (Rs./ha)			
			IP	FP	Gross Cost	Gross Return	Net Return	BCR	Gross Cost	Gross Return	Net Return	BCR
Sesame (TKG-55)	18	7.2	3.8	3.0	12322	38000	25678	3.08	11822	30000	18178	2.53
Black gram (Azad-1)	06	2.4	9.3	6.8	15880	74400	58520	4.68	14378	54400	40022	3.78

In village Heeranar, Dantewada district, delayed onset of monsoon and deficit rainfall situations are common. Demonstration of drought tolerant variety Indira Barani Dhan-1 of rice was demonstrated with four farmers in 10 ha area during 2015-16. The variety performed well under drought situation and increase in yield was to the extent of 35.21% over local variety (21.3 q/ha).

During the year 2015, in Badmal village, Sonepur delayed onset of monsoon was experienced along with scanty rainfall. Keeping the situation in view, short duration paddy variety Jogesh was demonstrated in 10 ha area involving 25 farmers, this resulted in yield increase up to 31% over farmers practice (21 q/ha).

The village Bhoimunda in Jharsuguda is drought prone and needs suitable short duration varieties tolerant to drought. Therefore, short duration paddy variety- Sahabhagi Dhan was introduced for higher yield and drought tolerance. The increase in net returns was to the extent of 50% (Table 34).

**Table 34. Yield of improved paddy variety against farmers' practice in Jharsuguda, Odisha**

Treatment	Yield (q/ha)	% increase in yield	Area (ha)	Net Return (Rs/ha)	B:C Ratio
FP	24.0	-	0.4	12800	1.80
IP	31.0	29.17	4.0	19200	2.06



**Short duration drought tolerant paddy variety Sahabhagi Dhan at Jharsuguda, Odisha**

Sodicity is a major challenge for rice production in the country. District Kaushambi, Uttar Pradesh has nearly 14000 ha area under sodic soil. The pH ranges from 8.8 to 9.2 and only rice can be crop grown with very low productivity (29.3 q/ha). Proper management can play a significant role in harnessing the potential of these soils. Reclaiming such salt affected soils by chemical amendments and drainage is one option but it involves higher cost and beyond the access of small farmer. Demonstration of salt tolerant variety (CSR-36) was taken up which can grow upto 9 pH. The yield observed was 43.50q/ha in comparisoion to farmer’s practice (34.26q/ha) of growing NDR-359.

In Dunda village in Uttarkashi district of Uttarakhand since 2011, considering the lack of irrigation facilities and uneven rainfall in the area the drought tolerant pigeonpea variety (V L Arhar -1) was promoted since *kharif* 2011. Results of different years are given below (Table 35 & 36).

**Table 35. Performance of the V L Arhar -1 over local cultivars in Uttarkashi, Uttarakhand**

Season/year	No. of farmers	Area (ha)	Average Yield (q/ha)		increase in yield (%)
			IP	FP	
Kharif-2011	67	2.7	14.5	9.0	32.4
Kharif-2012	81	4.0	15.2	10.0	34.2
Kharif-2013	70	5.0	15.35	9.30	39.4
Kharif-2014	75	7.0	16.58	11.00	33.7
Kharif-2015	75	7.0	18.50	9.75	47.2

**Table 36. Year wise economic analysis of the improved variety in comparison with traditional variety in Uttarkashi, Uttarakhand**

Year	IP (Rs/ha)				FP (Rs/ha)			
	GC	GR	NR	BCR	GC	GR	NR	BCR
2011	18500	84100	65600	4.54	15200	52200	37000	3.43
2012	14500	91200	76700	6.28	13800	60000	46200	4.34
2013	17800	92100	74300	5.17	16500	55800	39300	3.38
2014	19800	99480	79680	5.02	17200	66000	48800	3.83
2015	18500	84100	65600	4.54	15200	52200	37000	3.43

Farmers of Khagribari village, Coochbehar, generally sow long duration paddy varieties like MTU-7029 and masuri of duration 140 days, which are affected by terminal moisture stress. Demonstration of short duration paddy variety of GB-1 (115-120 days) in kharif season in 9 ha area covering 63 farmers resulted in increased yield of 41 q/ha as compared to farmer practice (30 q/ha) with B:C ratio of 1.98.

Sakrorha village of Jehanabad district experiences drought situation growing *kharif* and paddy varieties like MTU-7029, BPT-5204 having a duration of 100-120 days are not suitable for delayed sowing conditions. Demonstrations of short duration varieties of paddy like, Abhishek, Samrat and Prabhat (90-95 days duration) were taken up in 31 farmers in 31.25 acres of the village which resulted in realising B C ratio of 2.14 as compared to 1.73 of farmers.



**Short duration paddy variety Samrat and Abhishek at Jehanabad, Bihar**

Farmers of Sadanandpur village, Supaul district transplant even 2-month-old paddy seedlings because of delay in rain, which affect the yield significantly. To minimize the impact and to stabilize the productivity even under sub optimal rainfall conditions, short

duration variety of paddy (prabhat) was demonstrated in 2 ha area covering 12 farmers which improved the yield up to 18%.

In village Belwa & Gunghara, Godda district demonstration of short duration paddy variety Heera (duration 75 days) and Sahbhagi (duration 120 days) in 10.5 ha area covering 94 farmers were taken up. The yield of the variety of Heera and Sahbhagi increased by 21% and 17% over the local.



**Short duration paddy variety Sahabhagi and Heera at Godda, Jharkhand**

The NICRA village Chhachhamau of district Pratapgarh is salt affected village. The major problem of the village is high pH. Considering the fact, demonstration of salt tolerant variety of paddy (CSR-36) was conducted in 20.23 ha area with 70 farmers. The results showed that the yield of CSR-36 was 26.6% higher than the existing variety i.e. MTU – 7029 (27.6 qt/ha MTU and 35.5 qt/ha CSR – 36). To overcome the vulnerability of sodicity in village of Chhachhamau, Pratapgarh, demonstration of wheat var. KRL-210 under salt affected condition was taken up in 5 ha area benefitting 26 farmers. The yield increased by 16.6% over the farmers' practice



**Salt tolerant paddy variety CSR-36 at Pratapgarh, UP**

In Sipni village of Tirap district, demonstration of high yielding drought tolerant summer rice variety dehanghi, which is medium in duration (115 days) with 128 cm height having medium bold grain type with yield potential of 33 qt/ha was taken up. The variety is resistant to blast and moderately resistant to stem borer, case worm and leaf folder and tolerant to medium drought. The variety is sown in line by dibbling method during mid - April. The performance of the variety was very satisfactory and out of total 35 ha under summer rice cultivation, the variety was cultivated in 21 ha areas in the NICRA village (Table 37).

**Table 37. Economic analysis of improved variety with local practice in Tirap, Arunachal Pradesh**

Name of the interventions	Area (ha)	No. of farmers	Yield (q/ha)	Gross cost (Rs/ha)	Gross income (Rs./ha)	Net income (Rs/ha)	B:C ratio
Drought tolerant summer rice variety : Dehanghi	2	10	27.68	14,193	26,209	12,061	1.85
Local check	-	-	18.20	12,780	16,985	4,205	1.32

Paddy is the major crop in the Hnahthial village of Lunglei district. Almost 45% area of the village couldnot be cultivated due to moisture stress or late onset of monsoon. Demonstrations of short duration variety of paddy (CAU-R1) through SRI method were taken up in 10 farmer's field in 8.5 ha area. Besides increase in production, were happy with saving of water and weed control through cono weeder practice. The yield obtained was 38.2 q/ha with net returns of Rs.57625/ha.



**Drought tolerant summer rice variety (Dehanghi) at Tirap, Arunachal Pradesh**



**Short duration variety of paddy (CAU-R1) at Lunglei, Mizoram**

Cultivation of local varieties of paddy don't permit timely land preparation and sowing of *rabi* crops in time NICRA village N.Vanlaiphai, Serchhip in Mizoram due to which the fields remain fallow after the harvesting of paddy. Introduction of medium duration HYV of paddy (CAU-R 1) was taken up and cultivated by four farmers in 1.6 ha area (Table 38).

**Table 38. Performance of medium duration paddy variety in Serchhip, Mizoram**

Crop variety	CAU-R1	Local
Yield (t/ha)	3.0	2.0
Net returns (Rs.)	49,050	26,550
BC Ratio	2.89	2.02

In Sangti village of West Kameng, maize is usually cultivated during the 1<sup>st</sup> week to 15<sup>th</sup> May with local variety, which was low in yield and of long duration under rainfed condition. In order to escape the terminal drought situation, a maize variety RCM-76 was demonstrated in five farmers' fields covering 2 ha area. This variety gave yield of 51q/ha as compared to local (38q/ha).



**Drought tolerant maize variety (RCM-76) at West Kameng, Arunachal Pradesh**

In the NICRA village of Salchapra, Cachar district, balckgram variety IPU 2-43 was demonstrated in 2.6 ha of land covering eight farmers. The yield observed was 6.5q/ha as compared to local (6.0q/ha).

In Aliba village of Mokokchung district, farmers usually cultivate local varieties which don't give good yield and results in low returns. Therefore, HQPM-1 was promoted with an objective to increase maize production with high protein as it is an important component in livestock and poultry feeds. During 2015-16, five farmers covering an area of 1.5 hectares raised the variety and an yield of 40.5 q/ha obtained as compared to 32.45 q/ha from local variety (Table 39).

**Table 39. Performance of maize variety in Mokokchung, Nagaland**

No. of farmers	Area (ha)	yield (q/ha)		% increase in yield	Economics of IP (Rs./ha)			
		IP	FP		Gross Cost	Gross Return	Net Return	BCR
5	1.5	40.5	32.45	21.08	22500	60750	38250	2.7
					Economics of FP (Rs./ha)			
					18000	38940	20940	2.16

Drought tolerant paddy variety sahbhagi dhan was demonstrated in village of Port Mout, Port Blair in an area of 0.4 ha which commonly experiences drought at grain filling stage. Higher grain yield of 54.3 q/ha was recorded in sahbhagi variety, which was about 30.8 % higher over farmers' practice.

**Table 40. Performance of short duration varieties across different districts**

Crop	Variety	No. of farmers	Area (ha)	Demo yield (q/ha)	Farmer practice (q/ha)	B:C ratio	District
Paddy	Pusa basmati-1121	24	9.6	34.2	32.5	1.6	Fatehgarh sahib
	Pusa basmati-1121	6	4.0	50.8	48.2	2.0	Bathinda
	Pusa basmati-1121	10	48.6	46.4	44.7	2.2	Faridkot
	PR-124	4	1.6	73.3	72.7	3.1	Faridkot
	Pusa basmati-1121	24	9.6	34.2	32.5	1.6	Fatehgarh Sahib
	NDR-97	15	2.5	30.0	20.0	1.9	Kathua
	Pusa-1509	15	6.0	47.4	50.2	1.9	Yamunanagar
	Sahbhagi	32	5.0	38.1	32.6	1.4	Aurangabad
	Abhishek	25	12.0	28.0	22.0	2.4	Chatra
	GB-1	63	8.66	41.0	30.0	1.9	Coochbehar
	Naveen	12	3.0	32.0	19.5	1.5	East Singhbhum
	Sahbhagi	47	4.8	45	38.5	1.6	Godda
	Anjali	4	0.5	30.6	23.8	1.7	Gumla
	Abhishek	3	0.2	40.9	32.8	2.1	Jehanabad
	Susk samarat	3	0.2	38.5	32.8	2.0	Jehanabad
	Prabhat	25	12.0	34.5	32.8	1.8	Jehanabad
	Komal	18	10.0	37.2	32.8	1.9	Jehanabad
	Chandan	22	10.0	37.0	32.8	1.9	Jehanabad
	Anjali	22	3.0	26.5	18.7	2.4	Koderma

Crop	Variety	No. of farmers	Area (ha)	Demo yield (q/ha)	Farmer practice (q/ha)	B:C ratio	District
	CR Dhan 40	23	3.0	26.8	18.8	2.4	Koderma
	Prabhat	122	32.0	32.0	22.4	1.4	Saran
	Prabhat	12	2.0	26.0	22.0	1.6	Supaul
	CAU R3	4	1.0	52.7	47.7	1.4	Imphal East
	Sahbhagi	30	8.09	31.3	27.6	2.1	Pratapgarh
	HUR-3020	10	4.0	44.2	35.2	3.2	Sonbhadra
	Jogesh	16	04	30.8	22.8	1.8	Sonepur
Wheat	HD-3086	10	4.0	48.5	46.2	2.3	Faridkot
	Samrat	25	3.0	12.0	7.6	2.0	East Singhbhum
	PBW-677	10	4.0	47.3	45.7	2.3	Faridkot
	HD-2967	10	4.0	47.2	45.4	2.4	Faridkot
	WR 544	2	1.0	36.6	31.5	1.9	Buxar
	DBW17	2	1.0	35.0	31.5	1.9	Buxar
	HD 2967	52	10	34.2	31.5	2.0	Jehnabad
	PBW 373	16	4.0	33.8	31.5	1.9	Bharatpur
	RVW-4106	10	25	48.0	-	2.3	Morena
	HI 8663	7	2.8	18.4	12.7	1.2	Jhabua
	HI 1544	30	12.0	44.3	34.1	3.0	Guna
Maize	SCMH - 411	25	4.0	72.0	45.0	2.4	Godda
	HQPM - 1	47	3.5	62.0	37.0	2.2	Godda
	HQPM-1	2	0.5	33.3	26.0	1.8	Gumla
	PMH-1	2	0.5	32.9	26.2	1.8	Gumla
	Kanchan	4	0.5	33.7	23.8	1.8	Gumla
	Shourya	54	4.0	43.6	17.2	3.1	Nawada
	HQPM-1	05	1.5	40.5	32.4	2.7	Mokokchung
	HQPM-5	05	02	18.5	14.0	2.5	Mon
	GM-6	10	4.0	17.3	15.2	1.7	Nandurbar
Chickpea	GNG 1581	14	4.0	22.1	16.0	3.5	Jehanabad
	Jaki - 9218	95	14.0	17.2	10.5	5.4	Palamu
	K.W.R.-108	25	5.0	7.25	6.20	1.3	Jhansi
	RSG-963	15	3.0	14.8	12.6	3.8	Sonbhadra
	J G 11	20	1.0	18.2	10.2	2.7	Uttarkashi
	Jaki-92-18	25	10.0	20.0	16.0	2.9	Amravati

Crop	Variety	No. of farmers	Area (ha)	Demo yield (q/ha)	Farmer practice (q/ha)	B:C ratio	District
Mustard	Laxmi gold	32	8.0	15.4	11.6	3.0	Jehnabad
	Pusa Mahak	65	11	8.2	5.1	6.6	Palamu
	Rohini	10	2.0	10.2	9.6	2.9	Jhansi
	NRCHB-101	112	45	18	15.5	2.8	Bharatpur
	Rohani	30	20	12.3	16.94	3.1	Tikamgarh
	RVM-2	15	3.60	18.1	14.78	3.3	Datia
Soybean	JS-335	3	1	14.9	10.20	1.9	Mon
	JS-9305	50	20	21.1	12.56	2.4	Amaravati
	JS 9305	10	4.0	13.3	9.58	2.8	Jabhua
	Ganga-8	2	0.8	7.4	5.5	5.7	Ratlam
Blackgram	KU-301	5	0.5	7.4	-	2.0	Ri -Bhoi
	TAU-2	08	2.5	8.2	5.10	2.6	Dantewada
	PU-35	10	25	8.0	-	3.4	Morena
	JU 86	08	3.2	3.4	2.2	2.8	Jhabua
	RBV-38	6	2.4	6.2	4.8	4.0	Ratlam
	Prasad	14	04	4.1	5.2	2.1	Ganjam
	Prasad	16	08	5.6	4.6	2.1	Sonepur
	VBN.6	30	6.0	8.5	7.20	2.9	Namakkal
	MDU 1	22	4.5	8.0	6.5	1.8	Villupuram
Pigeonpea	V. Pusa 992	10	01	9.62	6.02	2.4	Tirap
	PRG-158	15	10	45	41	3.0	Anantapur
	ICPL 88039	10	25	18.0	-	4.8	Morena
	TS3R	10	4.0	4.8	4.0	2.6	Gulbarga
	BRG-2	50	6.0	11.9	9.5	2.1	Tumakuru
	BRG-4	12	5.0	12.1	9.8	2.1	Tumakuru
Greengram	WGG-42	25	10	5.3	4.3	3.5	Nalgonda
	PKVM-4	14	6.0	5.8	4.2	2.4	Nandurbar
	GM-4	13	5.7	8.3	6.7	3.2	Kutch
	GG-5	12	5.0	12.7	11.3	1.8	Rajkot
	TARM-1	13	5.0	5.1	7.4	2.3	Ganjam
	TARM-1	22	8.0	7.2	5.4	2.4	Sonepur
	Co.8	22	5.0	8.2	7.3	2.3	Namakkal
	Co 8	57	11.4	6.7	5.7	1.7	Villupuram

Crop	Variety	No. of farmers	Area (ha)	Demo yield (q/ha)	Farmer practice (q/ha)	B:C ratio	District
Groundnut	TM 37	30	4.0	10.2	8.6	6.9	Guna
Summer moong	SML-668	16	5.0	8.7	7.9	1.7	Faridkot
	PDM-139	10	2.5	5.8	4.3	1.4	Hamirpur
	S.M.L-668	16	6.4	1.7	1.1	1.2	Jhansi
	SML-668	6	3.0	6.7	4.2	2.7	Dantewada
Finger Millet	Birsa Niger-3	8	3.0	3.5	2.6	1.5	Gumla
Lentil	KLS 218	38	14.0	13.4	11.2	3.1	Jehanabad
Cotton	Ajit 155	25	10	13.5	7.7	2.1	Amravati
Safflower	PBNS-12	10	4.0	8.5	6.0	1.3	Aurangabad

**Table 41. Performance of drought tolerant varieties across different districts**

Crop	Variety	No. of farmers	Area (ha)	Demo yield (q/ha)	Farmer practice (q/ha)	B:C ratio	District
Paddy	Shusk samrat	10	2	35.4	30.7	1.41	Aurangabad
	Naveen	2	2.5	42.2	36.0	1.7	Buxar
	Sahbhagi	9	3.17	46.0	36.0	1.8	Buxar
	Sahabhagi	12	3.5	30.5	19.5	1.4	East Singhbhum
	Sahabhagi	38	42.0	41.8	32.8	2.1	Jehanabad
	Prabhat	12	20.5	33.2	32.8	1.9	Jehanabad
	Sahbhagi	31	11.0	29.5	20.6	2.5	Koderma
	Abhishek	17	10.0	34.8	26.5	2.9	Koderma
	Sahbhagi	38	5.0	36.0	30.6	1.6	Saran
	Sahbhagi	38	10.0	33.0	25.0	1.8	Supaul
	SARS-2	4	1.0	26.0	16.0	1.9	Mon
	Dehangi	10	2.0	27.7	18.2	1.9	Tirap
	Sahbhagi	26	10.0	44.1	40.2	2.5	Kaushambi
	Vivek dhan-154	50	1.0	26.0	20.5	1.3	Uttarakashi
	Sahbhagi	10	2.0	30.2	23.5	2.0	Dantewada
	Indira Barani Dhan-1	9	3.5	29.5	24.5	2.8	Dantewada
	MTU-1010	10	4.0	58.5	39.6	3.3	Balaghat
	Sahabhagi dhan	18	6.0	22.3	26.8	2.1	Ganjam
	Sahabhagi dhan	29	4.0	31.0	24.0	2.0	Jharsuguda

Crop	Variety	No. of farmers	Area (ha)	Demo yield (q/ha)	Farmer practice (q/ha)	B:C ratio	District
	Sahabhazi dhan	32	10.0	32.40	22.8	1.8	Sonepur
	MAS-26	5	10.0	32.0	26.0	2.0	Tumakuru
	ANNA (R) 4	10	4.0	32.5	37.9	1.1	Ramanathapuram
Finger millet	Ragi 404	18	4.0	12.0	7.0	2.1	Chatra
	Ragi 404	72	10	25.0	16.0	4.3	Palamu
	PRM-1	55	5.5	10.2	8.5	1.8	Tehri Gharwal
	Suryanandi	55	22.0	24.8	5.1	3.4	Kurnool
	Indira Ragi-1	7	2.0	13.4	8.6	2.1	Dantewada
	ML-365	20	8.0	24.5	19.5	2.0	Davanagere
	ML-365	35	14.0	21.7	15.6	2.0	Chickballapur
	ML-365	70	25.0	27.2	19.3	1.8	Tumakuru
	GPU-28	8	16.0	24.5	19.0	1.6	Tumakuru
	Co 15	25	5.0	18.5	13.9	2.8	Villupuram
	Pigeonpea	Narendra arher -1			11.9	8.80	2.5
Bahar		30	2.5	11.4	8.6	4.7	Koderma
Var.MAL13		52	10.0	18.4	12.2	6.1	Nawada
NA- 1		80	10.0	18.0	11.5	4.4	Palamu
VL Arhar -1		75	7.0	19.0	10.0	4.5	Uttarkashi
BDN- 711		20	8.0	9.0	7.5	2.9	Aurangabad
BDN- 711		20	8.0	10.2	9.5	4.3	Jalna
ICPL-87119		50	20.0	10.2	7.7	3.7	Kurnool
PRG-176		30	12.0	12.3	8.7	3.4	Nalgonda
TJT-501		10	1.0	14.2	9.4	3.9	Dantewada
JKM 189		10	4.0	11.1	7.8	3.9	Jhabua
BRG-5		15	6.0	13.6	10.7	3.7	Chikkballapur
Maize	Birsa Makka-1	31	1.5	37.4	29.4	2.3	Koderma
	Mukta	5	2.0	39.4	35.5	2.8	Kota
	JM-216	5	1.0	44.5	38.9	2.8	Balaghat
Green Gram	Pusa Vishal	06	0.32	10.6	7.40	4.2	Koderma
	GNG469	38	5.0	16.5	12.2	4.4	Nawada
	PDM-139	30	5.9	7.6	6.0	2.2	Chitrakoot
	BM-2003-2	20	8.0	8.0	6.0	2.5	Aurangabad
	RMG-344	10	4.0	6.1	5.5	3.3	Jhunjhunu

Crop	Variety	No. of farmers	Area (ha)	Demo yield (q/ha)	Farmer practice (q/ha)	B:C ratio	District
Black gram	GM-4	50	20	6.35	4.62	3.80	Barmer
	TJM-3	10	25.0	8.1	6.0	3.34	Morena
	PU-31	24	1.7	9.5	6.8	3.7	Koderma
	Azad-3	13	5.0	8.1	7.1	2.8	Bahraich
	Pant Urd-35	20	1.0	12.5	8.1	3.0	Uttarkashi
	PU-31	20	4.0	8.6	5.9	3.5	Kota
	Shekhar-2	07	1.6	5.0	3.5	1.5	Datia
	Shekhar 2	47	18.8	10.0	5.8	3.2	Guna
Chick pea	KPJ-59	16	1.3	18.5	13.7	2.9	Koderma
	JG-11	5	2.0	14.8	11.2	3.4	Balaghat
	JG 130	30	12.0	16.7	14.2	2.5	Guna
Mustard	Pusa Bold	41	8.3	11.0	7.80	2.5	Koderma
	NRCHB-101	40	20.0	17.8	15.6	3.2	Kota
	NRCDR-2	5	2.0	12.7	7.6	1.8	Balaghat
	Pusa Tarak	51	12	13.4	9.2	3.1	Satna
Foxtail millet	Meera	7	3.0	5.3	4.9	1.5	Mon
	DHFt-109-3	5	2.0	16.8	13.5	1.8	Gadag
Pearl millet	HHB-67	100	40.0	6.5	4.5	1.6	Jodhpur
	MPMH-17	50	20.0	12.2	7.8	2.5	Barmer
Groundnut	ICGS-76	15	4	24.8	18.8	1.8	Ukhrul
	Dharani (TCGS-1043)	8	20	15.0	27.5	3.4	Anantapur
	GG-9	5	2	23.3	19.5	3.0	Amreli
	GM-4	05	2.0	12.5	10.0	5.7	Banaskantha
	CO.6	12	3.0	18.5	14.5	2.9	Namakkal
	TMV 13	5	2.0	13.0	9.7	2.8	Villupuram
sesame	Pragati	49	14.9	3.6	3.0	1.5	Chitrakoot
	RT-346	20	5.0	3.7	2.8	2.5	Kota
	JTS-21	25	5.0	3.5	1.8	1.2	Satna
	TKG 308	10	5.0	6.7	8.1	8.1	Tikamgarh
	TKG-306	7	1.0	4.6	2.5	1.4	Datia
Soybean	PS-1225	106	5.0	6.2	5.8	1.1	Tehri Gharwal
	MAUS-71	20	8.0	9.0	7.0	1.5	Aurangabad

Crop	Variety	No. of farmers	Area (ha)	Demo yield (q/ha)	Farmer practice (q/ha)	B:C ratio	District
Wheat	JS-9560	10	25	14.6	-	2.0	Morena
	JS-9560	9	3.60	10.7	7.6	2.2	Datia
	JS 9560	10	4.0	13.8	9.5	2.8	Jabhua
	JS-9560	6	2.4	13.8	-	2.9	Ratlam
	JS 95-60	30	12.0	10.0	6.4	1.9	Guna
	V L 907	50	5.0	22.5	16.3	2.0	Uttarakashi
	Netravati	5	2.0	8.0	6.5	1.1	Aurangabad
	RAJ-4120	109	17	38	31	1.5	Bharatpur
	Ratan	03	1.2	22.7	20.2	3.0	Bhatapara
Sorghum	RVW-4106	10	4.0	40.3	31.9	1.6	Datia
	Parbhani Moti	35	14	14.0	12.0	1.2	Aurangabad
	Phule Anuradha	25	10.0	11.2	7.6	2.6	Baramati
	Phule Vasudha	20	8.0	13.6	10.5	2.4	Baramati
Barley	Parbhani Moti	50	20.0	15.6	10.4	1.4	Jalna
	RD -2592	51	9.6	41.0	33.0	1.5	Bharatpur
Cluster bean	RGC-1066	15	6.0	6.53	5.72	1.0	Jhunjhunu
	RGC-1017	50	20.0	6.17	4.56	1.3	Barmer
Mothbean	CZM-2	25	10.0	4.25	3.00	2.4	Jodhpur
	RMO-435	50	20.0	5.50	3.70	3.1	Barmer
Castor	GCH-2	25	10.0	30.2	25.3	4.0	Kutch

### Flood Tolerant Varieties

In Sirusuwada NICRA village of Srikakulam district in Andhra Pradesh, paddy is the main crop and farmers are growing varieties like BPT 5204 (Samba mashuri), MTU 7029 (Swarna), MTU 1001 (Vijetha) which are susceptible to flood situation though having high yield potential and market demand in the district. Hence, the flood tolerant paddy varieties like PLA 1100 (Badava Mashuri), RGL 2537 (Srikakulam sannalu), MTU 1061 (Indra) and MTU 1064 (Amara) were introduced and demonstrations were conducted in farmers' fields (Table 42).

**Table 42. Performance of flood tolerance paddy varieties in Srikakulam, AP**

Practice	IP				FP
Paddy variety	MTU-1064	RGL 2537	PLA-1100	MTU-1061	MTU-7029
Yield (q/ha)	52.4	50.5	50.4	49.3	47.6



**Performance of flood tolerant paddy variety during high inundation at Srikakulam, AP**

During *kharif* 2015 heavy rains were received during the cyclonic period in November 2015 (111.2 mm) in four days (17-11-2015 to 20-11-2015) and the paddy was lodged in 440 ha area in Matsypuri village, West Godavari. In submerged areas, lodging tolerant varieties like MTU-1064 and MTU-1061 were partially lodged whereas swarna (MTU-7029) was completely lodged. It was observed that the yield increase was 39% in MTU 1061 and 31% in MTU 1064 compared to MTU 7029 (Table 43).

**Table 43. The yield and economics of flood tolerant paddy cultivars in West Godavari, AP during *kharif* 2015**

Treatments	Variety	Yield (kg/ha)	Cost of cultivation (Rs/ha)	Gross income (Rs/ha)	Net income (Rs/ha)	B:C ratio
Farmers practice	MTU 7029	4688	47550	63750	16200	0.25
Improved Technology	MTU 1061	6563	43950	91000	47050	1.93
	MTU 1064	6188	41458	84150	42692	1.97



**Damage due to lodging and flood tolerant paddy variety MTU 1061 in West Godavari, AP**

In village Khuntli, Valsad, water logging tolerant variety of paddy GAR-13 and MTU-1010 were demonstrated, which are high yielding, short duration, and tolerant to water logging conditions in 100 farmers field in 20 ha area. An additional net profit to the tune

of Rs.18900/ha was realized by the farmers under waterlogged conditions. About 126 farmers of 17 villages covered under water logging tolerant cultivars during kharif season.

In Kasotibali village of Kendrapara district, flash floods are common and highly unpredictable. Demonstration of flood tolerant variety of paddy swarna-sub1 in 10 ha area covering 20 farmers was taken up. The variety survives complete submergence up to 14 days. The yield of swarna sub-1 recorded was 44 q/ha as compared to local (40 q/ha) (Table 44).

**Table 44. Performance of Swarna Sub-1 in comparison to farmer practice in Kendrapara, Odisha**

Treatments	Crop	Variety	Seed yield (kg/ha)	Gross cost (Rs./ha)	Gross returns (Rs./ha)	Net returns (Rs./ha)	Benefit cost ratio
Demo	Paddy	Swarna Sub-1	4400	32000	68200	36200	2.13
Farmers practice	Paddy	Swarna	4020	20000	40200	20200	2.01

Demonstrated flood tolerant variety CR 1009 Sub 1 in an area of 100 acres in NICRA village of Rayapuram of Thiruvarur district. CR 1009 Sub 1 is an improved version of CR 1009 with *Sub 1* gene conferring submergence tolerance at seedling level for 15 days immediately after transplantation. CR 1009 sub 1 is a short bold rice with high milling percentage and head rice recovery suitable for idly making. This variety is recommended as an alternate to CR 1009. CR 1009 sub-1 has recorded an average yield of 5427 kg/ha even after 19 days of submergence during November 2015 and December 2015. The yield was 14.4% high over other local varieties. The department of Agriculture, Thiruvarur procured 1.5 tonnes of CR 1009 sub 1 seeds from the NICRA village Rayapuram. The farmers could earn at least Rs.5000- 6000 more by switching over to CR 1009 Sub-1 cultivation of rice compared to conventional CR 1009.



**Flood tolerant paddy variety CR 1009 during different crop stages at Thiruvarur, TN**

In village Salchapra of Cachar, recurrent flood is common. Introduced short duration (90 days) paddy variety, dishang that helped the farmers to tackle the flood problem and can be grown in all the three seasons. The variety was demonstrated in 8.0 ha area covering 28 farmers as post flood sali paddy during 2015-16. The yield obtained was 21q/ha compared to farmer's practice 16 q/ha.

In Udmari village of Dhubri, rice is the main crop in *kharif* season. Farmers in NICRA village are unable to cultivate winter rice (*Sali*) in time due to floods and mainly adopt traditional late *Sali* varieties resulting in low yield. Demonstration of submergence tolerant rice variety Swarna sub-1 in 13 farmers' field in four ha area during 2015-16 was very successful as it withstood flood situation for 11-15 days. The variety showed 46% yield increase over traditional variety. Many farmers of the village adopted the technology, after seeing the results of the variety in fellow farmer's field affected by flood (Table 45).

**Table 45. Impact and economics of submergence tolerant rice variety in Dhubri, Assam**

Variety	No. of farmers	Area (ha)	Yield (q/ha)	Gross cost (Rs/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	B:C
Swarna sub-1	13	4	38.60	20,535	38,607	18,072	1.90
Traditional variety	13	4	26.54	18342	26,538	8,196	1.44



**Short duration paddy variety Dishang at Cachar, Assam**



**Flood tolerant paddy variety swarna sub-1 at Dhubri, Assam**

In village Phutahola, Dibrugarh, demonstration of submergence tolerant winter rice variety Jalashree and Jalkunwari was taken up in 4.0 ha covering 13 farmers. The first submergence occurred from 12-14<sup>th</sup> June 2015 while the variety was in nursery bed and second submergence occurred from 2-9<sup>th</sup> September 2015 in main field. Jalshree yielded 46q/ha and Jalkunwari 49 q/ha even after seven days of submergence.



**Submergence tolerance paddy variety Jalashree and Jalkuwari at Dibrugarh, Assam**

In village Punioni-baghchong, Sonitpur during the peak rainy seasons of (June to July) the paddy field remains submerged for long duration which often creates problem in transplanting the seedlings of appropriate age i.e., 20 to 30 days. Demonstration of Gitesh, high yielding paddy variety was taken up in 2 farmer's field in 1 ha area. Transplanting of this variety can be done within the seedling age of 30 to 60 days and there is no yield loss in transplanting of old seedlings. The variety matures within 155 to 160 days and yields around 50 to 55 q/ha. The technology was first introduced in the field of six farmers and the number of farmers increased to 40 after observing the successful performance of the technology and got spread to nearby villages.

**Table 46. Performance of flood tolerant varieties of paddy in different districts**

Variety	No. of farmers	Area (ha)	Yield (q/ha) demo	Yield (q/ha) farmers practice	B.C ratio	District
Gitesh	10	4.0	40.0	28.2	1.8	Dhubri
Swarna sub-1	13	4.0	38.6	26.5	1.9	Dhubri
Sahyadri-3	26	4.0	45.5	26.7	1.5	Ratnagiri
Karjat-8	50	11.0	33.7	26.7	1.3	Ratnagiri
MTU-1061	15	6.0	65.6	52.4	1.9	West Godavari
MTU-1064	15	6.0	59.0	52.4	2.4	West Godavari
RGL-2537	15	8.0	53.5	47.6	2.3	Srikakulam
Swarna sub-1	15	5.0	43	30	2.4	Supaul
Jalashree	13	4.0	45.7	36.0	2.8	Dibrugarh
Panindra	13	4.0	42.0	30.0	3.0	Dibrugarh
Gitesh	2	1.0	54.5	43.4	2.2	Sonitpur
Jalashree	2	1.0	39.2	21.6	1.6	Sonitpur
Padumoni	2	0.8	42.0	27.0	1.7	Sonitpur
Taothabi	01	0.5	51.6	-	1.8	Imphal East

Variety	No. of farmers	Area (ha)	Yield (q/ha) demo	Yield (q/ha) farmers practice	B.C ratio	District
Swarna sub-1	22	4.0	42.0	31.0	1.5	Dhalai
Swarna sub-1	75	30	33.0	28.0	1.6	Maharajganj
Swarna sub-1	16	4.0	39.1	42.3	2.4	Ganjam
Swarna sub-1	20	10	44.0	40.2	2.1	Kendrapara

### Resilient Intercropping Systems

To minimize the risk and to bring stability, intercropping systems were demonstrated, in Shekta village of Aurangabad, Maharashtra, intercropping systems viz., cotton + green gram (1:1) were taken up in 20 farmers on 8 ha area during *kharif* 2015. Intercropping system of cotton and greengram (1:1) gave net income of Rs.41464/ha compared to sole crop of cotton Rs.33580/ha. While cotton and black gram (1:1) recorded yield of 16 q/ha compared to sole crop of cotton 13.3 q/ha. Soybean + Pigeon pea (4:2) were sown during *kharif*, 2015 in 10 farmers' field on four ha area. Intercropping system of soybean & pigeonpea (4:2) gave additional net income of 6030 Rs/ha over the sole crop soybean (Table 47). The proven intercropping systems based on the experiences of NICRA are being scaled up by the KVK in the district through National Food Security Mission (NFSM), Rashtriya Krishi Vikas Yojana (RKVY), front line demonstrations, through state agricultural department SAO, Aurangabad and ADO, Zillah Parishad, Aurangabad implementing intercropping demonstrations 80,000 to 1 lakh ha area in Aurangabad district through continuous training and technology back upto given by KVK scientists.

**Table 47. Impact of intercropping system over sole cropping at Aurangabad, Maharashtra**

Treatments	Seed yield (kg/ha)	Cost of cultivation (Rs/ha)	Gross income (Rs/ha)	Net income (Rs/ha)	B:C ratio
Cotton sole	1378	33620	67200	33580	1:1.99
Cotton (1250kg) + Green gram (190kg)	1593	35000	76464	41464	1:2.18
Cotton sole	1330	33120	63840	30720	1:1.92
Cotton (1300kg)+	1600	34700	76800	42100	1:2.21
Sole crop soybean Black gram (170kg)	710	20350	28400	8050	1:1.39
Soybean (500kg) + pigeon pea(180kg)	882	21200	35280	14080	1:1.66

(Cotton: Rs 4100/q, Greengram : Rs 5100/q, Soybean : Rs3200/q, Pigeonpea : Rs.7000/q)

In Yagantipalle village of Kurnool, delayed onset of rains and prolonged dry spells during the crop period is very common in rainfed situation. Such situation results in economic losses to the farmers due to partial or total failure of sole crops. Demonstration of pigeonpea + setaria (1:5) intercropping system was taken up. Results indicated that the gross income of pigeonpea + setaria intercropping system were higher (Rs.57417/ha) than sole crop of setaria (Rs. 28942/ha). This practice has emerged as a promising drought coping strategy and resulted in higher yields per unit area and time (Table 48).

**Table 48. The yield and economics of pigeonpea (P) + setaria (S) intercropping systems during 2011-2016 at Kurnool, AP**

Treatments	Variety	Yield (kg/ha)	Cost of cultivation (Rs/ha)	Gross income (Rs/ha)	Net income (Rs/ha)	B:C ratio
2011-12						
Farmers practice	Sole crop	17.78	11972	22543	10571	1:1.8
Improved technology	P+S	16.50(S)	13987	27975	13988	1:2.0
		2.45 (P)				
2012-13						
Farmers practice	Sole crop	1462	15973	21936	5963	1:2.05
Improved technology	P+S	1386(S)	18570	33927	15357	1:174
		345(P)				
2013-14						
Farmers practice	Sole crop	2320	16075	27532	11457	1:2.13
Improved technology	P+S	2084(S)	18960	58650	39690	1:3.09
		815(P)				
2014-15						
Farmers practice	Sole crop	1700	16370	49700	33330	1:3.0
Improved technology	P+S	2073(S)	14350	63747	49397	1:4.4
		675(P)				
2015-16						
Farmers practice	Sole crop	2170	16290	45254	28942	1:2.77
Improved technology	P+S	2151(S)	21432	79123	57417	1:3.69
		401 ®				

In village Karjala, Amreli, demonstration of intercropping of sesame+ cotton (1:1) in five farmers' fields in two hectare area was taken up. Results showed 27.5% increase in yield over local variety (24.5 q/ha), more than 30 farmers have adopted this intercropping system in the village.



**Intercropping systems of setaria+ pigeonpea (5:1) at Kurnool, AP**



**Intercropping systems of sesame+ cotton (1:1) at Amreli, Gujarat**

In village Chomakot, Kota soybean is a major kharif crop. Demonstration of soybean with short duration variety (JS 95-60) intercropped with blackgram (PU-31) and maize (5:2 ratio) in 10 farmer's field in 4 ha area was taken up. The average yield obtained was 19.7 q/ha and 19.1 q/ha as compared to sole crop 15.25 q/ha. Additional income of Rs. 31654/ha was realized by both the intercropping system as compare to sole crop.

In NICRA village Bilakundi, Belagavi farmers were practicing only sole crop but after NICRA intervention, more number of farmers switched to the practice of intercropping to reduce the risk due to climate change (Table 49).

**Table 49. Performance of intercropping system in Belagavi district, Karnataka**

Inter cropping system	No. of farmers	Area (ha)	Yield (q/ha)		% increase in yield	NR		B.C ratio	
			IP	FP		IP	FP	IP	FP
Pigeonpea + Bajra	16	2.60	7.00	4.50	55.5	28250	17750	3.05	2.91
Pigeonpea +Foxtail millet	30	4.20	8.17	5.75	42.0	34800	24650	3.44	3.50
Foxtail millet +Bajra	07	1.63	12.23	7.50	63.0	20075	11450	2.91	2.56
Groundnut+Foxtail millet	10	2.00	8.10	6.79	19.3	25525	22550	2.70	2.97

Demonstration of intercropping system in S. Raghuttahalli village of Chikballpur with use of seed cum fertilizer drill for groundnut and redgram (10:2) and finger millet and redgram (10:2) were taken up. These interventions gave yield of 11.9 q/ha as compared to farmers' practice (9.92 q/ha) in groundnut and redgram intercropping while in finger millet and redgram system yield was also increased 68.11 q/ha over farmers' practice (61.5 q/ha).

The major crop of the village Siddanuru, Davanagere is maize and it covers nearly 70 percent of sown area in *kharif*. The sowing of maize got delayed by 15 days due to delay in monsoon. Drought tolerant redgram variety (BRG-2) seeds were provided as a critical input to the farmers. Demonstration of intercropping system with maize+redgram (BRG-2) in 6:1 ratio in 21.2 ha area covering 53 farmers' field was taken up. The farmers who had adopted the intercropping technology along with BRG-2 obtained good yield (62.37q/ha) as compared to sole crop maize (46.5 q/ha).



**Intercropping systems of groundnut + pigeonpea at Chikkaballapura, Karnataka**



**Intercropping systems of Maize + Pigeonpea at Davanagere, Karnataka**

**Table 50. Performance of intercropping systems in various districts**

Crop	No. of farmers	Area (ha)	Main Yield (q/ha)	Yield (q/ha) FP	B.C ratio	District
Maize + Pigeonpea (6:2)	2	2.0	73.8	62.4	2.0	Davanagere
Soybean + Pigeonpea (6:2)	50	20	21.1	12.5	2.0	Amravati
Foxtail millet +Bajra (4:4)	07	1.7	12.2	7.5	2.9	Belagavi
Pigeonpea + Bajra(1:2)	16	2.6	7.0	4.5	3.0	Belagavi
Pigeonpea +Foxtail millet (1:2)	30	4.2	8.1	5.7	3.4	Belagavi
Groundnut +Foxtail millet (4:2)	10	2.00	8.1	6.8	2.7	Belagavi
Soybean + Pigeonpea (4:2)	10	4.0	8.82	7.1	1.6	Aurangabad
Cotton +Green gram (1:1)	10	4.0	15.9	13.8	2.2	Aurangabad
Cotton +Black gram (1:1)	10	4.0	16.0	13.3	2.2	Aurangabad
Rabi sorghum +Safflower (6:3)	30	12.0	20.0	14.0	2.5	Aurangabad
Groundnut+ Pigeonpea (4:1)	1	0.4	16.5	15.4	2.1	Gumla
Maize+ Pigeonpea (6:2)	3	1.2	35.6	22.2	1.9	Gumla
Maize+ Pigeonpea (1:1)	3	1.2	35.6	22.2	1.9	Chatra
Pigeonpea+ Blackgram	10	1.0	16.9	8.6	3.3	Koderma
Wheat+ Mustard	15	8.0	43.1	31.9	2.0	Koderma
Pigeonpea+ Groundnut	20	1.0	15.0	9.9	3.6	Villupuram
Chick pea + Coriander	5	2.0	16.7	-	4.2	Balaghat

## Crop Diversification

In village Umarani of Nandurbar, farmers having irrigation facility generally cultivate wheat in *rabi* season. Low productivity of wheat is due to limited irrigation facility and light to medium soils. In the prevailing agro-climatic conditions demonstration of potato in eight farmers' fields in 0.8 ha area was taken up. Net income from potato cultivation was Rs.1,32,000/ha as compared to Rs.15770/ha from wheat cultivation. More number of farmers are now ready to cultivate potato instead of wheat.

In Nacharam village of Khammam district, farmers keep lands fallow after *kharif* paddy, which is the common practice in the village due to lack of assured water supply during *rabi*. Demonstration of sunhemp after *kharif* paddy under NICRA project was taken up in 16 ha area. Farmers got an average yield of 10 q/ha with net returns of Rs. 30,750/ha. Sunhemp is a leguminous crop used for fodder purpose. Sunhemp is drought tolerant and yields even under terminal drought conditions.



**Crop diversification towards potato cultivation at Nandurbar, MS**



**Crop diversification towards sunhemp cultivation at Khammam, TS**

In village Nandyalagudem, Nalgonda district, paddy was diversified into vegetables in 3.6 ha with 46 farmers and from paddy to Mulberry (var. S-32, a drought tolerant variety) covered 11.2 ha with 14 farmers. Per ha net returns of Rs. 247500 with ridge gourd, Rs. 192300 with tomato, Rs. 267000 with bitter gourd, Rs. 106750 with onion and Rs. 396000 with mulberry were obtained when compared to paddy where the highest net returns obtained was Rs.55000 per ha only (Table 51).

**Table 51. Impact of Vegetable cultivation in Nalgonda district, Telangana**

Crop	Yield (q/ha.)		Cost of Cultivation (Rs/ha)		Gross Income (Rs/ha)		BC Ratio	
	Demo	Check (Paddy)	Demo	Check	Demo	Check	Demo	Check
Ridge gourd	200	70	52500	60000	300000	115000	5.71	1.91
Tomato	500	65	57700	56000	250000	107500	4.33	1.91
Bitter gourd	160	62.5	53000	55000	320000	103750	6.03	1.88
Onion	180	60	37250	57000	106750	106000	3.86	1.85

In village Sanora, Datia crop diversification was done by high valued pigeonpea variety of ICPL-88039 to maximize the net return under rainfed farming system during kharif. Most of the farmers in this area sow black gram which has low return, instead of that short duration variety of pigeonpea was demonstrated in pigeon pea – wheat cropping pattern which was harvested in December first week and after that farmers could sow wheat crop in the same field. This pulse crop yielded 933 kg/ha, with net returns Rs. 40530/ha.

In village Bhoimunda, Jharsuguda farmers cultivate paddy in upland areas which give low returns and the hybrid maize variety 30R77 was introduced as an alternative to upland paddy. Now the area under hybrid maize has increased from 2 ha to 12 ha.



**Crop diversification towards hybrid maize cultivation at Jharsuguda, Odisha**



**Crop diversification towards pigeonpea (ICPL 88039) cultivation at Datia, MP**

## High value cash crop under protected cultivation

The Chhoel–Gadauri village of Kullu district experience low temperature and frost during Dec to Feb, which results into delayed nursery production of tomato under open conditions and causes heavy mortality of seedlings. This ultimately delays the transplanting which results into heavy crop loss due to heavy rainfall in July, high incidence of diseases and short duration of the cropping. To cope with the problem of low temperature, nursery raising in poly house was demonstrated in 13 farmer’s field during *kharif* 2015 for early transplanting of tomato. The transplanting could be advanced by almost one month and the duration of crop increased as compared to the late transplanting. Early transplanting of tomato crop in an area of 1.50 ha under irrigated condition resulted in higher yield (32961kg/ha) and net returns Rs. 294288/ha as compared to farmers’ practice (Table 52). Higher income was mainly due to early transplanting in the 2<sup>nd</sup> fortnight of March which could fetch in the market and the duration of harvesting was more as compared to late planting.

**Table 52. Performance of early transplanted tomato under irrigated condition in NICRA village in Himachal Pradesh**

Comparison of Treatments	Date of seed sowing	Date of Transplanting	Fruit yield (kg/ha)	Gross cost (Rs./ha)	Gross returns (Rs./ha)	Net returns (Rs./ha)	Benefit cost ratio
Demonstration	8 -10/2/2015	10 -16/3/2015	32961	101250	395538	294288	3.90
Farmers’ practice	17-20/2/2015	8-15/4/2015	25161	100550	201292	100742	2.00

In NICRA village Wakhawan, Phulwama district, farmers had lost whole of their crop due to floods. Demonstration of 10 poly houses covering 50 farmers cultivating off-season vegetables like cauliflower (var: Snow Ball-16), tomato (var: Shalimar-I) and Brinjal (var: Shalimar Brinjal hybrid-I) gave net returns of Rs. 70,000/ polyhouse. This intervention not only increased the production of vegetables in the area but also gave higher returns which was not possible earlier.

Polyhouse farming has significantly helped the farmers in reducing dependency on rainfall and efficient utilization of land and scarce water resources. In village Thipuzumi of Phek district, 10 numbers of low cost polyhouse each measuring 30×10ft was constructed using locally available low cost materials and polythene. Polythene was provided from the project fund however, other local materials were contributed by the farmers themselves. Tomato (variety ruby) was taken up in the polyhouse with support of micro irrigation system from nearby Jalkund. Average yield of tomato realized by the farmers was 118.6 q/ha with a net return of Rs. 2,66,520 and B: C ratio of 2.28 (Table 53). A total number of 30 polyhouses have been constructed in the village.

**Table 53. Impact and economics of protected cultivation in Phek district, Nagaland**

Technology demonstrate		No. of farmers	Area (ha)	Yield (q/ha)	% increase	Economics (Rs./ha)			
						Gross Cost	Gross Return	Net Return	BCR
Protected cultivation of Tomato variety Pusa Ruby	Demo	10	0.04	118.63	34.8	208000	474520	266520	2.28
	Local			88.0		201000	352000	151000	1.75



**Protected vegetable cultivation under polyhouse at Phek, Nagaland**

### Rainfed horticulture system

In Yagantipalli village of Banaganapalli mandal in an area of 10 acres, farmers used to irrigate the entire orchard by basin method of irrigation with field channels, which took 12 days to irrigate entire orchard. Drip irrigation was installed with double lateral having four drippers of eight lit/hour discharge on each side of the tree. After installation of drip irrigation, each mango tree received 300 liters of water every day, which is more than the peak requirement of mango tree (peak water requirement of mango tree 150 lit /day). The data clearly indicated that with drip irrigation gave higher fruit yield (12542 Kg/ha), which was 50% more than that of farmers practice (Table 54). The improved technologies resulted in increased income and higher cost benefit ratio.

**Table 54. Comparison of drip and basin irrigation systems for mango at Kurnool, AP**

Treatments	Yield (kg/ha)	Cost of cultivation (Rs/ha)	Gross income (Rs/ha)	Net income (Rs/ha)	B:C ratio
Basin method	8342	1,02,540	2,91,970	1,89,430	2.8
Drip irrigation	12542	95250	4,38,970	3,43,720	4.6

In village Amba, Ratlam district farmers face problem of low water availability during *rabi* season. Demonstration of *rabi* onion crop (var: ALR) was taken up with drip irrigation system in 1.2 ha area involving three farmers. The intervention saved 60% of irrigation water. Drip irrigation system field showed higher moisture content, better aeration, good bulb size and ultimately good quality output. The yield obtained by drip was 375 q/ha as compared to farmers' practice 307q/ha (Table 55). The cost benefit ratio of onion crop grown in drip irrigation system was 3.13 as compared to 2.80 by flood irrigation.

**Table 55. Comparison of drip irrigation with flood irrigation at Ratlam, MP**

Technology demonstrate	No. of farmers	Area (ha)	Yield (q/ha)	Economics of demonstration (Rs./ha)			
				Gross Cost	Gross Return	Net Return	BCR
Drip irrigation in rabi Onion	3	1.2	375	60000	187500	127500	3.13
Farmers' practice (Flood Irrigation)	1	0.4	307	55000	153500	39500	2.80



**Drip irrigation in mango at Kurnool, Andhra Pradesh**



**Cultivation of onion with drip irrigation method in Ratlam, MP**

Demonstrations on integrated nutrient management in mango were conducted in 12 farmer's field in the village, Chittecherla, Chittoor. Two sprays were taken up, first one before flowering during September-October and the second at fruit set stage during Feb-March. The results showed that fruit yield improved by 18% with foliar spray of micronutrient mixture compared to farmers' practice. There was also significant increase in fruit quality parameters, viz., fruit size and fruit weight by 17.2% and 19% respectively compared to those in farmers' plot.

In NICRA village Kattusiviri, Villupuram, demonstration of drip irrigation for efficient utilization of water and fertilizer in jasmine crop was taken up. The farmer could cultivate an additional area of 0.5 acre with the available water reserves and obtained an additional income of Rs. 13,000 per acre. Adoption of drip irrigation in jasmine crop led to efficient

use of water than flood irrigation. In addition, the weed population reduced considerably to a level of 40%.

### **Introduction of soil health management**

Soil health is the key parameter that determines the resilience of crop production under changing climate. A number of interventions were introduced to build soil carbon, control soil loss due to erosion and enhance water holding capacity of soils to build resilience. Mandatory soil testing was followed in all villages to ensure balanced use of chemical fertilizers. Improved methods of fertilizer application matching with crop requirement were recommended to reduce nitrous oxide emission.

The practice of green manuring involves incorporation of biomass mostly leguminous into the soil with a view to augment soil fertility. Green manuring contributes about 40 to 80 kg N/ha to the field. Besides supplying nitrogen, green manure also prevents loss of nitrogen by leaching and erosion. Green manuring reclaims salt affected soils. Decomposing manure releases a large amount of organic acids, which neutralizes the salts. In Kasotibali, Kendrapara demonstration on green manuring in 10 farmers' field with *dhaincha* increased the rice yield by 20- 30%.

Sunhemp is popular as green manure in many tropical and sub-tropical areas and an excellent organic N-source of for increasing soil organic matter, for control of root knot, nematode and for loosening of sub-soil. In village of Badhouchhi Kalan, Fatehgarh Sahib demonstration of incorporation of sunhemp in 58 farmers' field covered 20 ha area and increased the yield of paddy by 2.5-5 q/ha.

In NICRA village Pindi balochan, Faridkot 264 soil samples which were georeferenced and provided soil health card. Urea application was reduced by 45-50 kg N/ha when applied as per the recommendation. Farmers were guided not to apply DAP in kharif crops if it was applied to *rabi* crops under soils having medium available phosphorus (5-9 kg per acre). Many farmers have adopted this practice.

KVK Muzaffarnagar prepared 1046 soil health cards in NICRA village of Rasoolpur Jatan. Based on the soil test result it was observed that on an average one bag of urea was saved per ha and 25 kg of MOP consumption increased.

In Sekhta village, Aurangabad district, demonstration of recycling of organic waste in field through vermicompost preparation and use for soybean crop covering 10 farmers was taken up by applying 14 q during *kharif* season. It was observed that with use of vermicompost in soybean crop, grain yield increased by 30% (10.3 q/ha) over the farmers' practice (7.9 q/ha).

In village Sonauli Mohammadpur, Gonda district some area of the farmers is left fallow in kharif season. KVK Gonda introduced the green manuring practice to increase the organic carbon content in soil through dhaincha (*Sesbania*). Nearly 40 to 50 kg/ha of urea is saved through green manuring (Table 56).

**Table 56. Performance of wheat variety after green manuring during *kharif* season in Gonda, UP**

Crop/Var	Saving in nitrogen achieved due to green manuring (kg/ha)	Area (ha)	Yield (q/ha)		Increase (%)	B:C ratio	
			IP	FP		IP	FP
Wheat (K-9533)	24	2.0	36.4	34.7	4.89	1.33	1.27

Green manuring in village Gandhinagar Jhansi under *kharif* fallow-mustard, the dhaincha crop was sown just after first rains in 6.5 ha on 9 farmer's field and incorporated. The average biomass production at the time of incorporation was 245.5q/ha. About 30% increase in yield was observed by green manuring and additional net return of Rs.10458/ha was obtained with reduction in cost of nitrogen fertilizer (Table 57).

**Table 57. Performance of mustard after green manuring with dhaincha in Jhansi, UP**

Technology	Nitrogen Application (Kg/ha)	Yield (kg/ha)	Net Return (Rs/ha)	Additional Return (Rs/ha)	B:C
Farmers' Practice	80.0	1306.0	30726.00	10458.00	3.78
Green manuring with daincha	60.0	1691.0	41184.00		419

### Soil health cards for rational application of Nitrogen and mitigation of Nitrous Oxide emissions

Fertilizer recommendations were made based on the inherent nutrient status of the soil based on the soil card. In majority of the NICRA villages, the quantum of nitrogen application was significantly higher and recommendations made based on the nutrient supplying capacity of the soil reduced the quantum of N application. Due to this, the savings in nitrogen fertilizer was observed to the extent of 15-40%, which turns out to be 25-50 kg N fertilizer/ acre/ season for various crops. Soil health cards provided information about the limiting nutrient status of the soil and correction of limiting nutrient which significantly increased crop yields in many crops. During the year, 2015-16 About 13,366 soil health cards were prepared and distributed to the community in the NICRA villages.

### 3.3 Livestock and Fisheries Production System

Livestock and fisheries production system interventions are vital for livelihoods and nutritional security. Interventions on livestock and fisheries sectors involves utilizing common pool resources (CPRs) for fodder production during weather aberrations, augmentation of fodder availability during lean periods, feed and fodder storage methods for utilization during lean period, prophylaxis measures for prevention of endemic diseases, improved shelters for reducing thermal stress in livestock, improved stress tolerant animal and poultry breeds, management of fish ponds/tanks and promotion of improved breeds of livestock as adaptation strategy. Highlights of technology interventions are given below:

#### Introduction of high productive resilient breeds

Improved stress tolerant and high productivity breeds were introduced in NICRA villages particularly in poultry sector. Poultry breeds like Vanaraja (Cachar, East Sikkim, Lunglei, Ri-Bhoi, West Tripura, Nandurbar, Datia, Jharsuguda, Kalahandi, Sonepur and Pulwama), Grampriya (Jehanabad and Senapati), Kalinga Brown (Cachar), Kamrupa (Dibrugarh), Srinidhi (Dimapur and Jalna), Kroiller (Mon, West Garo Hills), Chabro (Jhansi), CARI Nirbheek, CARI Shyama (Muzzafarnagar), Rajasri (Chittoor), Giriraja (Aurangabad, Ratnagiri, Gulbarga and Bhatapara), Rainbow rooster (Khammam, Ganjam), Kadaknath (Jabhua), Namakkal 1 crossbred (Thiruvarur), Nandanam- 4 (Villupuram), Rhode Island Red (Bathinda) were introduced in NICRA villages so as provide nutritional security at household level and also to empower the women farmers. Goat breeds like Beetal (Chatra, Gumla), Sirohi and Beetal (Godda), Malabar and Teresa (Port blair), Assam Hill (Ri-Bhoi), Lalitpuri (Chitrakoot, Satna), Sirohi (Kaushambi), Jamunapari (Muzzafarnagar, Tikamgarh and Belgaum), Swajat (Ahmednagar), Narisuvarna (Chickballapur), Madras Red (Villupuram), Beetal buck (Hamirpur), Hogget breed for wool production (Kinnaur) were introduced as they are more resilient and productive under aberrant weather conditions. Similarly, improved breeds of pig and duck such as Khaki Campbell (East Singhbhum, Kendrapara), T&D breed (Gumla), Hampshire and Khaki cambell (Lunglei), Hampshire Cross (Ri Bhoi, West kameng), Chara chemballi (Sonitpur) were introduced in NICRA villages to provide livelihoods and enhance the rural income. High yielding and promising Indian breeds of large ruminants such as Tharparkar, Murrah (Bharatpur, Jodhpur and Datia), Gir (Bilaspur) along with improved housing were introduced.

Resilience and impact of introduction of improved breeds on farmers' income was assessed at different locations. Cold stress tolerant backyard poultry breed (Vanaraja) rearing was taken by 50 farmers in NICRA village Wakhwan, Phulwama, Jammu Kashmir with 500 chicks. The growth performance was significant in Vanaraja than local birds and live weight of four weeks old Vanaraja and Desi chicks ranged from 345 to 370 and 118 to

155 g, respectively. Age at 1<sup>st</sup> egg laying in Vanaraja and local birds was 182 and 217 days, respectively. A similar trend was observed in number of eggs laid per bird (64 and 21) in 40 weeks period.

Agriculture alone cannot meet livelihood security of small and marginal farmers in rainfed regions. There is a need to supplement the income of farmers through income generating activities like backyard poultry. At Shekta village of Aurangabad district, adaptation of improved breed (Giriraja) by 20 farm families resulted in higher live weight gain, increased number of eggs and income than local (Table 58).

**Table 58. Impact of improved breed over local at Aurangabad, MS**

Particulars	Initial Weight		Wt. of birds after one year	No of eggs per bird per year	Total Expenditure per bird (Rs)	Income from eggs (Rs)	Income from meat (Rs)	Total Income (Rs)	Annual income of 10 birds	Total Expenditure on 10 birds per year	Net Profit from 10 birds per year
	Day 1	Day 60									
Local	15gm	0.750kg	3 kg	50	100	600	450	1050	10200	1000	9200
Giriraj	25gm	1.10 kg	5 Kg	120	170	1130	680	1810	18100	1700	16400

Similarly high returns were observed with improved backyard poultry breed Vanaraja under drought condition in village Umarani of Nandurbar and Bhoimunda of Jharsuguda district and Giriraja in Haral village, Ratnagiri. As the egg yield and weight gain are low in native bird, introduction of improved breed of poultry (Nandanam-4) in village Kattusiviri, Villupuram provided 42% additional income to 25 farm families.

Egg and poultry meat production in Northeast is largely dependent on backyard farming with indigenous chicken breed. The genetic potential of these local chickens for egg and meat production is very poor with annual egg production of 30-50 eggs per hen and low body weight gain. To improve the productivity of backyard poultry, Kuroiler dual-purpose breed was introduced which produced more eggs and meat than local birds. Kuroiler in Marapara, Sananggre and Rongbokgre villages produced 90% more meat and 162% more eggs with B:C ratio up to 2.89.

The backyard poultry in Sikkim is mostly taken up by the farm women as source for income generation. Dual purpose improved birds were introduced in NICRA adopted Nandok village, East Sikkim. About 250 numbers of birds were distributed among 10 women farmers. The parameter wise observation showed significant performance of the improved poultry bird over the local ones; in respect of average body weight of male at 3 months (1.89 kg), average body weight of female at 3 months (1.57 kg), age at first laying (150- 155 days) and average egg production (170 per annum).



**Kuroiler farming of poultry in West Garo hills, Meghalaya**



**Vanaraja birds for Backyard poultry in East Sikkim, Sikkim**

Backyard duck rearing with non-descript breed is a traditional income generating activity in Punioni-baghchong village of Sonitpur district. In order to upgrade the local population and enhance productivity and income, introduced Chara chemballi duck in selected villages of Assam as the breed having high egg laying ability and can be a part of paddy-duck-fish integrated farming system for pest control in paddy. This resulted in enhancement of egg production from 152 to more than 200 eggs per year and more net return (Rs.7050) with B:C ratio of 1:2.56. Similarly, high returns were observed in NICRA adopted village Hnahthial, Lunglei with Khaki Campbell duck rearing under warm and humid climate during summer, cool and dry condition during winter.



**Khaki Cambell duck rearing in Sonitpur, Assam**

In village Port Mout & Badmas Pahar, Port-blair, introduction of Malabar and Tresa Goat breed bucks for breed upgradation of non-descript local goat resulted in increased birth weight (2.4 vs 3.1kg) of kids and market weight (21 Vs 29 kg) of bucks when compared to local at their farm yard.

In NICRA village S. Raghuttahalli, Chikkballapur Narisuvarna breed rams were introduced to upgrade the local sheep. This breed is efficient grazer, moderately high temperature tolerant with twining. Introduction of Narisuvarna improved the income of farmers by 52% through twining and increased live weight gain.

Seventeen landless and marginal farm woman families in NICRA village Mardanpur of Chatra district reared the introduced resilient breed of pig (T&D). The breed under free-range system in two farrowing gave more piglets and the piglets (T & D) reached live weight of 90 kg at nine month age, where as local breed only 45 kg. Farmers got about one lakh rupees annual income from this enterprise.

### **Fodder Production with improved cultivars**

Fodder production with high yielding improved cultivars is being promoted in most of the NICRA villages to increase the fodder availability both at household and village level. The less productive grasses are being replaced with improved cultivars, drought tolerant varieties of fodder in NICRA villages to enhance availability of green fodder during lean period and productivity of the animals. The harvested fodder either being fed for the animals or conserved in the form of haylage (dried and dehydrated green fodder) or silage (preserved under anaerobic condition) for use during lean period.

In village Pindi balochan, Faridkot, demonstration of improved high yielding variety of fodder maize (J-1006) in 38 ha area at 75 farmers' fields resulted in substantial increase in milk production (12-13 lit/day as compared to without intervention of 10-11 lit/day). The availability of fodder extended up to summer season.

Keeping in view the necessity of year round green fodder availability for dairy animals, different fodder production technologies were demonstrated in NICRA village Sakrorha, Jehanabad. About 133 farmers raised improved varieties of sorghum (var. M.P. Chari), fodder maize (var. African Tall) and berseem (var. Vardan) in 42.5 acres land and had a average B: C ratio of 4.70, 5.29 and 2.19, respectively as compared to 3.97, 4.56 and 1.78 in case of farmer's practice.

To meet the year round requirement of green fodder for high yielding milch animals, hybrid Napier grass was promoted in farmers' fields having irrigation facility. In village Port Mout & Badmas Pahar, Port-Blair demonstrated hybrid Napier (var. Co-3) in four farmer's field and the harvested fodder being fed to the dairy animals. This intervention gave higher gross return (Rs. 26500/ ha) and net return (Rs. 9500 /ha) with a B: C ratio of 2.5.

Green fodder plays major role in the diet of milch animals, thereby providing required nutrients for milk production and health of the dairy animals. Continuous drought in recent years has reduced the availability of fodder. Due to non-availability of quality green fodder throughout the year, milk producers are forced to utilise extra concentrates for optimum milk production. To overcome this problem, low cost hydroponic fodder production model was introduced in the village Yagantipalle of Kurnool district. In this method, for every kg of maize grain, 6-8 kg highly nutritious green fodder was produced within 7 days, which solved the problem of green fodder to a great extent. An increase in milk yield (7%) and milk fat (8.97%) was recorded observed by feeding 12 kg hydroponic

maize fodder along with 7 kg dry roughages (Table 59). An amount of Rs.1580 was saved due to reduction in concentrate feeding by hydroponic fodder.

**Table 59. Impact hydroponically grown maize fodder over farmers' practice at Kurnool, AP**

Particulars	Farmers practice	Demonstration
Milk Yield (60 days)	244.2	261.2
Increase in milk yield		7%
% fat in milk	5.64	6.14
% increase in milk fat		8.97%
Gross income	7082	8358
Cost of concentrate feeding	1240	930
Net income	5842	7428
B:C ratio	5.71	8.98



**Fodder maize and hydroponic fodder cultivation in Kurnool, AP**

In Chittecherla village of Chittoor district, demonstration of multi cut short duration (105-110 days) fodder sorghum variety CSH 24 MF in 30 farmers' fields was taken up. It recorded an average fodder yield of 15.2t/ha per year, whereas the farmers variety SSG 988 recorded an average yield of 12.5t/ha per year, which resulted in increased availability of fodder for livestock during lean period.

Cultivation of improved fodder variety of sorghum (MP Chary) by 35 farmers in 15.2 ha area in NICRA village Nandyalagudem of Nalgonda district and APBN-1 by 23 farmers in 1.2 ha area increased the fodder availability by 21% in the village.

To fulfill the requirement of the green fodder in NICRA village Bhalot, Kutch demonstrated fodder production with improved cultivar of lucerne (Anand-2) in 70 farmer's field in 14 ha area and moisture stress tolerant variety of fodder sorghum (var.Gundri) in 50 farmers field in 20 ha area increased the fodder availability at the

household level by 62%, which resulted in increased milk production by 40 liters in village per day and income by Rs. 1600 per day.



**Improved cultivars of fodder sorghum and Lucern in Kutch, Gujarat**

In village Khuntli, Valsad, demonstration of perennial fodder varieties, viz, CO-1, CO-2, CO-3, and CO-4 having profuse tillering, lodging resistance, high crude protein content, broad green leaves, less water requirement and less content of oxalate enabled the farmers to have round the year availability of green fodder. This technology has been adopted by 1046 farmers in 200 ha area in the district covering five blocks. Availability of quality fodder round the year reduced inter-calving period from 16 to 18 months to 14 to 16 months and also increased income (Rs.25000 per year).

In Kattusiviri village, demonstration of drought tolerant fodder grass (Anjan grass) ensured fodder availability to livestock of 25 farmers during summer season. In Siddanuru village of Davangere, demonstrated perennial fodders like Napier (Sampoorna, DHN-6) under limited irrigation conditions. This enhanced the green fodder availability and increased milk production (16 %) and also reduced cost of milk production (14-16%). By spending Rs 4455/- on cultivation of hybrid napier in four kathas (0.107 ha or 0.264 acre) of land, a net profit of Rs 4395/- was realized in Punioni-baghchong village of Sonitpur.



**Availability of green and dry fodder for animals in Davangere, Karnataka**

In village North Pulipur, West Tripura demonstrated cultivation of fodder crop Oat (var: Kent) in the community land for fodder production during *rabi* season to meet the fodder requirement as well as to provide additional income to the farmers, which resulted in high production of fodder (42 q/ha) and a net return of Rs.21892/- to the farmers.

Unavailability of green fodder during lean period is a serious problem under rainfed situation in NICRA village Mann of Hamirpur district. Hence, azolla a protein rich aquatic fern, which needs minimal water for its propagation and serves as protein supplement for livestock has been demonstrated. *Azolla* is also reported to be rich in essential minerals, vitamins and contains 21-23% crude protein and increased the milk productivity by 10-15%. About 35-40 % livestock rearers have adopted cultivation of *azolla* in the village after seeing the impact.

In village Haral, Ratnagiri most of the milch animals are being fed on dry fodder, which has low nutritional value. Demonstrated new improved technique of *azolla* cultivation for reduction in feeding cost (concentrate) of milch animals. Use of *azolla* combined with dry fodder resulted in increase in milk yield (5.2 lit/day) compared to farmers' practice (4.1lit/day).

**Table 60. Demonstrations of improved fodder cultivars across the NICRA villages**

Particulars	Farmers practice	Demonstration
Maharashtra	Ahmednagar, Amravati, Aurangabad, Jalna, Nandurbar, Baramati, Ratnagiri	Multi cut fodder (Pearl millet, Sorghum), Maize (Yashwant grass, MP Chari, African tall ), Hybrid Napier (BNH-10, CO-3), Lucerne (RL-88)
Bihar	Supaul, Jehanabad, Aurangabad, Nawadah	Oat (Kent, JHO-822), Sudan grass, Berseem (Vardan), Sorghum (MP Chari), Fodder maize (African tall), Sorghum (SX-17)
Uttar Pradesh	Gonda, Hamirpur, Jhansi, Muzaffarnagar, Pratapgarh	Oat (Kent, JHO-822), Hy. Napier (NB-21), Jowar (CSV-15, CSH-24), Barseem (J.H.B-146), Sorghum (MP Chari), Barseem (Vardan)
Andhra Pradesh	Anantapur, Chittoor, Kurnool	Multi cut fodder (CoFS-29), Hybrid Napier (CO-4,) Fodder sorghum (CSH 24), Maize (African tall), Lucerne
Telangana	Khammam, Nalgonda	Sweet sorghum (Sugar graze), Maize (APBN-1, MP-Chary)
Gujarat	Kutch, Valsad, Amreli,	Lucerne, Fodder Sorghum (Gundri), Perennial Grass (BNH-10), Lucerne (Anand-3)
Madhya Pradesh	Balaghat, Datia, Guna, Jhabua, Morena	Barseem (BL-1), Maize (J-1006, MP Chari), Hybrid napier (IGFRI-6), Lucerne

Particulars	Farmers practice	Demonstration
		(LL 3), Sorghum (MP Chary), Barseem (BB-3), Barley (BH- 959), Oat (JHO-822)
Karnataka	Chikkballapur, Davanagere, Gadag, Tumakuru	Guinea grass, Multi cut Sorghum (CO-3 & CO- 4, CoFS-29), Sampoorna (DHN-6), Maize (Guinea grass, Rhodes grass & Signal grass)
Tamil Nadu	Villupuram	Anjan Grass, Stylosanthes, Lucerne
Jharkhand	Gumla	Oat (JHO 822)
West Bengal	Malda	Sudan grass
Odisha	Kalahandi, Sonapur	Maize (hybrid napier)
Uttarakhand	Uttarkashi	Hybrid nappier (Co-3), Sorghum (M.P Chari), Oat (JHO 342)
Punjab	Bathinda, Ropar, Faridkot	Maize (J1006), Barseem (HB-2),
Himachal Pradesh	Chamba, Kullu	Oat(JHO-99, PLP-1), Maize (African tall)
Jammu& Kashmir	Pulwama, Bandipora	Oats (PLP-1), Fodder maize (African tall), Sorghum (MP Chari) Cow pea (UPC 9202), Oats (sabzar)
Andman & Nicobar	Port Blair	Hybrid Napier (CO3)
Assam	Dhubri	Napier (NB 21)
Nagaland	Phek	Oat (Kent)
Arunachal Pradesh	Tirap	Oats 9 (HJ 114), Berseem (Mescavi)
Assam	Sonitpur	Hybrid Napier (CO-3)

### Conservation of green fodder as silage for lean season supplementation

Availability of green fodder becomes critical during winter for feeding milch animals in Chhoel-Gadouri village of Kullu district. Hence, conservation of maize + cowpea as silage in drums was demonstrated in the village with 25 farmers. Silage has been prepared during August-September and was used for feeding the animals during December, January and February. This helped in maintenance of good animal health and higher milk yield (0.8-1.0 liter /day) during the peak winter months (Table 61).

**Table 61. Impact of silage feeding in milch animals at Kullu, HP**

No. of farmers	Fodder crop	Quantity of storage (q)	Period of use	Animal being fed	Milk yield (liters/day)	
					Without intervention	With intervention
25	Maize +cow Pea	85	Dec-Jan	CB Cow	6.5	7.5

Under changing climate, erratic and low rainfall condition, dairy farming provides livelihoods and forms a major source of daily income in rural areas. The major constraint in dairy farming is availability of green fodder after November- December. In Nirmal Pimpri, Ahmednagar the green fodder is available for feeding animals till the end of November–December month and farmers are unable to cultivate multi-cut annual or perennial fodder crops as a result of water scarcity. Farmers are forced to purchase green fodder like lucerne, maize from neighboring villages at higher rate (Rs.3 to 4 /kg); which increases cost of milk production. Considering the importance of green fodder feeding in milch animals, silage making was demonstrated using polythene bags. Seeing the impact of silage on animal health, milk production and savings on green fodder procurement cost during the year 2015-16, about 87 farmers of village Nirmal Pimpri and 100 farmers of village Pimpri Lokai prepared silage and a total 187 farmers prepared 2026 t silage for feeding 149 animals for three months (scarcity period) and saved Rs 1,45,440 on purchase of green fodder from neighboring villages (Table 62). About 1300 silage bags were given to more than 700 farmers covering 35-40 villages during the year 2015-16 in the district. One farmers group is also providing service of making silage bags available as well as their filling at farmers’ field. Recently co-operative and private dairies of the districts also started promoting the silage by providing silage bags at subsidy rates and bringing farmers to the NICRA villages.

**Table 62. Yield and economics of silage making during 2015-16 at Ahmednagar, MS**

Treatments	Av. green fodder cost (Rs/kg)	Green fodder cost (Rs/month animal)	Milk production (lit/day/animal)	Fat (%)	Av. Income from milk (Rs/Cow/Month)
Farmers practice	3.50	5151	12.08	3.56	2097.3
Silage making	2.78	4808	12.31	3.68	2726.5

In village Jalgaon (K.P), Baramati suffers very frequently with water scarcity and drought resulting in scarcity of green fodder during summer season. Demonstration of silage making with African tall variety during 2015-16 at 22 farmer’s field (of pit size 24ft x25ft x 5 feet, capacity 9 tonne) resulted in availability of 20kg silage per day per animal from February to May (Table 63). Feeding of silage conserved the green fodder and enhanced the milk production in the village. This motivated all the farmers and KVK Baramati has organized 60 large scale demonstrations on fodder maize production and silage making in convergence with MACP and 68 in collaboration with NDDDB, Anand. Twenty-eight villages have adopted the silage making on their own after seeing success of this technology having a total of 132 units.

**Table 63. The results of the demonstration on silage making at Baramati, MS**

Particulars	Milk yield (Lit. per day per cow)	Percent increase in milk yield	Gross cost per cow /lactation (Rs.)	Gross return per cow / lactation (Rs.)	Net Return (Rs.)	B:C Ratio
Demo	12.50	11.6%	64846	76250	11404	1.17
Local check	11.20		63154	68320	5166	1.08

**Table 64. Demonstration and impact of silage making in NICRA villages**

District	Crop	Storage Method	No. of farmers	Milk yield (lit/day)	
				Farmers' Practice	Silage
Ratnagiri	Hybrid Napier grass (var. CO-3)	Plastic bag	9	4.1	5.8
Baramati	Fodder maize	Polythene bags (Cross bred HF)	22	12.5	11.2
Ahmadnagar	Muticut fodder sorghum	Polythene bags	50	12.1	12.3
Kurnool	Lucerne	Polythene bags	10	4.81	5.82
Amreli	Maize	Polythene bags	5	16.0	19.0
Davanagere	Ragi straw and maize stovers	HDPE sheets	15	7.1	8.0
Gadag	Maize	Polythene bags	3	4.8	5.4
Kullu	Maize +cowpea	Plastic Drums	21	6.5	7.3
Faridkot	Fodder maize	Silo pits	3	12.5	14.8

### Combating nutrient deficiency and heat stress in dairy animals

In order to sustain the productivity of dairy animals during lean period, demonstration of urea molasses mineral block (UMMB) as a supplement was carried out in NICRA village Saidsohal, Kathua. Supplementation of UMMB at the rate of 1kg/d/cow resulted in increased milk yield by 0.9-1.5 l/day (Table 65).

**Table 65. Economic impact of feeding UMMB in Kathua district, J&K**

Parameter	Cluster 1	Cluster 2	Cluster 3	Cluster 4
Increased milk yield (l/d)	1.1	1.4	0.9	1.5
Increased income from the sale of milk/day/cow @ INR 30/l	33	42	27	45
UMMB intake/d/ cow (kg)	1	1	1	1
Cost of feeding UMMB @ INR 20/kg	20.00	20.00	20.00	20.00
Net profit (INR)	13.00	22.00	7.00	25.00

Abiotic stress caused by higher humidity and temperature in summer severely affects the productivity of dairy animals at Rasidpur village, Ropar. Apart from low milk yield, anoestrous and repeat breeding are the two major problems that add to the turmoil of dairy farmers. Around 80% animals in NICRA villages are being affected from this problem at one or the other point of time in the year. Demonstrations on supplementation of mineral mixture to mitigate heat stress in dairy animals reduced anoestrous and repeat breeding problem (58%) in the village and increased productivity of the animals.

A dietary supplement, having both minerals and vitamins not only alleviated problem of anoestrus and repeat breeding to a large extent but also increased milk yield in 176 dairy animals (cow and buffaloes) covering 57 farm families in Pindi balochan, village of Faridkot.

In Chhoel-Gadouri village of Kullu district, demonstrations on area specific mineral mixture supplementation, improved cultivars for year round production of green fodder and silage making were carried out. Feeding of area specific mineral mixture (50 g/animal/day) for four months resulted in improvement in general and reproductive health of 117 lactating cows. Introduction of new fodder varieties in the *kharif* and *rabi* season along with perennial grasses and tree fodder resulted in substantial increase in milk yield. The practice of green fodder supplementation along with dry crop residues being continued for eight to ten months in a year when compared to earlier only for 5-6 months.

In village Purkhawas, Jodhpur demonstrated Urea Mineral Molasses Blocks (UMMB) to the dairy farmers to overcome the mineral deficiency and also for increasing milk production in milch animals. UMMB supplementation enhanced milk production and reduced calving interval. Dairy farmers supplementing UMMB are now earning Rs 100-150 more from milk production in a week when compared to without supplementation. About 60 progressive dairy farmers of eight adjoining villages have adopted the technology (Table 66) after seeing the benefit of timely conception and increased milk production in milch animals.

**Table 66. Adoption of livestock interventions in the NICRA village and the adjoining villages in Jodhpur, Rajasthan**

Interventions	Extent of adoption in the village in (Nos.)							
	2012		2013		2014		2015	
Breed up gradation (Nos.)	Adopted	Adjoining	Adopted	Adjoining	Adopted	Adjoining	Adopted	Adjoining
Cow	46	17	58	22	74	27	93	35
Buffalo	30	4	34	8	40	14	46	22
Goat	142	46	188	62	216	92	262	138

### Improved housing for livestock

In Bongheri village of South 24 paraganas, poultry is a popular livelihood option for the villagers. However, due to frequent storms and cyclones, the traditional housing got damaged and increased mortality of birds. Demonstrated a double floor durable housing with iron and net structure. The housing accommodates 20 poultry birds at the bottom floor and 20 pairs of ornamental bird at the top floor (Table 67). The culling percentage of poultry birds have reduced and the egg production per cycle was increased. The ornamental birds provide an additional income to the family. Five farmers have expressed their interest to follow the technology this year due to reduced bird mortality, increase in egg production, improvement in general health of the birds, protection against storms and cyclones and also due to the prifitability associated with improved housing.

**Table 67. Economics of improved housing for poultry**

Intervention	Productivity	Gross Cost (Rs.)	Gross Return (Rs.)	Net Return (Rs.)	BCR
Double floor durable housing	Poultry: Egg:220/month Meat: 7 kg/yr Ornamental bird: 150 chicks/yr	12100	28000	15900	2.31



**Double floor durable housing system at South 24 paraganas, WB**

In village Port Mout & Badmas Pahar, Port-Blair the productivity of animals largely depend on the type of shelter and local climatic condition. In the NICRA adopted villages, it was observed that all the poultry sheds were closed type resulting into mass mortality of country birds during pre and post monsoon seasons due to improper cleaning and ammonia accumulation. Similarly, deteriorated health conditions in dairy animals were noticed in these villages. Farmers were motivated to convert their poultry and animal shelters to open type shelters by providing financial assistance from NICRA project to mitigate the climatic variability. It reduced the mortality in birds due to cross ventilation in poultry sheds and also the magnitude of heat stress in dairy, reduced mortality of newborn calf, and increased milk production. Four numbers of demonstration conducted and recorded 140 eggs /bird and gross return (Rs. 28000/Unit) and net return (Rs.21000/Unit) with B: C ratio of 4.0

In Muttar village of Alleppy district, farmers faced the problem of flooding during monsoon season causes faster spread of diseases in poultry. Demonstrated improved housing for poultry with modified cages for climate resilience. Poultry cages with (120cm x 90cm x 75cm) size using wire mesh on all the sides, wooden planks at the bottom and tin sheet as roofing material. This cage was fixed on GI pipes at the height of 120 cm to withstand flood. During 2015-16, twenty-two birds were accommodated in this cage. Seventy numbers of such cages were demonstrated in NICRA village (Table 68).

**Table 68. Impact of improved housing on profitability of backyard poultry rearing in Muttar village (Average of 20 units), Alleppey, Kerala**

Parameter	Improvement	
	2011-12	2015-16
No of birds	9	22
Mortality due to flood/disease outbreak (%)	53	13
Egg production (per year)	810	2684
Sale of spent chicken (kg) per year (in addition to own use)	5	15
Gross annual cost (Rs.)	4151	12266
Gross annual return (Rs.)	4588	15978
Net annual return (Rs.)	432	3682

Heavy rainfall, rainstorms, high temperature and high intensity rainfall predispose the animals to many parasitic and infectious diseases, which also result in higher mortality due to climatic extremes. Further, high ambient temperatures outside the thermo-neutral zone cause significant changes in physiological processes including feed intake, production and reproduction. Extreme cold stress during December to February also causes the animals to suffer from many diseases. A semi-intensive system of rearing poultry in a slatted floor with proper roof can provide shelter to tackle heat stress during summer and rainstorms during monsoon as well as from cold stress during winter. Locally available bamboo and tree planks were used for making slatted floor. The roof of the shelter was made with GI sheet. Machang type of housing was constructed at in three poultry farmer's house in NICRA village of Serchhip district, Mizoram. Farmers rearing

Vanaraja birds under machang type housing achieved more benefit than their traditional method of rearing (Table 69).

**Table 69. Impact and economic evaluation of backyard poultry, Serchhip, Mizoram**

Technology Impact					
Measurable Indicators		Economics of Demo			
Demo	Local	Gross Cost	Gross return	Net return	B:C
Body wt.	Body wt.	Rs.30,000/-	Rs.65,400/-	Rs.35,400/-	2.81
Day old chick-38.5g	Day old chick-32g				
1st Month-255g	1st Month-95g				
2nd Month-855g	2nd Month-760g				
4th Month-1250g	4th Month-750g				
6th Month-3400g	6th Month-1400g				
Age at 1st egg-5months 20 days	Age at 1st egg-6months 28 days				
Egg production – 12 nos./month 109 nos./year	Egg production – 6 nos./month 56 nos./year				
Avg. egg wt.-54g	Avg. egg wt.- 40g				

In village Sujan Singh Sutaroka Tala, Barmer to protect animals from summer heat stress four improved shelters developed by CAZRI were constructed in E-W orientation with a size of (15x10x10 feet) for large animals and with a size (10x10x10 feet) for small animals. In shelter, 2<sup>o</sup> to 3<sup>o</sup> C differences was recorded inside and outside temperature. This resulted in increase in milk production and had positive impact on animal health. On an average, each farmer got an additional return of Rs.15000/-. Due to impact of shelter on livestock 21 farmers of nearby villages are came forward to construct this type of animal house structure at with their resources.



**Improved housing for poultry in Muttar village, Alleppy, Kerala**



**Improved shelter for animals at Barmer, Rajasthan**

## Low cost scientific pigsty for fattening pig

Pig is a very economic and important animal of the tribal people of Sipni of Tirap district of Arunachal Pradesh. Almost all the households have 2 -3 pigs for their own purpose but rearing condition is very poor. Traditionally pigs are kept in a very compact area without concrete and raised floor. The growth of pigs under this rearing was slow, poor and incidence of parasitic infection and diseases were high. Seeing this situation, low cost scientific pigsty was constructed with locally available materials to improve the growth and minimize the parasitic infection and diseases. The intervention was introduced during 2014-15 by constructing 2 nos. low cost scientific pigsty and the intervention was popularized among the farmers. During 2015-16, 5 more numbers of farmers adopted the intervention, which also got spread to the nearby villages (Table 70).

**Table 70. Impact and Economics of low cost pig sty in Tirap, Arunachal Pradesh**

Name of the technology	Units	No. of farmers	Parameters Gross cost (Rs)	Gross cost (Rs)	Gross income (Rs)	Net income (Rs)	B:C ratio
Scientific low cost pigsty	05	05	1. Body weight at 10 months = 65 kg/pig 2. Disease incidence = 4.3 % 3. Meat production (kg).= 61.4 kg / pig	12,260	23,790	11530	1.94
Local check	-	-	1.Body weight at 10 months = 46 kg/pig 2.Disease incidence = 21 % 3.Meat production (kg).= 38.6 kg / pig	10160	16,873	6713	1.66

## Animal health camps

Mortality and morbidity losses due to abiotic and biotic stresses in livestock plays an important role in deriving supplementary income for small and marginal farmers in rain dependent villages. There is need to improve the health of animals through regular health camps.

In Pindi Balochan village of faridkot, organised health check up camp for disease diagnosis and its treatment in animals. Animals were treated for various ailments/ diseases including parasitic infestation, mastitis, repeat breeding, and production of loss as well as making aware the farmers about importance of animal disease management for better animal productivity (Table 71).

**Table 71. Different interventions undertaken to manage animal health at Faridkot, Punjab**

Intervention	No. of farmers	No. of Animals / Units
Preventive Vaccination	242	908 animals
Animal Health Check up	112	227 animals
Breed Up-gradation	60	110 animals
De-worming	92	266 animals
Artificial Insemination (AI)	26	33
Mitigation of mineral deficiency	42	176

In Thipuzu village of Phek district, animal health camps were conducted to reduce losses due to epidemics and cure common diseases in livestock. Preventive vaccination was taken up for poultry with F1 and R2B vaccine against Ranikhet disease. Cattle and pig were provided with mineral supplements and symptomatic treatment of ailing animals. About 81 farmers benefitted from animal health camp. Mortality rate was reduced to 11% as compared to 21% in untreated group.



**Animal health check up in NICRA villages at Phek, Nagaland and South 24 Paragans, West Bengal**

### **Integrated farming system models (IFS) for enhanced resilience**

Integrated farming system module was developed in NICRA village Sanora and Barodi, Datia to enhance the farm income of marginal and small holding farmers against extreme weather condition. Dependence on single farm enterprise by farmers is a risky proposition as it has limited resilience to cope with climate variability. Integrated farming system involves more than one in limited area in which residue of one is used as input for another enterprise to minimize the cost of cultivation and to get the sustainable yield. In this context demonstration of integrated farming, having multiple component was conducted on farmer's field within one ha area against farmer's practice of single component.

Components in integrated modules are field crops, vegetable crops, Livestock, fisheries and poultry with compost making and biogas production. Slurry was used for application in field and vegetable crops. Net returns from IFS model was Rs. 80000/year and increase in crop yield was noticed up to 65% per year, while an additional 130-person days/year of employment was generated.

The NICRA village Dhansiripar, Dimapur having 80 small ponds in which fish are reared in these ponds as secondary source of income but the return was not good enough as the farmers' practiced monocropping. However, paddy is the major crop in Dhansiripar village of Dimapur district, moisture stress condition especially during flowering of paddy reduces the yield drastically. In order to compensate this loss composite fish farming was introduced for additional income generation. An area of three hectare was covered benefitting 10 beneficiaries under composite fish farming with six species combination in the ratio of 20:20:15:20:20:10:15 of Catla, Rohu, Mrigal, Silver Carp, Grass Carp and Common Carp, respectively. Water samples were also collected from each pond and analyzed. The average initial pH of pond recorded was  $6.42 \pm 0.24$  which is moderately acidic, therefore advised to go for liming. Accordingly 1000 kg of lime/ha was applied. The major source of income was from the sale of fish, which was harvested after eight months of rearing. Farmers could get 550 to 1000 kg of fish/ha and could earn about Rs.70,000/ha. The net return realized was Rs 26500/ha with B: C ratio of 1.58.



**Composite fish production in Dhansiripar village at Dimapur, Nagaland**

Water reed (*Schoenoplectus lacustris* Linn) cum fish farming in low-lying areas for higher income, enhance employment and also for conservation of wetland was promoted in unproductive paddy fields, low lying areas, wetland with good source of water and spacious benches/plots. This integrated farming module yielded a net profit of Rs. 63956 in first year and Rs. 88604 from second year from an area of 0.25 ha. The dyke of the pond and channel can be used for growing fruit and vegetables from which the farmers also got an additional income. Cultivation and promotion of such farming system not only improved the socio-economic status of rural people by way of improved income and employment but also helped in conservation of wetlands and utilization of paddy fields not suitable for cultivation. The intervention was taken up during the month of April, 2015 over 0.75

ha with three numbers of NICRA farmers in Top Chingtha, Imphal East. The culture of fish in water reed fields generally benefits water reed plants; with better aeration of water, greater tilling due to the movement of fish. The excreta of fish increase the fertility of soil. Farmer's could get a net return of Rs. 88604/- per 0.25 ha against Rs. 29988/- with water reed as sole crop and Rs. 9800/- with paddy cultivation. The water reed produced in the project area caters the raw material requirement of secondary agriculture in and around the NICRA village to the tune of Rs. 23226 kg of fresh water reed. This module got spread up to 15 ha area covering 13 farmers in Imphal East Districts and other State.



**Water reed cum fish farming at Imphal East, Manipur.**

### 3.4 Institutional Interventions as enabling support systems

Strengthening of enabling support systems in the village comprised of existing institutions and also initiation of new institutions i.e., Village Climate Risk Management Committee (VCRMC), establishment and management of custom hiring centre (CHC) for farm implements, seed bank, fodder bank, creation of commodity groups, water sharing groups, community nursery, etc., are important components of the project. Initiation of collective marketing by tapping value chains, community nursery, and introduction of weather index based insurance and providing climate information and advisory services using data from automatic weather station and village level manual weather station were taken up to synergise the efforts.

#### Small farm mechanization through custom hiring centre (CHC)

Timeliness of agricultural operations is crucial to cope with climatic variability, especially with sowing and intercultural operations. Timely sowing will help to maximize benefit in variable climates. Promotion of appropriate agricultural machinery for performing critical operation is important for rainfed situations. Keeping this in perspective, custom hiring centers were started in each NICRA village to meet various farm machinery needs of the communities and to support various natural resources management interventions such as *in-situ* moisture conservation, mulching, residue incorporation instead of burning, zero tillage and water saving irrigation technology (drip, sprinkler, raingun, etc.). Most popular implements used in 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. During 2015-16, revenue generated from custom hiring centres was higher in Namakkal (Rs. 311629), Morena (Rs. 104795), Valsad (Rs. 99690), West Tripura (Rs. 62275), Faridkot (Rs. 65250), Aurangabad (Rs. 58000), Chatra (Rs. 37922), and Gonda (Rs. 18870).

#### Impact of custom hiring centre

In Manjhil, Nawadah demonstration of zero till drill for paddy, wheat and gram in 16 ha area in 32 farmer's field were taken up. The practice resulted in increased yield by 14%, 11%, 13% in paddy, wheat and gram as compared to farmer practice (42.2 q/ha, 42.5 q/ha, 18.3 q/ha), respectively.

In Bharu village of Jhunjhunu district, earlier farmers harvested their crops manually and incurred Rs. 9000-11000/ha on labour cost for harvesting of wheat and barley with reaper binder there is significant reduction in cost and grain losses (Table 72).

**Table 72. Impact of reaper binder machine for reducing losses at Jhunjhunu, Rajasthan**

Equipment used	Reaper binder
Area and crop	181 ha and wheat & barley
Cost saving in harvesting	60%
Reduction in grain losses	10-15%
Operational rate (Rs./ ha)	4000-5500

In Rasidpur village of Faridkot, generally the fields are not leveled, which directly affect the sowing, nutrient supply, irrigation, plant growth and yield. Demonstration of laser land levelling resulted in uniform application of irrigation water and increased the yield of paddy and net returns (Table 73).

**Table 73. Impact of laser land leveler for water saving in Faridkot, Punjab**

Equipment used	Laser land leveller
Area and farmers	296 ha and 98 farmers
Water saving	10-15%
Paddy yield	73 q/ha
Net returns (Rs. ha)	68252

In village Sonauli Mohammadpur, Gonda demonstration of laser-guided land leveler for precision leveling in NICRA Village was taken up. Seeing the benefits and outcome through precision leveling, the lesser guided land leveler was extended to several farmers in the village (Table 74).

**Table 74. Impact of laser land leveler against traditional practice at Gonda, UP**

Equipment used	Laser land leveller	Traditional practice
Area and farmers	22 ha and 18 farmers	
Yield of paddy	52.5 q/ha	43.75 q/ha

In Hengbung village Senapati, during 2015-16, 96 farmers have hired different farm equipment and implements from CHC and covered 30 ha area. A net income of Rs. 15,000 was generated by renting seven equipments. In Aliba village of Mokokchung, demonstration of power tiller in 37 ha area in 42 farmer's field was taken up. The farmers found this machine very useful, as it was very convenient for carrying out agricultural operations in small plots. Apart from this, farmers reported transplanting of paddy in time and saved 65% of cost on labour.

### **Village level seed bank**

Availability of quality seed is an issue and seed banks were created to provide quality seed of resilient crop varieties to famers in NICRA villages. Therefore, seed production of short duration, drought and flood tolerant varieties was demonstrated in several NICRA villages in rice, wheat, soybean, mustard, chickpea, sorghum, gram, foxtail millet and contributed to their spread in the NICRA villages. VCRMCS facilitated seed bank activities in the NICRA village (Table 75).

**Table 75. Short duration drought tolerant varieties produced at farmers' level for seed bank in NICRA villages**

State	District	Crop	Variety	Quantity (qt)/ produced	No. of farmers	Area (ha)
Himachal Pradesh	Hamirpur	Wheat	HPW-349	3	28	3
Haryana	Sirsa	Wheat	KRL-219, KRL-210	140	25	50
Jharkhand	Chatra	Rice, Mustard, Wheat	Anjali, Siwani, Helna	96	36	7.4
	Godda	Paddy, Mustard, Gram	Sahbhagi, Pusa -27, JAKI - 9218	6	47	4.8
Bihar	Buxar	Rice, Chickpea, Wheat, Pigeonpea	Naveen, Sahbhagi, Pusa 256, HD 2967, WR 544, Narendra Arhar 2	16	294	138.5
	Nawadah	Pigeon pea, Paddy, Gram	MAL13, Sahabhagi, GNG 469	53	48	4
	Supaul	Paddy, Wheat	Prabhat, Sahbhagi, DBW-14	2	12	40
West Bengal	South 24 Paraganas Assam	Paddy	Sabita	3	30	4
Assam	Dibrugarh	Rapeseed	TS-38	50	20	15
Nagaland	Mon	Maize	HQPM-1	1	10	4
Uttar Pradesh	Gonda	Paddy, Wheat	NDR – 359, K - 9533	104	312	118
	Jhansi	Wheat, & Groundnut, Sesamum, Urd, Moong, Lentil Raj-4120, Raj-3700, HUW-234, PBW-502, W.H.-147, TAG-24, T.G.37 Azad-3, Shekhar, Pragati, Shekhar, KLB-320 & K-75	114.5	22	30	78
	Sonbhadra	Pigeonpea, paddy,	NDA-1,	40	78	21

State	District	Crop	Variety	Quantity (qt)/ produced	No. of farmers	Area (ha)
		lentil, chickpea	HUR-3020, Shusksmarat & Sahabhagi, NDL-1, RSG-963			
Maharashtra	Amravati	Soybean, chickpea	JS-9305, Jacki-9218	124	123	25
	Baramati	Rabi Sorghum	Phule Anuradha, Phule Vasudha	15	4	6
Gujarat	Kutch	Lucerne	GAUL-1 (Anand-2)	3	70	14
Rajasthan	Barmer	Mothbean, Green gram, Clusterbean	RMO-435, GM-4, RGC-1017	8.2	30	42
Madhya Pradesh	Ratlam	Wheat	HI-1531	8	2	2
	Balaghat	Paddy	Mtu-1010, JRH-5	15	12	6
	Guna	Soybean, Wheat, Gram	JS 95-60, HI 1544, JG 14	2587	220	293
	Satna	Green gram, Rice, Mustard, Chickpea Barley, Wheat	Samrat, JR-201, Pusa Tarak, JG-14 JB-1, JW-17	19	103	65
Odisha	Sonepur	Paddy	Sahbhagi dhan	20	18	8



Village level seed bank for distribution of seeds to NICRA villages and neighbouring villages

## Fodder bank in NICRA Villages

Availability of suitable varieties of fodder seed for delayed planting situation is a serious constraint for implementation of contingency plans in NICRA villages. To fulfill the requirement of the green fodder in NICRA villages during off season, drought season etc, fodder bank was established under NICRA project with high yielding improved varieties of fodder such as multi cut fodder (pearl millet, sorghum), maize (Yashwant grass, MP Chari, African tall ), hybrid napier (BNH-10, CO-3, NB-), lucerne (RL-88), multi cut baif (bajra), oat (Kent, JHO – 822), sorghum (CSV-15, CSH-24), berseem (J.H.B-146, Vardan), maize (MP Chari). These varieties have higher nutritive value and enabled farmers to have round the year the production of green fodder.

In Bhalot village of Kutch district, during summer 2015-16, green fodder of 108 tons of maize and sorghum and 184 tons of dry fodder (sorghum and wheat straw) was collected from different sources. A total of 364 tons of fodder was supplied to the cattle during summer 2016 from fodder bank. Milk production in the village increased due to fodder bank and other villages purchased the fodder from fodder bank. Earlier, before 2011, there was no dairy for milk marketing and one private dairy was collecting on an average 110 liter of milk daily. While, today one milk collection center has been established by “Sarhad (Co-operative) Dairy” and collecting average 340-liter milk even during summer. Today, four persons have started large size dairy farm of cows and buffalo. About 140 farm families rearing 365 cattle are benefited from this activity.



Fodder bank for feeding animals during lean seasons in NICRA villages

## Agro- advisory services

Automatic weather stations were established at NICRA KVKs and mini-weather observatories in NICRA villages to record weather parameters such as rainfall, temperature and wind speed etc on real time. Agro-met advisories were prepared by the KVK's and disseminated to farmers by utilizing the data from meteorological center. About 94 NICRA Agromet Advisory Service (AAS) bulletins were issued for NICRA village, Yagantipalle of Kurnool.

## 4. Extreme Events

### Village Level Contingency Plans for delayed onset/deficit rainfall conditions

Village level contingency plans were prepared for drought-prone districts in 17 States. The monsoon action plan essentially deals with village level contingency measures in field crops to tackle likely scenarios of delay in onset of monsoon and deficit rainfall situations. The contingency plan for the village entails demonstration of short duration varieties of main crop in case of delay in planting and demonstration of alternate crop in case of delay beyond cutoff sowing date for e.g., 15 July or later. In addition to cope with deficit rainfall conditions, demonstration of several drought proofing contingency measures related to crop, soil moisture, nutrient and water management were included in the plan. Drought in rainfed areas often results in shortage of fodder for livestock. The plans also cover fodder production strategies to be implemented in the adopted village. In the event of any kharif-unsown areas leftover in the village, an early *rabi* crop plan was prepared for implementation to compensate for the loss in production during kharif.

### Response of NICRA-KVKs to extreme events

NICRA KVK at Chittoor, has received 477 mm of rainfall during novemebr 1-19<sup>th</sup> due to which significant damage to crops was observed. Issued crop advisories on adoption of contingency measures to minimize and prevent further damage in standing crops. In case excess rains, farmers were advised to avoid groundnut sowings immediately as there was chance of occurrence of seedling rot due to excess moisture. Farmers were advised to take up groundnut sowing in the month of December first fortnight and advised to drain out the water from paddy fields and apply 25 kg urea, 15 kg MOP per acre as top dressing to fields which are at tillering stage. Farmers were advised to drain out the fields and spray 5% salt solution on the ear heads to prevent grain germination and discoloration paddy crop, which was at harvesting stage. To control leaf spot disease in rice, spray of monocrotophos@1.6ml or hexaconazole @ 2ml/lit of water was recommended. Farmers who were taking up paddy transplanting was advised to leave 20 cm row for every 2 m for better aeration and light penetration. In blackgram and greengram which was in vegetative stage to control leaf spot and powdery mildew diseases spray of mancozeb @ 2.5g or chlorothalonil @ 2g or carbendizem @ 1g or thiophenate methyl @ 1 g./L of water was advised. In tomato, farmers were advised to control alternaria spot disease and bacterial wilt by spraying blitox @ 30 g and streptomycin @ 2 g. in 10 lt. of water at flowering stage.

In NICRA village Matsyapuri, West Godavari rainfall of 130 mm was received during the month of November and the paddy was lodged in an area of 438.6 ha, about 75% of total area. It was observed that in submerged areas, lodging tolerant varieties like MTU-1064 and MTU-1061 were partially lodged whereas swarna and MTU-7029 were

completely lodged due to heavy rains and high speed winds. The paddy crop was in milking to grain hardening stage. The variety of MTU-1140 was not lodged as compared to MTU-7029 and recommendations were made to drain out the excess water from the fields and spray of validamycin or hexaconazole @ 2ml/lit as prophylactic measure to prevent sheath blight. Further, farmers were suggested to spray 5% salt solution to prevent grain discoloration and germination.



**Completely lodged MTU-7029 in West Godavari, AP**



**Semi lodged MTU-1061 in West Godavari, AP**

During December-January 2015-16, high temperatures were observed in the NICRA villages in the states of Rajasthan, Wetsren UP, Punjab, Haryana. In Rajasthan, variety of wheat (Raj 4037) which is tolerant to high temperature during grain filling was taken up in NICRA village of Bharatpur. The extent of damage was found to be less compared to traditional wheat varieties. Early sown (October) wheat varieties were affected with heat wave compared to the normal sown wheat.

The mustard sown early in the districts of Bharatpur, Kota, and Jhunjunu, etc., in Rajasthan was affected due to rise in temperature. The vegetative growth and branching got effected which had significant influence on crop yield. High temperature tolerant varieties such as NRC DR 2, NRC BH-101 were taken up in NICRA villages in Bharatpur and the extent of damage was less in these varieties compared to the farmers' practice. Seed treatment with 0.1% thiourea is being taken up for uniform germination. Spraying of 0.1%, thiourea was taken up to avoid forced maturity. Greater incidence of aphid was observed in mustard due to rise in temperature. Farmers were advised about the control measures and the spray schedule.

Unseasonal rains during 9-15 March 2016 in the state of Punjab and Haryana adversely affected wheat, mustard, sugarcane crops. Timely sown wheat with happy seeder in combined harvested rice fields in Punjab (Fatehgar Sahib, Ropar, Faridkot and Batinda) and Haryana (Yamunanagar) escaped crop damage due to lodging or water stagnation

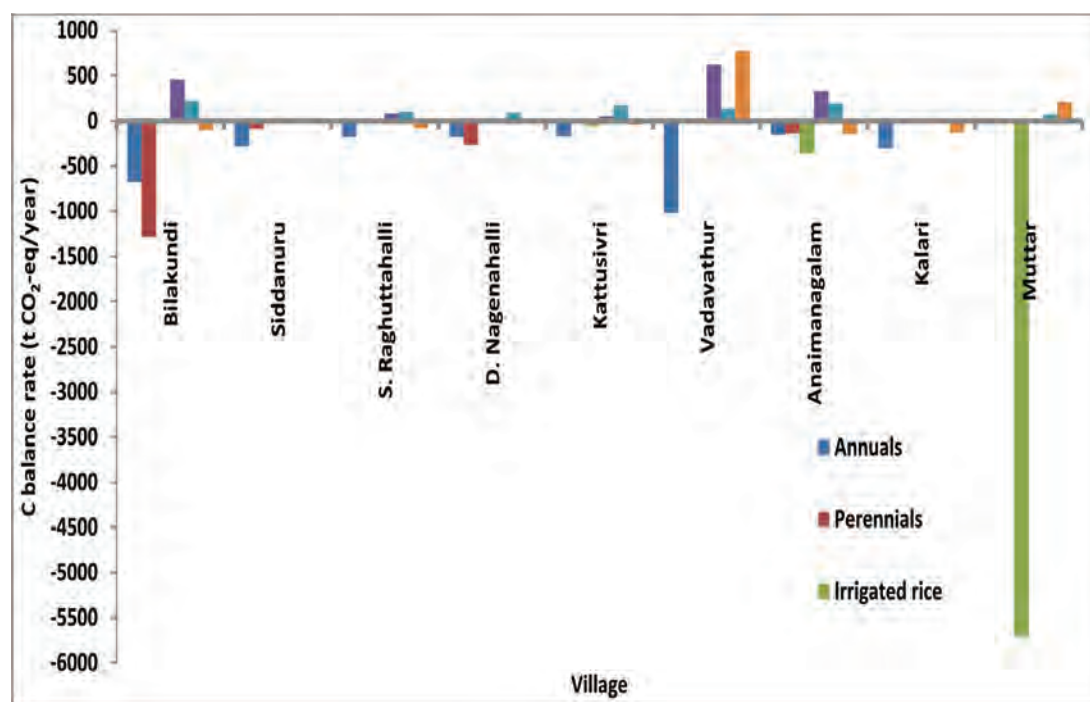
(infiltration/percolation of water was high). Other conventionally sown fields suffered water logging up to 7 days, which resulted in significant damage. Recovery of the lodged plants with happy seeder sown plots was faster due to less water stagnation (up to 50% recovery of affected plants). In sugarcane, sowing with furrow irrigated raised bed planting had less damage as compared to farmers' practice in Yamunanagar.



**Comparison of conventional sown wheat with zero till sown wheat in Faridkot, Punjab**

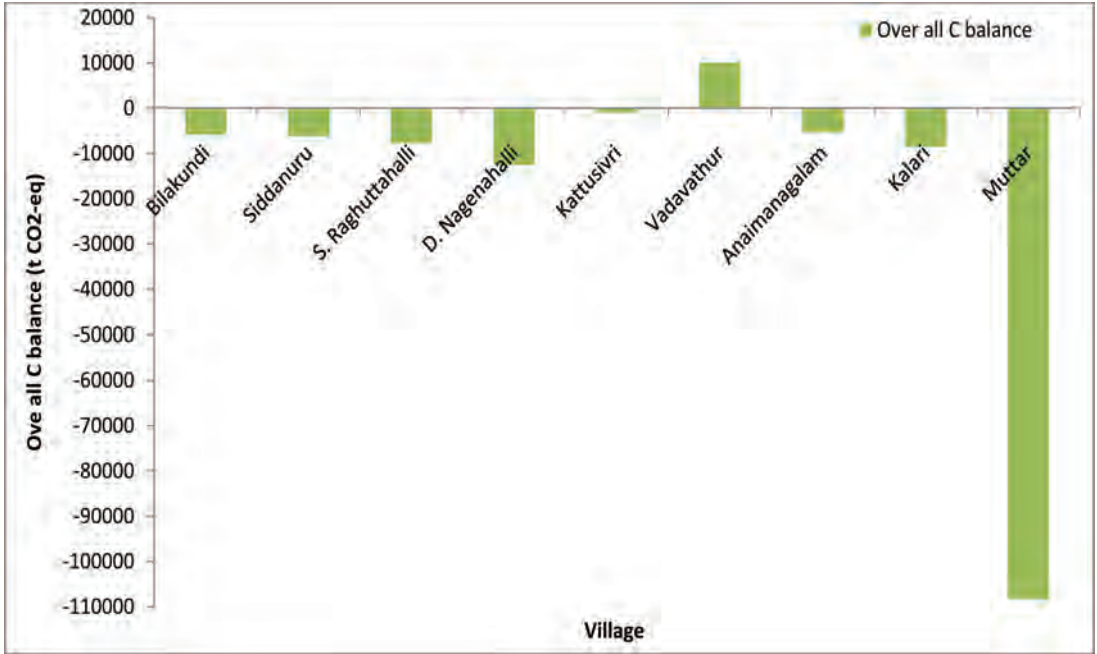
## 5. Village Level Carbon Balance Studies

Quantification of carbon balance in the NICRA-villages resulting from various resilient practices was taken up to assess the quantum of emission reductions and enhancement of carbon sinks from the agriculture and allied sectors, without compromising the food production. *Ex-Ante* Carbon balance Tool (EX-ACT) developed by FAO based on the IPCC default values was used to study the impact of resilient management practices on the carbon balance in the NICRA-villages. 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 for the model include 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 as tons of carbon equivalents (t CO<sub>2</sub>-eq).



Carbon balance rate (t CO<sub>2</sub>-eq / year) from climate resilient practices in the NICRA-villages in zone VIII (Karnataka, Tamil Nadu and Kerala) (‘Negative’ values indicate net sink and ‘Positive’ values indicate net emissions)

Carbon balance study with EX-ACT model was done for forty five villages from different parts of the country and the final carbon balance values for the 45 villages from twelve states (Andhra Pradesh, Telangana, Maharashtra, Gujarat, Rajasthan, Karnataka, Tamil Nadu, Kerala, Bihar, Jharkhand, West Bengal and A&N Island) were computed. Figures show that carbon balance of nine villages from arid regions of the South Indian states of Karnataka, Tamilnadu and Kerala that the adaptation and mitigation measures implemented in these villages resulted in net sink and contributed to the mitigation of green house gases to the extent of -5413.25 t CO<sub>2</sub> equivalents/year. The maximum mitigation potential achieved was from the arable systems due to the adoption of management practices such as improved cultivar, fertilizer management, efficient irrigation systems, etc. In case of Muttar village from Kerala, irrigated rice has contributed towards mitigation due to reduced burning of the crop residue, non-flooding of the rice fields and addition of organic matter from outside.



**Over all carbon balance (t CO<sub>2</sub>-eq) from climate resilient management practices in NICRA-villages in Southern states ('Negative' values indicate net sink and 'Positive' values indicate net emission)**

## 6. Resilience Indicators for Adaptation Interventions

The impact of various adaptation interventions on economics and resilience was examined in Anantapur and West Godavari districts. It was observed that the adaptation intervention in the form of change of crop variety (Indra in place of Swarna) performed better in terms of higher yield and net returns. The yield level was much closer to the normal yield indicating enhanced resilience to flood situation. Another major finding was that income resilience was more pronounced when the livelihoods are diversified..

Technological interventions that have potential to do well in the face of weather aberrations are being evaluated in selected districts in the country. As part of this, a study was conducted in West Godavari district of Andhra Pradesh which faced severe floods because of heavy rains during 2013-14. The productivity and economics as influenced by the incidence of flood is presented (Table 76). Yield, costs and profitability were adversely affected during 2013-14 compared to normal year. The average yields decreased by more than 30% while cost of cultivation increased by Rs. 2500/ac due to difficulty in harvesting (Table 77). The net returns declined from Rs. 12800/ac to a mere Rs.2173/ac (Table 77).

**Table 76. Impact of flood on rice yield and economics, West Godavari, AP**

Year		Yield (q/ac)	COC (Rs/ac)	NR (Rs/ac)
Normal	Mean	24.2	13290.6	12817.3
	n	142	142	142
	Std. Deviation	5.4	2985.1	6381.4
Stress (Flood/ cyclone)	Mean	16.3	16335.5	2173.4
	n	145	145	145
	Std. Deviation	7.4	2645.0	8026.1

*COC: Cost of cultivation, NR: Net returns*

**Table 77. Introduction of flood tolerant variety as adaptation measure in West Godavari, AP**

Variety/ Season	Normal	Flood/ heavy rain	Resilience (Stress yield/normal)
MTU-7029 (Swarna)	21.45 (3.91)	10.15 (3.68)	0.47
MTU-1061 (Indra)	23.47 (3.78)	13.96 (5.10)	0.59
Difference	NS	Significant	

*Figures in parentheses represent standard deviations*

## 7. Convergence with Line Departments

All NICRA implementing KVKs carried out number of interventions in convergence with on-going development programmes or schemes during the reporting year. Convergence was established with the following important development schemes, namely- IWMP, RKVY, NHM, NFSM, ATMA, MGNREGA, National Micro and Minor Irrigation Scheme, Pradhan Mantri Gram Sadak Yojana, Chief Minister Sadak Yojna, Backward Rural Grant Fund, Silk Board, Sunderban Development Board, IVRI, PDADMAS, Forest Department, MESO, IAP Yojana, etc. This convergence brought synergies among different government programmes/schemes in terms of planning, process and implementation. In case of NRM, support was mobilized for various water harvesting structures, recharge structures, micro irrigation systems, lining of farm ponds, deepening of drainage channels, distribution of green manuring seeds, tree planting including horticulture, etc. In crop production, convergence with line departments was used for increasing the spread of HYV of food crops, promotion of cultivation practices such as SRI, Direct Seeded Rice in various states. In case of animal husbandry, interventions such as animal health camps, timely availability of medicines, large-scale production and availability of improved fodder crops seed, planting material and material for silage making were taken up. Capacity building of the farmers in NICRA villages was also taken up in trainings, exposure visits as part of the ongoing programmes. Efforts were made to enhance the coverage of the interventions in the village with the support of the line departments through convergence. The details of different convergence programmes are given below (Table 78).

**Table 78. Convergence in collaboration with KVKs for development**

KVK	Organization	Nature of intervention
Malda, Dibrugarh, East Sikkim, Mokochung, Ri-bhoi, West garo hills, Cachar, Gorakhpur, Kota, Belagavi, Kolar	State Department of Agriculture, District Veterinary Office under ALDA Programme, Fishery Department, District AH & Veterinary deptt.	Animal health camp for vaccination, artificial insemination of local cows for breed up-gradation. vaccination and treatment of livestock, fishery pond and supply of fingerlings, vaccines, medicines, de worming doses and medicines for animal treatment, silage making
Nalgonda, Kutch Ahmednagar, Amravati, Baramati, Gumla, Koderma, Chatra, Lunglei,	Andhra Pradesh Micro Irrigation Project, GGRC Agriculture Department,	Drip irrigation systems and required material, Farm ponds, <i>In-situ</i> soil & water

KVK	Organization	Nature of intervention
Phek, Senapati, Chitrakoot, Kushinagar, Dantewada, Belagavi, Villupuram	MGNREGA, IWDP, Department of Horticulture	conservation practices, check dam, Farm bunding, Jalkund, Land leveling, etc.
Muzzafarnagar, Gorakhpur, Nalgonda	District Agriculture department	Dhaincha seed to farmers, Vegetable seed
Koderma. Mokokchung,	State Department of Agriculture	Demonstration of pigeon pea, Demonstration of SRI
Bhagapat, Tumakuru	State Agriculture Department, IFFCO	Vermicompost
East Sikkim. Lunglei	ATMA	Training programme, exposure visit



**ATMA members visit NICRA village, Amaravati, Maharashtra**



**Team of IFFCO Company along with village level extension functionaries visit to Amravati, MS**



**SAO visits to Jalna, MS**



**Animal health camp at Baramati, MS**

## 8. Monitoring of NICRA Villages

The monitoring committee were constituted to review the technical progress of different modules like NRM, crop production, livestock & fishery and institutional intervention in NICRA villages and for making appropriate suggestions for improvement. The details of zone wise visits by KVKs are mentioned here under (Table 79).

**Table 79. NICRA KVKs monitored by Zonal Monitoring Committees (ZMCs)**

KVK	Organization	Nature of intervention
I	Sirsa, Bathinda, Faridkot	7-8 October, 2013
	Kathua, Pulwama	22-24 January, 2014
	Kinnaur, Kullu, Chamba	9-13 September, 2014
	Yamunanagar, Fatehgarh Sahib, Hamirpur	13-15 April, 2015
	Ropar	8 July, 2015
II	Aurangabad, Koderma & Nawadah	30 October to 1 November, 2013
	Coochbehar, Malda & South 24-Paranagas	17-21 February, 2014
	Chatra, Palamu, Gumla	12-14 March, 2015
	Jehanabad, Buxar and Saran	20-22 May, 2015
	Port-Blair	15-19 March, 2016
III	Sonitpur, Dhubri, Ri-Bhoi, Dibrugarh, Tirap	23 to 28 June, 2014
IV	Bagpat & Muzaffarnagar	24-25 August, 2013
	Bahraich, Gonda and Chitrakoot	14-15 April, 2014
	Hamirpur and Jhansi	16-20 February, 2015
	Gorakhpur, Kushinagar, Maharajgunj and Sonbhadra	17-20 March, 2015
	Tehri Garhwal and Uttarkashi	23-36 March, 2015
V	Khammam & Nalgonda	19-20 September, 2013
	Amravati, Gondia,	9-10 October 2013
	Srikakulam,	20 December, 2013
	West Godavari	27 December, 2013
	Kurnool, Anantapur	3 to 4 February, 2014
	Ahmednagar, Auranbagad & Nandurbar	4 to 8 March, 2014
VI	Bharatpur & Kota	20-21 September, 2013

<b>KVK</b>	<b>Organization</b>	<b>Nature of intervention</b>
	Jhunjhunu, Jodhpur & Valsad	24-28 February, 2014
	Kutch and Rajkot	29 Sept-1 October, 2014
VII	Bilaspur, Raipur, Jharsuguda & Sonepur	3 to 6 September, 2013
	Satna, Chhatarpur, Tikamgarh, Guna, Morena	19-23 January, 2015
VIII	Nagapattinam, Namakkal, Ramanathapuram & Villupuram	23-26 September, 2013
	Alleppey	15 February, 2014
	Tumkur, Davangere, Chickballapur, Belgam	20-23 February 2015

## 9. Review cum Action Plan Preparation Workshops

Workshop on *kharif* review and *rabi* progress during 2015-16 was organized in KVK Aurangabad during 20-21 November 2015 of Zone V NICRA KVKs. Dr. B.Venketswarlu Vice-Chancellor, VNMKV Parbhani was the chief guest of the workshop. The meeting captured the salient achievements, success stories and *rabi* action plan from 15 NICRA KVKs. Each NICRA KVK also presented the details about *kharif* progress report and climate resilient agricultural practices.

ICAR-CRIDA organized a three days workshop on assessing the impacts of TDC –NICRA interventions by involving 20 KVKs representing various zones of the country during 10-12 March 2016 along with the nodal officers from ATARIs and Program Coordinators from KVKs. The purpose of the workshop was to quantify the impacts of various interventions (under different modules: NRM, crop production, livestock interventions and custom hiring centre) being taken up in the NICRA village by using the formats. Interventions were quantified using these formats at the individual farmer level and comparison was made with the farmer’s practice.

Zonal workshops at all the eight Agricultural Technology Application Research Institutes (ATARIs) were conducted during April to June 2016 to review the progress in 2015-16 (Table 80). Each NICRA KVK presented the action plan for 2016-17 giving the details of climate resilient agriculture practices.

**Table 80. Details of TDC-NICRA Annual Review Workshop 2015-16**

Zone / No. of KVKs	ATARI	Place of meeting	Date of meeting
I (13)	Ludhiana	Hisar, Haryana	2nd June, 2016
II (17)	Kolkata	ATARI, Kolkata (WB)	21-22nd April, 2016
III (23)	Barapani	CIFRI-RC, Guwahati, Assam	6-7th May 2016
IV (15)	Kanpur	ATARI, Kanpur, (UP)	18-19th April, 2016
V (15)	Hyderabad	KVK Ahmednagar, (MS)	3-4th May 2016
VI (10)	Jodhpur	ATARI ,Jodhpur, (Raj)	16th April, 2016
VII (17)	Jabalpur	KVK Diwas (MP)	12-13th May, 2016
VIII (11)	Bengaluru	ATARI, Bengaluru , (KA)	10- 11th May, 2016



**Workshop on kharif review and rabi progress 2015-16 at Aurangabad, Maharashtra**



**Workshop on impact of TDC-NICRA interventions on 10-12 March, 2016 at CRIDA, Hyderabad, TS**



**Review workshop (2015-16) at ATARI VI, Jodhpur, Rajasthan**



**Review workshop (2015-16) at ATARI VIII, Bengaluru, Karnataka**



**Review workshop (2015-16) at ATARI III, Barapani, Meghalaya**



**Review workshop (2015-16) at ATARI V, Hyderabad, TS**

## 10. Capacity Building Activities

Trainings were organized on various aspects aiming at enhancing the adaptive capacity of the communities and skill upgradation. During 2015-16, a total of 1042 programmes were organized involving 32219 participants (Table 81). About 526 programmes were conducted involving 7581 participants by the new 21 KVKs (Table 82). Trainings were conducted on various aspects of climate change, impacts of climate change, adaptation to climate change, natural resource management for enhancing the adaptive capacity, efficient cultivars and cropping systems, livestock and fisheries, nutrient management, resource conservation technology, farm implements and machineries, livestock, feed and fodder management, nursery raising, vermincompost preparation and kitchen gardening for enhancing nutritional security, etc. in NICRA villages.

**Table 81. Theme-wise training programme conducted by 100 KVKs**

Thematic area related to climate change	No. of courses	No. of participants
Crop Diversification	102	3036
Crop Management	265	8858
Farm Implements and Machinery	55	1506
Integrated Farming System	36	680
Livestock	190	6010
Nutrient Management	162	5312
Natural Resource Management	140	4417
Resource Conservation Technologies	92	2400
Total	1042	32219

**Table 82. Training programme conducted by new KVKs**

Sl.no	Name of KVK	2015	
		Programmes (no.)	Participants (no.)
1	Bandipora	29	684
2	Banka	2	175
3	Godda	6	166
4	Ukhrol	7	120
5	Jaintia hills	14	171
6	Serchhip	7	367
7	Mon	13	453

Sl.no	Name of KVK	2015	
		Programmes (no.)	Participants (no.)
8	Dhalai	3	75
9	Pratapgarh	16	424
10	Kaushambi	12	295
11	Jalna	283	539
12	Chittoor	27	847
13	Barmer	3	82
14	Banaskantha	15	456
15	Amreli	8	300
16	Jhabua	27	664
17	Ratlam	16	376
18	Kalahandi	12	476
19	Gadag	13	341
20	Gulbarga	13	570
	Total	526	7581



**Capacity building for farmers on various aspects of climate change and variability in NICRA villages**

## 11. Awards and Recognitions

On ICAR-CRIDA Foundation Day (12<sup>th</sup> April, 2016), fourteen farmers were awarded from TDC-NICRA villages across the states in recognition of their efforts in implementing climate resilient practices and towards their spread in the NICRA village. The NICRA-KVKs are Alleppy, Kerala (2 farmer), Ganjam, Odisha (1 farmer), Kurnool, Andhra Pradesh (1 farmer), Srikakulam, Andhra Pradesh (1 farmer), Khammam, Telangana (1 farmer), Kutch, Gujarat (1 farmer), Nandurbar, Maharashtra (1 farmer), Tumkur, Karnataka (2 farmers), Datia, Madhya Pradesh (2 farmers) and Namakkal, Tamil Nadu (2 farmers).



Farmers were awarded during ICAR-CRIDA Foundation Day 2016

## 12. Distinguished Visitors



**Present DG, ICAR & Former Director, IARI visit to NICRA village, Gurgaon**



**Dr. Ch. Srinivasa Rao Director, CRIDA visit to NICRA village of Alleppey**



**Vice Chancellor, Dr. A.K.Singh visit to Jabhua KVK (Madhya Pradesh)**



**Dr. S. Sahoo, Jt. Director Extension visit to NICRA village Jharsuguda**



**Dr. Rajbir Singh, Director ATARI (Zone I) visit to NICRA village of Bathinda**



**Shri Omkar Singh, IAS, Hon'ble VC (Ag. University Kota) Interaction in NICRA village with farmers**

## 13. Publications

- NICRA report 2015. Annual Report 2015-16 of ATARI II (F. H. Rahman, D. Ghosh, K. S. Das, S. K. Mandal, P. P. Pal and S. K. Roy). ICAR-Agricultural Technology Application Research Institute, Salt Lake City, Kolkata-700 097 Kolkata. 60P.
- NICRA report 2015. NICRA-TDC Salient Achievements of KVKs under ICAR-ATARI, Jodhpur (P.P.Rohilla, S.K.Singh, Shyopal Ram Jat). ICAR-Agricultural Technology Application Research Institute CAZRI Campus, Jodhpur, Rajasthan. 39p.
- Srinivasa Rao, Ch., Prasad, JVNS, Prasad, YG., Prasannakumar, Shailesh Borkar, Singh, AK., and Sikka, AK. (2016). Climate Resilient Villages in India. ICAR-Central Research Institute for Dryland Agriculture, Santoshnagar, Hyderabad. 20p.
- Srinivasa Rao, Ch., Gopinath, K.A., Prasad, J.V.N.S., Prasannakumar, Singh, A.K. (2016). Climate Resilient Villages for Sustainable Food Security in Tropical India: Concept, Process, Technologies, Institutions and Impacts. Advances in Agronomy. Vol 140: 101-214 p.

## 14. Contributors –NICRA KVKs

S. No	Name of the KVK	State	Crops	Soil	Rainfall (mm)	Name of the Program Coordinator
<b>ATARI I</b>						
1.	Sirsa	Haryana	Rice, Wheat, Cotton and Sorghum	Sandy loam	300	L.S. Beniwal
2.	Yamunanagar	Haryana	Wheat	Sandy loam	1107	B.R.Kamboj
3.	Chamba	Himachal Pradesh	Maize, Wheat and Apple	Sandy loam	1590	Rajiv Raina
4.	Hamirpur	Himachal Pradesh	Wheat, Maize and Chickpea	Sandy clay loam	1025	Pradeep Kumar
5.	Kullu	Himachal Pradesh	Maize, Wheat and Black gram	Coarse loamy	919	Surinder. K Thakur
6.	Kinnaur	Himachal Pradesh	Maize, Barley, Rajmash, Pea and Apple	Sand to loamy sand	672	Pankaj Gupta
7.	Kathua	Jammu & Kashmir	Maize and Wheat	Sandy loam	1168	Amrish Vaid
8.	Pulwama	Jammu & Kashmir	Paddy and Apple	Silty clay loam	305	Fayaz Misgar
9.	Bandipora	Jammu & Kashmir	Paddy, Maize, Wheat	Silty clay loam	1476	A.H. Hakeem
10.	Bathinda	Punjab	Paddy , Wheat and Cotton	Loamy	292	Jatinder Singh Grover
11.	Fatehgarh Sahib	Punjab	Rice and Wheat	loam/sandy loam	877	S.C.Sharma
12.	Faridkot	Punjab	Paddy, Wheat, Cotton and Mustard	Sandy loam & clay loam	433	Jagdish Grover
13.	Ropar	Punjab	Rice, Wheat and Poplar	sandy loam	750	Harinder Singh
<b>ATARI II</b>						
14.	Port Blair	A & N Island	Paddy and Coconut	Clay loam	3100	Nagesh Ram
15.	Aurangabad	Bihar	Paddy, Wheat, Lentil, Chickpea and Mustard	Clay loam	1150	Nityanand
16.	Buxar	Bihar	Rice and Wheat	Clay and loamy	891	Deo Karan
17.	Jehanabad	Bihar	Paddy, Wheat, Lentil and Redgram	Clay loam	952	Shobha Rani
18.	Nawadah	Bihar	Pigeonpea, Paddy, Maize, Chickpea and Wheat	Sandy loam	1037	S.K. Mishra

S. No	Name of the KVK	State	Crops	Soil	Rainfall (mm)	Name of the Program Coordinator
19.	Saran	Bihar	Paddy, Wheat, Maize, Pigeonpea and Potato	Sandy loam	1140	Ratnesh Kumar Jha
20.	Supaul	Bihar	Paddy, Wheat, Greengram and Maize	Sandy loam	1450	S.K. Choudhari
21.	Banka	Bihar	Paddy, Wheat	Clay-Loam	1200	Kumari Sarada
22.	Chatra	Jharkhand	Paddy, Maize, Pigeonpea and Wheat	Sandy loam	810	Ranjay Kumar Singh
23.	East Singhbhum	Jharkhand	Rice and Chickpea	Sandy loam	1750	Artibeena Ekka
24.	Gumla	Jharkhand	Paddy, Maize, Black gram, Groundnut, Niger and Wheat	Sandy loam and clay loam	1450	Sanjay Kumar
25.	Koderma	Jharkhand	Paddy, Pigeonpea, Maize and Wheat	Sandy loam	1193	Chanchila Kumari
26.	Palamau	Jharkhand	Paddy, Maize, Pigeonpea, Wheat, Black gram and Chickpea	Sandy loam/ clay loam	1257	Lalit Kumar Das
27.	Godda	Jharkhand	Paddy, Chickpea, Mustard, Vegetables	Red lateritic	1530	Ravi Shankar
28.	Coochbehar	West Bengal	Rice, Wheat, Mustard, Potato and Jute	Coarse textured acidic soils	2983	Sanjay Das
29.	Malda	West Bengal	Maize, Blackgram, Wheat, Mustard and Jute	Loamy to sandy loam	1453	P.K.Ganguly
30.	South 24 Paraganas	West Bengal	Paddy	Clay and	1750 silty clay	Nilendu Jyoti Maitra
<b>ATARI III</b>						
31.	Tirap	Arunchal Pradesh	Rice, Maize, Foxtail millet and Toria	Sandy loam and clay loam	2506	Mrs. Indu
32.	West Kameng	Arunchal Pradesh	Maize, Fieldpea, Soybean, Rajmash and Paddy	Sandy	1705	N.D. Singh
33.	West Siang	Arunchal Pradesh	Paddy, Maize and Orange	Silty clay loam	1906	Chitangad Shing Raghav
34.	Cachar	Assam	Rice, Potato and Rajmash	Clay	3181	Pranabjyoti Sarma
35.	Dibrugarh	Assam	Rice and Toria	Sandy loam and clay loam	2000	H.K. Bhattacharya
36.	Dhubri	Assam	Rice and Toria	Sandy loam, clay loam and clay	3280	Bhabesh Deka

S. No	Name of the KVK	State	Crops	Soil	Rainfall (mm)	Name of the Program Coordinator
37.	Sonitpur	Assam	Rice, Toria, Sugarcane and Vegetables	Sandy, loamy sand and sandy loam	1940	Pramod Chandra Deka
38.	Karbi-Anglong	Assam	Paddy, Maize, Rapeseed and Mustard	Sandy Loam	876	A.K. Deka
39.	Imphal East	Manipur	Paddy, Rapeseed Mustard, Green Pea and Potato	Alluvial	1592	T. Medhabati Devi
40.	Senapati	Manipur	Paddy, Maize, Soybean, potato, Fieldpea and Toria	Clay and sandy loam	1166	N. Jyotsna
41.	Ukhrul	Manipur	Paddy, Groundnut	Red clayey	1592	Y. Ramakrishna
42.	Umaim	Meghalaya	Paddy, Vegetables	Red loamy soil, sandy loam	2400	M.Mokidul Islam
43.	West Garo Hills	Meghalaya	Paddy, Arecanut and Cashew	Red sandy loam soil	4003	Tanmay Samajdar
44.	Jaintia Hills	Meghalaya	Rice, maize, ginger, turmeric	Black soil, red soil	2911	M.J. Syngkon
45.	Lunglei	Mizoram	Rice and Maize	Alluvial	2098	Lalmuanzovi
46.	Serchhip	Mizoram	Rice, Maize, Ginger, Soybean	Sandy loam	2300	Lalnunpuii Parte
47.	Dimapur	Nagaland	Rice, Maize and Mustard	Sandy loam	1657	Anamika Sharma
48.	Mokokchung	Nagaland	Paddy, Maize and Cucumber	Non lateritic red, alluvial and forest	1408	Pijush Kanti Biswas soils
49.	Phek	Nagaland	Paddy, Maize and Pea Non Laterite	Clay, Alluvial and Red Soil	1550	R.K. Singh
50.	Mon	Nagaland	Paddy, Maize	Red clayey	2554	Ruokuovilie Mezhatas
51.	East Sikkim	Sikkim	Paddy, Maize, Finger Millet and Ginger	Sandy loam	3800	A.K. Mohanty
52.	West Tripura	Tripura	Paddy, Maize, Bitter Gourd and Potato	Red loamy to sandy loam	2035	Dipak Nath
53.	Dhalai	Tripura	Paddy, Lentil, Vegetables	Red loamy to sandy loam	2218	Debaraj Barman
<b>ATARI IV</b>						
54.	Bahraich	Uttar Pradesh	Paddy, Wheat, Lentil and Toria	Sandy loam	900	Om Prakash Verma

S. No	Name of the KVK	State	Crops	Soil	Rainfall (mm)	Name of the Program Coordinator
55.	Bhagpat	Uttar Pradesh	Paddy, Wheat, Mustard and Sugarcane	Loam to Sandy loam	750	Gajendra Pal
56.	Chitrakoot	Uttar Pradesh	Paddy, Chickpea, Wheat, Lentil, Barley and Pigeonpea + Sorghum	Silty clay	542	Narender Singh
57.	Gorakhpur	Uttar Pradesh	Rice, Groundnut, Wheat, Lentil and Mustard	Sandy loam	1211	Sanjit Kumar
58.	Gonda	Uttar Pradesh	Paddy, Sugarcane, Wheat and Pigeonpea	Alluvial	1431	U.N.Singh
59.	Hamirpur	Uttar Pradesh	Chickpea, Wheat, Sesame, Pigeonpea, Mustard and Lentil	Kabar, maar	864	C.K. Rai
60.	Jhansi	Uttar Pradesh	Wheat, Groundnut and Black gram	Red & Black	885	Nishi Roy
61.	Kushinagar	Uttar Pradesh	Paddy, Wheat, Sesame and Lentil	sandy loam	1282	Akhilesh Kumar Dubey
62.	Maharajgunj	Uttar Pradesh	Rice, Wheat and Lentil	Alluvial	880	V.P.Singh
63.	Muzaffarnagar	Uttar Pradesh	Sugarcane, Wheat, Black gram, Sorghum and Mustard	Sandy loam to clay loam	670	P.K. Singh
64.	Sonbhadra	Uttar Pradesh	Paddy, Wheat, Lentil, Chickpea and Pigeonpea	Black	1035	S.K.Singh
65.	Kaushambi	Uttar Pradesh	Wheat, Rice, Gram	Loamy	975	Ajay Kumar
66.	Pratapgarh	Uttar Pradesh	Rice, wheat, maize	Loamy	795	A.K. Srivastava
67.	Tehri Gharwal	Uttarakhand	Wheat, Pea, Soybean, Finger Millet and Barnyard millet	Brown black, forest soil	1230	Laxmi Ravat
68.	Uttarkashi	Uttarakhand	Wheat, Paddy, Finger millet, Barnyard millet and Lentil	Sandy loam	1560	V.K. Sachan
<b>ATARI V</b>						
69.	Anantapur	Andhra Pradesh	Groundnut, Pigeonpea and Rice	Red_25%; Black_75%	602	P.Laxmi Reddy
70.	Kurnool	Andhra Pradesh	Pigeonpea, Paddy, Cotton, Sunflower, Chickpea and Sorghum	Sandy clay loam to clay loam	546	G. Dhana Lakshmi
71.	Srikakulam	Andhra Pradesh	Paddy, Greengram, Black gram, Sesame and Groundnut	Red sandy and sandy loam	1200	D. Chinnam Naidu

S. No	Name of the KVK	State	Crops	Soil	Rainfall (mm)	Name of the Program Coordinator
72.	West Godavari	Andhra Pradesh	Paddy	Alluvial	1185	Jaganadha Raju
73.	Chittoor	Andhra Pradesh	Paddy, Redgram Groundnut	Sandy loam	934	C Manohar Raju
74.	Amravati	Maharashtra	Soybean, Cotton, Pigeonpea, Wheat and Chickpea	Medium Black	877	K.A. Dhapke
75.	Aurangabad	Maharashtra	Cotton, Maize, Bajra, Wheat and Bengal gram	Shallow & light	644	S.B. Pawar
76.	Ahmednagar	Maharashtra	Pearl Millet, Soybean, Wheat and Chickpea	sandy loam	425	Deshmukh
77.	Baramati	Maharashtra	Sorghum, Wheat, Maize, Bajra and Chickpea	Medium black	524	Syed Shakir Ali
78.	Buldhana	Maharashtra	Cotton, redgram	Black	792	C.P. Jayabhaye
79.	Nandurbar	Maharashtra	Sorghum, Maize, Soybean, Black gram and Cotton	Red and black	813	R.S. Dahatonde
80.	Ratnagiri	Maharashtra	Rice, Finger Millet and Proso millet	Red lateritic soil	3594	Vishal Sawant
81.	Jalna	Maharashtra	Cotton, Pigeonpea, Maize	Black	750	Krishna Vishwanath Sonune
82.	Khammam	Telangana	Paddy, Cotton, Chilli and Redgram	Black cotton and red soil	1161	Hemantha Kumar
83.	Nalgonda	Telangana	Cotton, Paddy, Pigeonpea and Greengram	Sandy loam, light black to medium black soils	740	Narsimha Reddy
<b>ATARI VI</b>						
84.	Valsad	Gujarat	Paddy, Chickpea, Pigeonpea, Black gram and Sugarcane	Medium black	2208	R.F. Thakur
85.	Rajkot	Gujarat	Cotton, Groundnut and Wheat	Medium & shallow black	635	A.V.Khanpara
86.	Kutch	Gujarat	Castor, Cotton and Bajra	Sandy Loam	360	U.N. Tank
87.	Banaskantha	Gujarat	Bajra, Castor, and Pulses Sandy loamy	Loamy Sand to	578	A.J. Patel
88.	Amreli	Gujarat	Groundnut, Cotton and wheat	Medium & shallow black	580	N.S. Joshi

S. No	Name of the KVK	State	Crops	Soil	Rainfall (mm)	Name of the Program Coordinator
89.	Jhunjhunu	Rajasthan	Pearl Millet, Mustard, Cowpea, Cluster bean, Wheat and Chickpea	Sandy Loam	450	S.M. Mehta
90.	Bharatpur	Rajasthan	Pearl Millet, Sorghum, Wheat, Mustard and Barley	Alluvial	667	Amar Singh
91.	Jodhpur	Rajasthan	Mothbean, Pearl millet, Cluster bean and Green gram	Sandy Loam	318	S.K.Sharma
92.	Kota	Rajasthan	Soybean, Black gram, Wheat, Coriander, Chickpea, Mustard and Sesame	Black clay loam	745	Mahendra Singh Choudhari
93.	Barmer	Rajasthan	Pearl millet, Cluster bean, Mothbean and Greengram	Sandy loam	246	Pradeep Pagaria
<b>ATARI VII</b>						
94.	Raipur	Chhattisgarh	Paddy, Wheat and Chickpea	Vertisols	1100	Sameer Tamrakar
95.	Bilaspur	Chhattisgarh	Paddy, Wheat, Pigeonpea and Chickpea	Loamy	1260	K.R.Sahu
96.	Dantewada	Chhattisgarh	Paddy, Maize, Horse gram and Niger	Loamy	1390	Narayan Sahu
97.	Satna	Madhya Pradesh	Paddy, Pigeonpea, Chickpea and Wheat	Loamy	1100	R.S. Negi
98.	Guna	Madhya Pradesh	Soybean, Wheat, Chickpea and Coriander	Shallow to medium black	970	Sunita Mishra
99.	Morena	Madhya Pradesh	Pearl Millet, Pigeonpea, Mustard and Wheat	Alluvial	701	S.P. Singh
100.	Datia	Madhya Pradesh	Groundnut, Wheat, Chickpea and Sesame	Alfisols	743	R.K.S. Tomar
101.	Tikamgarh	Madhya Pradesh	Soybean, Wheat, Black gram, Mustard and Sesame	Alfisols	846	B.L.Sahu
102.	Chhatarpur	Madhya Pradesh	Wheat, Sesame, Chickpea, Black gram, Soybean, Groundnut and Barley	Sandy loam	1075	Veena Pani Shrivastava
103.	Balaghat	Madhya Pradesh	Paddy, Wheat, Chickpea, Pigeonpea and Black gram	Sandy loam	1447	R.L.Raut
104.	Ratlam	Madhya Pradesh	Pearl millet, Cluster bean and Greengram	Sandy loam	246	M.K. Shrivastava

S. No	Name of the KVK	State	Crops	Soil	Rainfall (mm)	Name of the Program Coordinator
105.	Jhabua	Madhya Pradesh	Soybean, cotton, maize and Blackgram	Shallow soil	855	I.S. Tomar
106.	Kendrapara	Odisha	Sugarcane, Black gram, Green gram, Groundnut, Paddy and Jute	Sandy loam	1556	Lalit Kumar Mohanty
107.	Jharsuguda	Odisha	Paddy and Maize	Red laterite	1023	Biswa Pattnaik
108.	Sonepur	Odisha	Paddy and Greengram	Red, brown forest	1293	S.N.Mishra
109.	Ganjam	Odisha	Paddy, Greengram, Groundnut, Maize and Black gram	Sandy-clay	1020	Rashant Kumar Panda
110.	Kalahandi	Odisha	Paddy, Greengram and Blackgram	Red soil	1330	Tapan Kumar Das
<b>ATARI VIII</b>						
111.	Tumkur	Karnataka	Groundnut, Maize, Finger Millet and Pigeonpea	Red loamy soils	696	N. Loganandhan
112.	Kolar	Karnataka	Paddy, Groundnut, Finger Millet and Pigeonpea	Red sandy loam	590	Manjunath Gowda
113.	Davangere	Karnataka	Maize, Cotton, Redgram and Finger Millet, Sorghum, Sugarcane	Red	590	Devaraja
114.	Belgaum	Karnataka	Maize, Sunflower, Groundnut, Wheat, Bengal gram and Sugarcane	Red and black	439	S. Shasi Kumar
115.	Gadag	Karnataka	Greengram, sorghum, groundnut, chickpea, maize	Medium black soil	630	L.G. Hiregoudar
116.	Kalburgi (Gulbarga)	Karnataka	Redgram, sorghum, chickpea	Deep black clayey soils	842	Raju Teggelli
117.	Alleppey	Kerala	Paddy and Banana	Clayey alluvial	2809	P. Muralidharan
118.	Namakkal	Tamil Nadu	Sorghum and Groundnut	Sandy loam	400	N. Akhila
119.	Thiruvarur	Tamil Nadu	Paddy, Blackgram, Greengram and Groundnut	Black soil	1124	R Bhaskaran
120.	Ramanathapuram	Tamil Nadu	Paddy, Cotton, Foxtail millet, Finger Millet and Sorghum	Sandy loam & clay loam	850	R. Durai Singh
121.	Villupuram	Tamil Nadu	Paddy, Groundnut, Sugarcane and Black gram	Sandy clay loam	1067	Sheeba

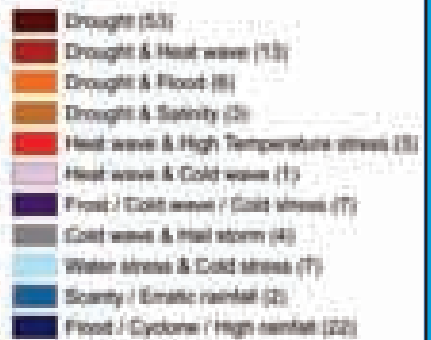
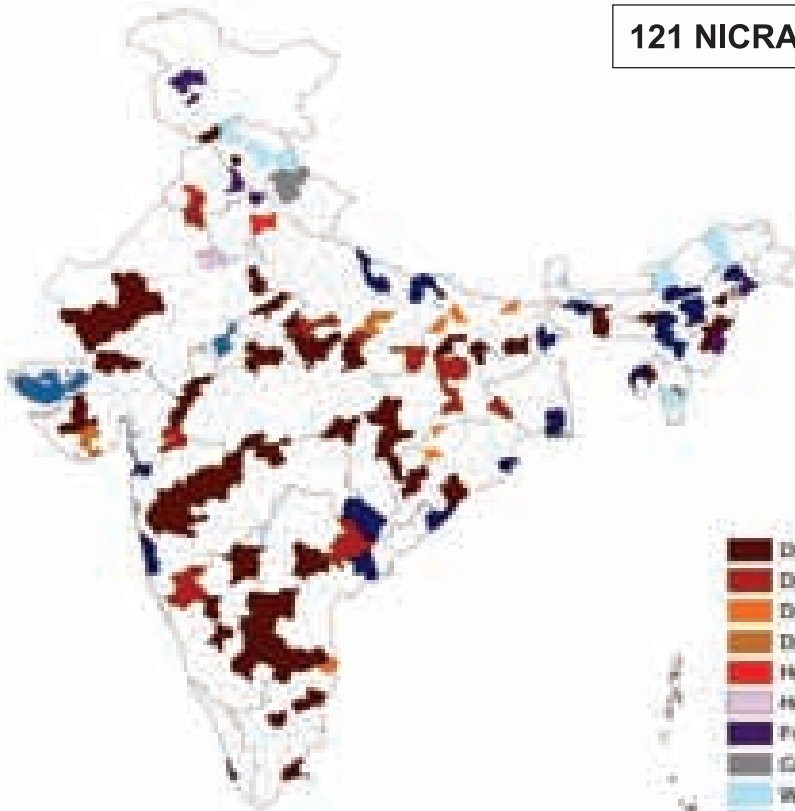
## 15. Budget Utilization

(Rs. in lakhs)

S.No.	Zone	Sanctioned Budget	Expenditure
1	I	163.00	144.92
2	II	213.75	179.01
3	III	293.00	237.72
4	IV	174.75	128.46
5	V	187.75	170.59
6	VI	138.75	110.97
7	VII	215.75	172.32
8	VIII	138.25	114.92
	Total	1525.00	1258.91



## 121 NICRA KVKs



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