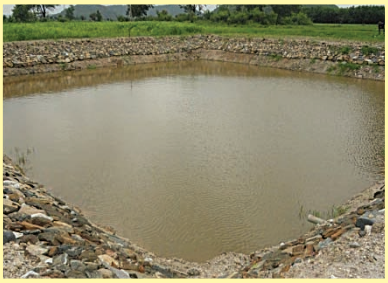
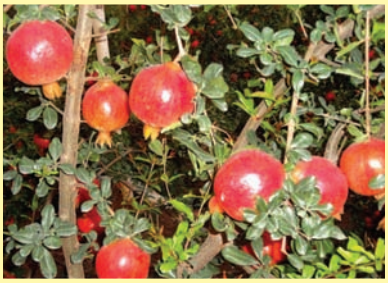
Evidences of
Climate Smart Agriculture in the Semi-Arid Tropics






ICAR-Agricultural Technology Application Research Institute (ATARI)

CRIDA Campus, Santhoshnagar, Hyderabad-500059, Telangana, India.

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Climate Smart Agriculture in the Semi-Arid Tropics

**YG Prasad, G Rajender Reddy, T Himabindu, JV Prasad,
D Keshava and AK Singh**

**ICAR- Agricultural Technology
Application Research Institute (ATARI)**

CRIDA Campus, Santhoshnagar, Hyderabad-500059
Telangana, India.

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Compiled by:
Dr. G Rajender Reddy, Nodal Officer, NICRA-TDC, Zone V, ICAR-ATARI, Hyderabad.

Contributors:
Principal Investigators, Co-PIs and Research Fellows of NICRA KVKs of Zone V (Andhra Pradesh, Telangana and Maharashtra)

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CRIDA Campus, Santoshnagar, Saidabad PO, Hyderabad-500 059
Ph: 040-24006500, 24530300, 24536517, Fax: 040-24533543
Website: http://zpd5hyd.nic.in
E-mail: zcu5hyd@gmail.com

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PREFACE

Technology Demonstration Component (TDC) is aimed at addressing current climate variability faced by farmers in agriculture and allied sectors under the National Innovations in Climate Resilient Agriculture (NICRA) project. Krishi Vigyan Kendras (KVKs) are the grassroot level project implementation partners working closely with farmers in adopted village clusters in 121 identified climatically vulnerable districts across the country. The major climate vulnerabilities addressed by the KVKs include drought, flood, cyclone, heat/cold wave and other extreme events. In the semi-arid tropics, 15 districts were identified for their vulnerability to drought and heat stress (12 districts) and floods (3 coastal districts). KVKs in these districts selected representative village clusters and established baseline at household and village level through participatory rural appraisal (PRA) and also created enabling village level support institution comprising of farmers. After analyzing the constraints and level of exposure, detailed village level action plans were prepared and climate resilient interventions were implemented in four modules viz., natural resource management, crop production systems, livestock and fisheries production systems and institutional interventions.

During 2015-16, the monsoon rainfall was erratic and many NICRA sites experienced deficit rainfall conditions. Rainwater harvesting in farm ponds, check dams and storage tanks followed by efficient use through supplemental irrigation at critical crop growth stages ensured better crop performance (by 20-30%) in rainfed areas. The practice of rainwater harvesting also facilitated improved rabi production in kharif fallows. In-situ soil moisture conservation practices through appropriate soil management practices enhanced productivity and profitability of farmers in rainfed areas.

Evidences of increased resilience in unfolding situations of drought was possible through crop diversification, choice of short duration and stress tolerant crop cultivars and intercropping systems. Emphasis was laid on appropriate fodder production and feed management for livestock, introduction of elite breeds and shelter management in small ruminants and backyard poultry. Captive rearing of fish seed in inland fisheries reduced cost of production and enhanced productivity. Need based training programmes on climate smart agricultural practices and technologies were organized by KVKs covering farmers, farm women, youth and extension personnel. Extension activities were taken up in all the districts for awareness and wider adoption of climate resilient agricultural practices.

This publication (Annual Report 2015-16) documents the evidences of climate smart agriculture in the predominantly rainfed districts in the three states of Andhra Pradesh, Telangana and Maharashtra. We gratefully acknowledge the guidance and constant support from Dr. Trilochan Mohapatra, Secretary, DARE & DG, ICAR; members of the High Level Monitoring Committee (HLMC), Agriculture Extension Division and Director, ICAR-CRIDA. We appreciate the valuable contributions of KVK project scientists and farmers in this important project for enhancing the resilience of agriculture in the semi-arid tropics.

Authors

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Executive Summary

National Innovations in Climate Resilient Agriculture (NICRA) is a multi-institutional and multi-disciplinary network project launched by ICAR) in 2011. The project aims to enhance resilience of Indian agriculture to climate change and climate variability through strategic research and technology demonstrations. Technology Demonstration Component is the lifeline of NICRA and is being implemented through 121 Krishi Vigyan Kendras (KVKs) in 121 climatically vulnerable districts across the country. Fifteen of these districts identified for their vulnerability to drought, flood and cyclone are located in the states of Andhra Pradesh, Telangana and Maharashtra. These include the districts of Anantapur, Chittoor, Kurnool, Srikakulam and West Godavari in Andhra Pradesh (5 implementing KVKs); Khammam and Nalgonda in Telangana (2 KVKs); Ahmednagar, Amravati, Aurangabad, Buldhana, Jalna, Nandurabar, Pune and Ratnagiri in Maharashtra (8 KVKs).

ICAR-Agricultural Technology Application Research Institute (ATARI), formerly known as Zonal Project Directorate (ZPD), located at Hyderabad is the zonal level coordination unit vested with the responsibility of planning, monitoring and reporting the impact of climate smart interventions carried out by NICRA KVKs in 15 districts across the semi-arid tropics in Zone V.

During 2015-16, 30709 farmers participated in the project activities covering an area of 6410 ha in the three states of Andhra Pradesh, Telangana and Maharashtra. Evidences of climate smart agricultural practices and technologies were documented in the thematic areas of Natural Resource Management (NRM, 1461 participating farmers), crop production systems (1305 farmers), livestock and fisheries production systems (473 farmers) and institutional interventions (1098 farmers). Nearly 7500 farmers were imparted capacity building training on climate smart agriculture and more than 14500 stakeholders were given exposure to the project extension activities.

Rainfall pattern

Seasonal rainfall (June to Sep) was deficient in Anantapur and Chittoor districts (Andhra Pradesh) and Amravati and Aurangabad districts (Maharashtra). In terms of rainfall distribution, most sites received normal or excess rainfall in June except Chittoor, Kurnool, Ahmednagar and Buldhana. Contrastingly, rainfall was deficit or scanty at most sites across all the three states. Crops experienced prolonged dry spells. Deficit or scanty rainfall conditions prevailed at Anantapur and Kurnool during July, August and September with adverse impact on groundnut crop.

Natural Resource Management

Under Natural Resource Management interventions, desilting of check dam in Anantapur resulted in increased water levels in the wells located in the vicinity. Desilting of percolation tank in

Kurnool resulted in additional storage capacity of 12.60 lakh liters of water. Due to arrangement of field drainage channel at Srikakulam, 45 acres of area escaped flood/inundation. Renovation of Jagannadha Naidu tank improved the storage capacity and the harvested water was utilized for cultivation of rabi crops. The harvested rainwater from farm ponds in Khammam district was useful to give supplemental irrigation at critical stages of crop growth and resulted in increased productivity of cotton, paddy and fodder grasses. Desilting of check dam resulted in groundwater recharge in 62 open wells in the vicinity of the check dam and crop residue incorporation saved 5091 tonnes of nitrogenous fertilizer at Amravati. Desilting of nala and construction of cement plug resulted in increased groundwater recharge and also facilitated in providing protective irrigation to crops during kharif and rabi seasons at Aurangabad. Construction of Konkan Vijay bhandaras (temporary checkdam) provided improved water storage for cultivation of rabi crops. Conservation of rainwater through *in-situ* moisture conservation technologies like conservation furrows in pigeonpea at Kurnool and in cotton at Aurangabad, broad bed furrow planting of soybean at Amravati and in Chickpea at Pune, farm bunding in soybean at Amravati, ridge and furrow planting in maize at Nandurbar and in cotton at Khammam and compartmental bunding in rabi sorghum at Pune resulted in enhanced yields. Supplemental irrigation at critical stages of crop growth through micro irrigation in pigeonpea at Kurnool and in cotton at Khammam enhanced yields by 20-30% over rainfed conditions. Green manuring in paddy at Khammam and vermicompost preparation and application at different NICRA centers helped in improving the soil physical and chemical properties besides considerable increment in the crop yields. Microirrigation systems i.e., drip irrigation in jasmine at Kurnool, in chilli at Nalgonda and in cotton & pigeonpea at Aurangabad, sprinkler irrigation in maize in Nandurbar and chickpea at Jalna, not only improved the water use efficiency but also productivity and profitability of the crops.

Crop Production

In NICRA village of West Godavari district flood tolerant variety MTU-1064 performed best followed by MU-1061in flood prone area. Improved varieties Dharani and K-6 (Groundnut) and cold tolerant variety Sheetal (Paddy) at Anantapur, Co-3 (Tomato) at Chittoor, Asha & ICPL87119 (Pigeonpea), Nandyala Sanaga-1 (Chickpea) at Kurnool, LCA-625 (Chilli) at Khammam, PRG-158 (Pigeonpea), WGG-42 (Greengram) at Nalgonda, JS-93-60, JS-9305 and MAUS-71 varieties of soybean at Ahmednagar, Amravati and Aurangabad, BDN-711 (Pigeonpea) and Parbhani Moti (Rabi sorghum) at Aurangabad and Jalna gave stable yields despite exposure to climate risks.

Among cropping systems, intercropping systems of foxtail millet (Seteria + pigeonpea (5:1) at Kurnool, Cotton+ pigeon pea (6:1) intercropping system at Nalgonda and Khammam, Soybean+pigeonpea (4:2), Bt cotton+greengram (1:1), Bt cotton+blackgram (1:1) and rabi sorghum+safflower (3:3) systems in Aurangabad performed better than sole crops.

Under delayed sowings, short duration variety of foxtail millet (Suryanandi) performed better alternative and was profitable than cotton at Kurnool and Anantapur under rainfed situation. Short duration green gram (MGG-295) at Khammam and crop diversification with vegetables (Tomato, ridge gourd and onion) were also found profitable over conventional crops. Similarly crop diversification with Pea (Malav) and Potato (Kufri Jyothi) at Nandurbar was found remunerative compared to traditional crops.

Direct sowing of paddy with fertilizer cum seed drill at Srikakulam, mechanical transplanting of paddy at West Godavari, use of seed cum fertilizer drill in soybean and chickpea at Amravati not only saved the cost of labour but also increased area of operation compared to conventional practices. Direct sowing of paddy with drum seeder in West Godavari and broadcasting of paddy at Khammam district not only saved water but also reduced the cost of cultivation.

Stem application of pesticides instead of foliar sprays at 40 and 60 days after sowing (DAS) effectively managed the sucking pests in cotton at Kurnool and Nandurbar: stem application with profenophos@ 2.0 ml/lt controlled the infestation of mealy bug in cotton at Srikakulam. Use of bio pesticides (*Pseudomonas, Bacillus*) + botanicals (karanj oil + neem oil) along with chemical sprays effectively controlled bacterial blight or oily spot in pomegranate at Ahmednagar. Use of yellow sticky trap brought down population of whitefly in cotton at Jalna.

Livestock and Fisheries

In livestock based interventions, improved fodder variety of Lucerne at Kurnool, Hybrid Napier grass (Co-4) and fodder sorghum (CSH 24 MF) at Chittoor, fodder jowar (MP Chari) and Hybrid Napier grass (APBN-1) at Nalgonda, sweet sorghum (sugar graze) at Khammam, multi cut fodder pearl millet and fodder sorghum (sugar graze) at Ahmednagar, improved fodder maize (African tall) at Aurangabad, fodder Lucerne (RL-88) at Nandurbar and fodder maize at Pune gave higher fodder yields.

Fodder production through hydroponics ensured supply of green fodder and cost of production compared to conventional methods. Silage making improved availability of the green, nutritious fodder during offseason and registered higher milk productivity in dairy animals than farmers practice. Introduction of superior breeding ram improved productivity at Srikakulam. Maintenance of superior breeding lamb in herd increased the production of lambs and reduced the mortality as compared to local at Khammam. Feed enrichment through azolla enhanced the milk productivity and fat content of milk. Supplementation of protein and nutrients through mineral block increased the milk yield by 19% in Kurnool district of Andhra Pradesh. Feeding of area specific mineral mixture at Pune along with paddy straw also improved milk yields.

Improved poultry breeds i.e., Rainbow rooster at Khammam, Giriraja at Ratnagiri, Vanaraja at Nandurbar, Vanaraja and Sreenidhi at Jalna were found superior in terms of number of eggs and

net income. Captive rearing of fish seed from fry stage to fingerling stage reduced the cost of fish production. Intensive goat rearing (Konkan Kanyal breed) on raised platforms reduced mortality rate in kids. Mortality and morbidity losses in livestock were reduced with mass vaccination and animal health camps in different NICRA villages.

Capacity Building

Need based training programmes (248) were organized with participation of 7458 farmers by NICRA KVKs in Zone-V. In Andhra Pradesh 94 training programmes were organized with the participation of 2962 farmers. In Telangana, 19 training programmes were organized with participation of 532 farmers and 81 farm women. In Maharashtra, 135 training programmes were conducted with active participation of 3883 farmers. The training programmes included natural resource management, resource conservation technologies, cropping systems, crop diversification, integrated pest and disease management, soil health improvement, water saving technologies, farm implements and machinery, livestock management etc.

Extension Activities

Extension activities (630) were organized across the zone with active participation of 14577 farmers. Among these 315 activities were conducted with participation of 7878 farmers in Andhra Pradesh. About 818 farmers and 187 farm women participated in 51 extension activities in Telangana State. About 264 extension activities were conducted with involvement of 5694 farmers in Maharashtra.

1. Introduction

Indian agriculture today faces a myriad of challenges pressured simultaneously by several sectoral and non-sectoral demands. These challenges become all the more daunting by the extreme weather vagaries that have become a regular feature over the years. Rainfed agriculture is considered to be relatively vulnerable to climate variability and change in view of its heavy dependence on rainfall. People dependent on rainfed agriculture are also less endowed in terms of financial, physical, human and social capital limiting their capacity to adapt to the changing climate. Experience over the past five years shows that climate variability is already impacting Indian Agriculture. Delayed onsets of monsoon, mid-season and terminal droughts in rainfed areas are causing huge losses to agriculture and livestock production. Climate change/ variability has been affecting the livelihood of farmers leading to the declining productivity and profitability of farming enterprise.

The majority of farmers are small and marginal land owners who are resource-poor. They are most affected due to their low adaptive capacity and risk-bearing ability. By incorporating various adaptation measures in the agriculture system one can increase the resilience and adaptive capacity of the small land holders. Evolving climate resilient agricultural technologies that would increase farm production and productivity *vis-à-vis* continuous management of natural and manmade resources constitute an integral part of sustaining agriculture in the era of climate change. Keeping this information in view, National Innovations in Climate Resilient Agriculture (NICRA) is implemented as a network project of Indian Council of Agricultural Research (ICAR) and is launched in February, 2011. The project aims to enhance resilience of Indian agriculture to climate change and climate variability through strategic research and technology demonstration. The project consists of four components viz. Strategic Research, Technology Demonstration, Capacity Building and Sponsored/Competitive Grants.

Technology Demonstration under NICRA

In order to deal with climatic change under technology demonstration component of NICRA, extensive demonstration of location-specific best bet practices contributing to climate resilience were organized in 15 districts in Andhra Pradesh, Telangana and Maharashtra. The project is implemented in selected districts by respective Krishi Vigyan Kendra (KVK).

Objectives:

- 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.
- To demonstrate site specific technology packages on farmers' fields for adapting to current climate risks.

- To enhance the capacity building of scientists and other stakeholders in climate resilient agricultural research and its application.

Under this component, an integrated package of proven technologies would be demonstrated in one village panchayat in each district for adaptation with an aim to mitigate the ill-effects of climate variability in crop and livestock production systems.

Process of Project Implementation

As a part of the process each KVK has developed action plans by adopting following steps:

1. Formation of inter-disciplinary team consisting of specialists from plant breeding, Natural Resource Management (NRM), Agronomy, Horticulture, Plant protection, livestock, Fisheries, Agricultural Economics, Extension and Home Science etc., The inter-disciplinary team formed in each KVK gave input in selection of an appropriate village, identification of climatic vulnerabilities with regards to agriculture and finalization of climate resilient technology package. The composition of the team varied depending upon the type of climatic vulnerability faced in selected village.
2. The target village was selected based on degree of vulnerability in the district by using secondary/published data like prolonged drought, dry-spells, extreme rainfall events, hailstorms, extreme temperatures, cold and heat waves, frost and flood ,etc.,
3. The village selected for the project activities represented the dominant cropping system of the district. The proportion of the rainfed area in the chosen village was supposed to be more than district average. A higher portion of small and marginal farmers were considered. It was made sure that majority of the farmers in selected village derived major portion of income from agriculture and allied activities. The climatic vulnerability of the village (Intensity of droughts, floods, Heat wave, cold wave etc.) represented that of the district.
4. Climatic characteristics of selected village in terms of quantum and distribution of rainfall, number of rainy days, intensity of rain-spells, number of dry spells over the last 10 years, length of growing season, number of floods that severely damage crops and livestock and other extreme events like frost, heat, cold waves, hail storms, sea inundation of agricultural fields was documented.
5. Participatory Rural Appraisal in selected villages was organized to understand major farming systems, resource situation and assessment of natural resource status, socio-economic, institutional and infrastructural status.
6. The multidisciplinary team in each KVK analyzed the constraints related to climatic variability and indentified the point of interventions focusing larger resource poor groups

addressing resource conservation which give long term and sustainable benefits. The modules that were implemented in selected villages focused on building resilience in soil, adapted cultivars and cropping systems to climatic variability, rainwater harvesting and recycling, water saving technologies, community managed custom hiring centers, crop contingency plans, livestock and fishery interventions and institutional interventions for community owner ship of the programme.

The technological interventions were implemented on participatory mode. The team in each KVK documented the impact of modules with measurable indicators. The progress of the project activities in all NICRA villages was monitored by ATARI, Hyderabad and monitoring cell at CRIDA. The interventions at each NICRA center cover the following four modules:

Module I: Natural Resource Management

This module consists of interventions related to in-situ moisture conservation, water 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, community nurseries for delayed monsoon, location specific intercropping systems with high sustainable yield index.

Module III: Livestock and Fisheries

This module consists of use of community lands for fodder production during droughts/floods, improved fodder/feed storage methods, preventive vaccination, improved shelters for reducing heat stress in livestock, management of fish ponds/tanks during water scarcity and excess water, etc.

Module IV: Institutional Interventions

This module consists of institutional interventions either by strengthening the existing ones or initiating new ones relating to seed bank, fodder bank, commodity groups, custom hiring centre, collective marketing and introduction of weather index based insurance and climate literacy through a village level weather station.

2. Profiles of selected NICRA villages – resources and constraints

Andhra Pradesh

Anantapur

Anantapur is the second most drought-affected district of India. It falls under scarce rainfall zone of Andhra Pradesh. It is in the arid agro ecological zone and is marked by dry summers and mild winters. The NICRA programme is implemented in three clusters of villages namely Chamaluru, Chakrayapeta and Peravali**.** The village Chamaluru has the population of 2790 with 519 households. This cluster has the cultivated area of 2167 ha. The mean annual rainfall of the cluster is 522 mm. The village has 280 bore wells and 40 open wells. The predominant crops grown in this village are: kharif groundnut, castor, pigeonpea, maize, paddy, tomato and brinjal. The major rabi crops grown in this village are groundnut, paddy, brinjal, tomato and fodder crops. Live stock is an important component in the village. The village has 60 cattle, 200 buffaloes, 150 goat, 900 sheep, 10 pairs of bullocks and 300 poultry birds.

The Chakrayapeta village has a population of 180 with 36 households and 104 ha of cultivated area. It receives an annual rainfall of 498 mm. The village has 5 bore wells. The major crops grown in this village are groundnut, castor, pigeon pea and fodder crops. Cattle (10), buffaloes (100), goat (50), sheep (2200), bullocks (5 pairs) and poultry birds (200) constitute important components of livestock grown in this village.

The village Peravali has a cultivated area of 714 ha with 431 households. It receives an annual rainfall of 498 mm. Groundnut, castor, tomato, pigeon pea and fodder crops are mainly cultivated in this village. The village has 62 bore wells and 66 open wells. It has 25 cattle, 200 buffaloes, 50 goats, 2250 sheep and 50 poultry birds. The cluster has both red and black soils. The range of ground water depletion in both black and red soils is 0.13-5.3m and 2.3-13.34 m respectively. The area experiences frequent droughts and water scarcity. Frequent dry spells, occurrence of late leaf spot (LLS), poor soil health and labour scarcity are few major constraints affecting the productivity in groundnut. Increased cost of cultivation due to high fertilizer application, high seed cost and poor LLS management are main reasons for low net returns. Horticultural crops (Mango, citrus, tamarind, guava, ber and vegetables) are grown under irrigation. The important livestock in this village constitutes dairy animals and poultry. Mortality and morbidity losses due to biotic and abiotic stress, fodder scarcity and poor access to live stock services are major livestock problems in this village.

Chittoor

The village selected for implementing NICRA Project activities is Chittecherla belongs to Chinnagottigallu Mandal. The major climatic vulnerability of the village is drought. The normal annual rainfall of the village is 774 mm. Agriculture in this area is mainly rainfed and main sources of irrigation are tanks and bore wells. There are 10 tanks and 16 small percolation tanks

in Chittecherla gram panchayat. The major soil types are red loamy soils and red sandy soils. The main crops in the selected village are paddy, groundnut, tomato, mango, pigeon pea and vegetables.

Kurnool

Kurnool is one of the drought prone districts of Andhra Pradesh. Yagantipalle village which is located at a distance of 4 km from Banaganapalle Panchayat of Banaganapalle mandal with 70% of rainfed agriculture was selected for implementing NICRA project. The village has 361 households with 640 ha of cultivated area. The major soil types are sandy clay loam to clay loam. The village has 176 cattle, 976 buffaloes and 300 sheep and Goat. Desi cotton and pigeonpea are the main crops grown during kharif and sorghum, sunflower and chickpea in rabi. The village Meerapuram has a population of 1835 members with 381 households and 200 ha of cultivated area. Sorghum and pigeonpea are important crops grown in this village. The village on an average receives a rainfall of 633 mm annually. The major source of irrigation is bore wells. Most of the crops are affected by late onset of monsoon followed by dry spells during critical crop growth periods, which in turn is severely affecting the yield of these crops. Water scarcity, poor soil health, frequent droughts and losses due to pest and diseases are major climatic vulnerabilities faced by the farming community. The major livestock in this village are cattle (12), buffaloes (1154), sheep and goat (570). Mortality and morbidity losses due to a biotic and biotic stresses, fodder scarcity and poor access to livestock services are major constraints for increased profitability in livestock.

Srikakulam

Srikakulam is one of the flood prone districts in Andhra Pradesh. Heavy floods occur generally during September and occasionally in October and November due to heavy rain fall and depressions formed in Bay of Bengal. The normal annual rainfall received in the district is 1162 mm. But, the rainfall distribution is quite erratic. Annampeta, Thimadam and Adduripeta villages in Burja mandal were selected for implementing the project activities during first year. The rainfall distribution in these villages was irregular and the crops were mostly rain fed. During second year (2011-12), to cover the flood prone area, Sirisuwada village of Kothuru mandal was selected in Rabi 2011-12 to make technological interventions in flood prone areas. The village is situated 3 km away from Kothuru Mandal Head-Quarters. It has 250 village households with total cultivated area of 600 ha. The major soil types are red sandy and red sandy loams with clay base. The mean annual rainfall received is about 982 mm. The major cropping systems in this village include paddy/cotton/vegetables/pulses/groundnut. Mid seasonal drought is most frequent due to erratic distribution of rainfall. The village is prone to floods due to excess rainfall received during monsoon season in low lying areas of around 150 acres lying near to Jagannatha Naidu tank either due to overflow of hill stream in Marripadu Gedda or water from Vamsadhara river.

West Godavari

Floods and cyclones are the major climatic constraints in the Godavari districts of Andhra Pradesh. Rice is the major crop in this district and most of the crop gets damaged by heavy rains during August to September months. Matsyapuri village was selected to implement the activities of NICRA. The village has 1602 households. Rice is the major crop grown in 616 ha area. The village has 150 ha fish and prawn ponds. It receives a mean annual rainfall of 1077 mm. The major soil types are alluvial soils. The major existing cropping systems are paddy-paddy-pulses. Floods and cyclones are major climatic vulnerabilities limiting the productivity of crops. Water logging, mid season drought, poor soil health are major limitations to the crop productivity in this village. The major livestock in this village are ruminants (1103). The village has 1179 poultry birds. Mortality and morbidity during and post flood, loss of fish during floods and fodder scarcity are major constraints for livestock in this village.

Telangana

Khammam

Khammam district is situated in Northern Telangana. The district comprises of 46 mandals under four revenue divisions namely, Khammam, Kothagudem, Palvoncha and Bhadrachalam. It is one of the agriculturally important districts in the state with a total geographical area of 16, 02,900 ha and net sown area of 469710 ha (29%). Nearly 47% area is under forests. The village of Nacharam (Nacharam and Cluster villages; Gangulanacharam, colony nacharam, Ramatanda, Bhadrutanda, Muniya tanda and Bheemlatanda) situated in Enkoor mandal of Khammam district is selected for implementing the project activities. The village has 749 households with a population of 3246. The village receives an annual rainfall of 1054 mm with uneven distribution. Seasonal drought and heat waves are the major climatic vulnerability of this cluster. The total cultivated area is about 1382 ha. Paddy, cotton, chilli and sugarcane are the major crops grown in the project village. The major soil types are black red soils. Major sources of irrigation include streams and bore wells. The major component of livestock constitutes white cattle-897, black cattle-928, sheep-913 and goat-1614.

Nalgonda

Nalgonda district falls under Southern Telangana region. The villages Nandyalagudem and Boring Thanda of Atmakoor (S) Mandal were selected for implementing NICRA project activities. The village is having 50 ha total cropped area with 155 households. Sandy loams, loamy sands and light black to medium black soils are the major soil types in this village. The average annual rainfall is 804 mm. But the distribution of rainfall is erratic. The major crops grown in these villages are cotton, pigeon pea, green gram, paddy and vegetables. Late onset of monsoon, mid and terminal dry spells and poor soil health are most common climatic vulnerabilities of this village. Wells and bore wells are major sources of irrigation. Heat wave affects the yield of mango

and sweet orange crops. Mortality and morbidity losses due to biotic and a biotic stresses and fodder scarcity are major causes for low productivity of livestock. Low seed replacement rate, poor access to quality seeds & farm machinery and poor livestock services are major institutional limitations for enhanced livelihoods in this village.

Maharashtra

Ahmednagar

The village Nirmal Pimpri was selected to implement the NICRA activities in Ahmednagar district. The village has a total population of 1268 with 319 households. The major soil types in the village are black soils. The village receives mean annual rainfall of 457 mm. The main source of the irrigation is open wells. Pearl millet, rabi sorghum, maize, wheat and onion are the main crops grown in the village. Drought is the major climatic vulnerability of the village. The soils in the selected village are medium in nitrogen, low in phosphorus and high in potassium. The average EC and pH of soil: EC-1 to 2 and pH-8.3 to 9.0.The average EC and pH of water: EC-1 to 4 and pH-8.0 to 9.0. The average EC and pH of silt: EC-0.26 and pH 7.97. The soils in the village have 1-3m soil depth. These soils have low infiltration capacity. Hence water stagnation and soil erosion are major problems in the village. The soils were deficit in micro nutrients (Fe and Mn). The village has 859 cows, 454 goats, 6 buffaloes and 53 bullocks. Low rainfall, frequent droughts, and fodder scarcity during summer are major constraints that limit the living standards of farmers in this village.

Amravati

NICRA village Takali (Bk), Nanggaon Kh (Tehsil) is selected for implementing the project activities in Amravati district. The village has 424 village households. It has total cultivated area of 880 ha. Medium black cotton soils are the major soils in this selected village. The village receives an annual normal rainfall of 918 mm. Cotton, soybean, pigeon pea, chickpea and wheat are major crops grown in this village. Drought, water stress and heat waves are major climatic vulnerabilities faced by the farming community.

Aurangabad

Shektha village in Gangapur Tehsil is selected for implementing the NICRA activities in Aurangabad district of Maharashtra. The farmers in selected village are cultivating 120 ha of cereals, 36 ha of pulses, 15 ha of oil seeds and 226 ha of cotton. The village has 380 ha of cultivated area out of which 75.5% area is rainfed. The village on an average receives mean annual rainfall of 644 mm. It is predominated with black soils (Shallow to light). Water scarcity, poor soil health, intermittent dry spells are limiting the productivity of crops. Mortality losses due to abiotic and biotic stresses, scarcity of fodder resources are main constraints for stepping up milk production in live stock. Low seed replacement, poor access to improved seeds, farm machinery and livestock services are limiting the standards of living of the farmers.

Buldhana

Village Girda of District Buldhana was selected for implementing NICRA project activities. The village has the population of 940 with 230 total households. This village is having 1352.17 ha geographical area and out of this 404.90 ha area is under cultivation. The village Girda receives an average rainfall of 853 mm from June to September. The village has black soils (light to medium). The area experiences frequent droughts and water scarcity. The village has 15 bore wells and 18 open wells. Predominant crops grown in this village are soybean in kharif season and chickpea in rabi. Live stock is an important component in the village. The village has 65 cows, 45 buffaloes, 200 goats, 23 pairs of bullocks and 320 poultry birds. The important livestock enterprises in this village are dairy animals and poultry. Mortality and morbidity losses due to biotic and a biotic stress, fodder scarcity and poor access to live stock services are major livestock problems in this village.

Jalna

Jalna is most drought affected district in Marathwada region of Maharashtra. NICRA project is launched in Kadegaon village of Badnapur Tehsil in Jalna district. Total population of village is 3150 with 355 households. It has literacy rate of 84.50 for male and 70.50 for females. The village Kadegaon has total 876.61 hectares of cultivable area. The average rainfall of Kadegaon village is 703 mm. The soils are medium deep to shallow challenging to frequency of irrigation. Most of the crops are grown under rainfed situation with protective irrigation. Major source of irrigation is through open wells and very few bore wells (Tube wells). It has more than 150 open wells. Only 22 ha area is under perennial irrigation and 350 ha under seasonal irrigation. The micro-irrigation system has 22 no. of sprinkler set and 75 no. of drip irrigation systems. The major crops grown in project village are cotton, pigeon pea, maize, pearl millet and soybean in kharif season and sorghum, chick pea and wheat in rabi season. The major economics of village depends on cotton production. Rabi sorghum is a major food crop which also provides fodder to animals. Sweet orange is the pre-dominant horticultural crop with 21 ha of area. Limited area is under vegetables like chilli, ginger and cauliflower. The village is having 372 bullocks, 180 desi cows, 06 crossbred cows, 210 buffalos, 360 goats and 550 hens under livestock. The village is having good marketing opportunities.

Nandurbar

Umarani (NICRA village) is situated in the Satpura ranges of Nandubar district. It receives an annual normal rainfall of 813 mm. The frequency of intense rainfall is 2.5 as decadal average in that area. It has 257 households and also has total cultivated area of 539 ha. The main source of irrigation in the village is bore wells and natural drains. The existing soil types are red and black. The soils are having shallow rooting depth, prone to soil erosion (moderate to severe). Soil erosion is a serious problem faced by the farmers. Major cropping systems in the village are

soybean, sorghum, maize and pigeon pea. The village on an average receives 814 mm of rainfall. The major crops grown in the village are kharif sorghum, soybean, chickpea and mango. The major climatic risks in this village are drought and heat stress. Most of the tribal farmers have 7-8 mango trees in their fields. Preparation of mango slices from raw mango (Amchur) is the main activity in summer season which is very important monitory source for upcoming kharif season.

Pune

The village Jalgoan KP, located in Baramati tehsil was selected to implement the NICRA programme in Pune district of Maharashtra. It comes under Western Maharashtra zone. The village has 398 households and has the population of 1268. The village on an average receives an annual rainfall of 537 mm. The major soil types existing in the village are medium black soils and are calcareous in nature. The major crops grown in the village are pearl millet, rabi sorghum, maize, onion and wheat. Drought is the major climatic vulnerability in this area. The village has total cultivated area of 1094 ha, out of which 980 ha are rainfed. It has livestock population of 869 cows, 454 goats, 6 buffalos and 53 bullocks.

Ratnagiri

Ratnagiri district of Maharashtra is high rainfall area with scarcity of water. The village selected under NICRA is Haral of Tehsil-Rajapur. The village has 353 households with a cultivated area of about 139 ha. Major existing soil types are red lateritic soils. It receives mean annual rainfall of 3375 mm. High rainfall with scarcity of water as a result of runoff is a major climatic vulnerability in this village. The major cropping systems in the village are rice and small millets. Farmers are cultivating crops like horse gram which can be grown on residual moisture. Cashew and mango are important fruit crops in this village. Sheep, goat, and dairy are important livestock enterprises in this village. Farmers are dependent only on agriculture for their livelihood and very few are engaged in agro enterprises.

Table 1: Details of various NICRA centers of Zone-V

Selected District	Name of NICRA village/villages	Actual rainfall (mm) 2015	Soil type	Major climatic vulnerability
Andhra Pradesh				
Anantapur	Chamaluru,Chakrayapeta and Peravali	454	Red soils	Drought
Chittoor	Chittecharla	880	Red soils	Drought
Kurnool	Yagantipalle	723	Black soils	Drought
Srikakulam	Sirusuwada	1002	Red sandy soils	Floods
West Godavari	Matsyapuri and Veera Varsam	1218	Alluvial soils	Floods

Selected District	Name of NICRA village/villages	Actual rainfall (mm) 2015	Soil type	Major climatic vulnerability
Telangana				
Khammam	Nacharam	1176	Black red soils	Drought, Heat stress
Nalgonda	Nandyalagudem and Boring Thanda	627	Black soils	Drought, Heat stress
Maharashtra				
Ahmednagar	Nirmal Pimpri, Pimpri lokai	365	Black soils	Drought
Amravati	Takali BK	726	Black soils	Drought
Aurangabad	Shekta	388	Black soils	Drought
Buldhana	Girda	784	Black soils	Drought
Jalna	Kadegoan	476	Medium black soils	Drought
Nandurbar	Umarani	743	Red & Black soils	Heat stress, drought
Pune	Jalgoan KP	459	Black soils	Drought
Ratnagiri	Haral	2411	Red &Lateritic soils	Floods

2.1 Annual rainfall at NICRA sites

The primary source of water for agricultural production in most of the world is rainfall. The crop productivity in rainfed regions depends upon the amount, intensity and distribution of rainfall in a given season and place. Precise documentation of these three main characteristics is essential for planning its full utilization in view of changing climate scenario, especially rainfall. Hence there is need to study the rainfall pattern to understand the crop and livestock behavior in different NICRA centers.

Quantum of rainfall

The NICRA centers located in Chittoor, Kurnool and West Godavari districts of Andhra Pradesh and khammam districts of Telangana received excess rainfall compared to the respective annual rainfall during 2015. The centers located in Anantapur and Srikakulam (Andhra Pradesh), Nalgonda (Telangana) and all NICRA centres of Maharashtra received deficit rainfall during 2015 (Table1). In Andhra Pradesh, Chittoor, Kurnool and West Godavari districts received excess rainfall by 106, 90 and 141 mm compared to the normal annual rainfall respectively. But the rainfall in Anantapur and Srikakulam was deficit by 98 and 262 mm than annual rainfall respectively. The rainfall in the districts of Khammam and Nalgonda was deviated to the extent of 1.29 and 22 percent compared to the respective normal rainfalls received during 2015. The

rainfall received in all NICRA centres of Maharashtra i.e., Ahmednagar, Amravati, Aurangabad, Buldhna, Jalna, Nandurbar, Pune and Ratnagiri was less by 92, 192, 256, 69, 227, 71, 46 and 964 mm respectively than corresponding normal annual rainfall (Table 2).

Table 2: Rainfall details of NICRA villages in Andhra Pradesh, Telangana and Maharashtra

Name of the centre	Normal annual rainfall (mm)	Rainfall during 2015 (mm)	Excess/deficit rainfall	% deviation of rainfall from the normal i.e., $\frac{\text{Actual – Normal}}{\text{Normal}} \times 100$
Andhra Pradesh				
Anantapur	552	454	-98	-17.8
Chittoor	774	880	+106	13.7
Kurnool	633	723	+90	14.2
Srikakulam	1264	1002	-262	-20.7
West Godavari	1077	1218	+141	13.1
Telangana				
Khammam	1161	1176	+15	1.3
Nalgonda	804	627	-177	-22.0
Maharashtra				
Ahmednagar	457	365	-92	-20.1
Amravati	918	726	-192	-20.9
Aurangabad	644	388	-256	-39.8
Buldhana	853	784	-69	-8.1
Jalna	703	476	-227	-32.3
Nandurbar	814	743	-71	-8.7
Pune	505	459	-46	-9.1
Ratnagiri	3375	2411	-964	-28.6

2.2 Seasonal rainfall distribution (2015-16)

Andhra Pradesh

Total rainfall received during the year 2015 was 454 mm in 16 rainy days and the rainfall during June-December was 314 mm in NICRA adopted village of Anantapur district. Rainfall was received on 16th June facilitating groundnut sowings. Groundnut crop experienced moisture stress due to occurrence of dry spell from 20th June-14th July (26 days).

The NICRA village of Chittoor district received an annual rainfall of 880 mm in 40 rainy days during 2015. Rainfall received during the cropping season was 834 mm. The rainfall received during the months of June, July, September, October and December was less than the normal rainfall in respective months.

The total rainfall received during 2015 was 723 mm in 40 rainy days at NICRA village of Kurnool district with 597 mm rainfall received during the cropping season. Sowings were taken up with rainfall received during the second fortnight of July. 19 days dry spell was observed during 23rd July to 10th August resulted in moisture stress in foxtail millet, pigeonpea and cotton crops. All rainfed crops were revived with receipt of rains during 3rd week of August & 1st week of September. 92.6 mm rainfall received during 2nd and 3rd October resulted in recharge farm ponds and percolation tank (Burrakunta). 200 bore wells located in the vicinity were filled facilitating the cultivation of rabi crops i.e., jowar, chickpea and sunflower without pre sowing irrigation.

The NICRA village Sirusuwada of Srikakulam district received 1002 mm rainfall during 2015 in 33 rainy days. The rainfall during the cropping season was 806 mm. June and August months received an excess rainfall of 118, 140 mm respectively. Paddy nurseries were sown during June. 12 days dry spell from 3-14th July resulted in withering and drying of paddy nurseries, one life saving irrigation was given by using the water stored in Jagannadha Naidu tank. A long dry spell of 21 days was experienced from July 16th July - 6th August. 148.7 mm rainfall received in a span of 9 rainy days during August lead to inundation of paddy in medium (4-5 days) and high (10-12 days) inundated areas.

Total rainfall received during the year 2015 was 1218 mm in 56 rainy days and rainfall during June-December (cropping season) was 1178 mm in NICRA village of West Godavari district. Excess rainfall of 137, 97, 2.6 and 65 mm was received during the months of June, August, September and November respectively.

Telangana

The NICRA adopted village at Nachram of Khammam district received a rainfall of 1176 mm in 47 rainy days during 2015. The rain fall received during the cropping season was 1093 mm. The rainfall received during June and October was higher than normal rainfall by 263 & 131 mm respectively. Excess rainfall during June resulted in full storage of water in farm ponds and streams. The harvested rain water from farm ponds and village tank are major source of irrigation during critical growth stages in paddy and cotton.

The NICRA village of Nalgonda district received total rainfall of 627 mm in 26 rainy days during 2015. Excess rainfall of 126 mm and 131 mm was received during the months of June and September. July, August, October, November and December months recorded deficit rainfall of 153, 111, 114, 34 & 3.5 mm respectively. Green gram experienced dry spells during flowering, pod formation and harvesting stages.

Maharashtra

The NICRA village of Ahmednagar received 365 mm rainfall received during the year 2015 in 17 rainy days and 295 mm received during the cropping season. Due to late onset of monsoon,

the sowings were delayed. Deficit rainfall of 53, 59, 15, 48, 29.6 & 5.3 was observed during the months of June, July, August, October, November and December compared to normal rainfall of respective months. Soybean, pearl millet, maize and groundnut crops wilted permanently due to prolonged dry spells during kharif season.

The total rainfall received during the year 2015 was 726 mm in 27 rainy days and the rainfall during the cropping season was 629 mm in NICRA village of Amravati district. Prolonged dry spell occurred for 20 days during 17th August to 6th September, affected soybean at pod filling stage, higher temperatures resulted in incidence of pests and diseases in kharif crops and wilting in pigeonpea. Deficit rainfall of 41, 230, 107 and 74 mm was observed compared to normal rainfall during the months of June, July, September and October respectively.

The NICRA village of Aurangabad district received a rainfall of 388 mm in 26 rainy days in 2015. Deficit rainfall of 15, 68, 112, 52, 23 and 11 cm was observed during June, July, August, October, November and December months respectively. The harvested rainwater from desilted nala was used to provide protective irrigation to kharif crops during critical growth stages.

784 mm rainfall was received in NICRA village of Buldhana district during the year 2015 in 31 rainy days and 681 mm during the cropping season. Deficit rainfall of 85, 71, 267 and 258 mm was received than the normal during the months of June, July, August and September respectively.

NICRA adopted village of Jalna district received total rainfall of 476 mm during the year 2015 in 12 rainy days. Rabi sorghum suffered moisture stress during the month of October.

NICRA adopted village in Nandurbar district received a rainfall of 743 mm in 23 rainy days during 2015. Deficit rainfall of 170 and 52 mm was recorded during August and October where as June, July and September months recorded excess rainfall than the normal.

In NICRA village of Pune district the total rainfall received during the year 2015 was 459 mm in 19 rainy days and rainfall during the cropping season was 382 mm. Kharif crops pearl millet, onion, sunflower, green gram and maize showed poor germination and also wilted due to prolonged dry spell during the month of June. Rainfall was deficit during the months of June, July, August, November and December.

NICRA village of Ratnagiri district received a rainfall of 2411 mm during 2015 in 84 rainy days and 2299 mm during the cropping season. Excess rainfall was recorded during the months of June, October, November and December whereas, July, August and September months recorded deficit rainfall compared to normal by 778, 401 and 80.5 mm respectively.

Table 3: Rainfall distribution at different NICRA sites during South West monsoon season during 2015

Centre	June			July			August			September			Seasonal (June to Sep)		
	Normal	Actual	Dev. (%)	Normal	Actual	Dev. (%)	Normal	Actual	Dev. (%)	Normal	Actual	Dev. (%)	Normal	Actual	Dev. (%)
Andhra Pradesh															
Anantapur	64	61	-5	67	29	-57	89	52	-42	118	83	-30	338	225	-33
Chittoor	81.2	42	-48	98.4	11.6	-88	114.3	124.4	9	128.3	73	-43	422.2	251	-41
Kurnool	65	32.3	-50	107	84.4	-21	115	78.9	-31	120	216.5	80	407	412.1	1
Srikakaulam	146	263.6	81	239	19.7	-92	205	344.7	68	188	178.2	-5	778	806.2	4
West Godavari	115	252.2	119	265	224.4	-15	190	287	51	178	180.6	1	748	944.2	26
Telangana															
Khammam	131	394	201	304	130	-57	300	155.8	-48	151	151	0	886	830.8	-6
Nalgonda	102.5	228	122	185.2	32	-83	194.7	84	-57	151.1	282	87	633.5	626	-1
Maharashtra															
Ahmednagar	95.4	41.8	-56	69.4	38.8	-44	56.9	57	0	133.1	148.5	12	354.8	286.1	-19
Amravati	146	184.75	27	276.5	80.25	-71	219.8	249.25	13	172.2	99.25	-42	814.5	613.5	-25
Aurangabad	131.8	117	-11	101	33.5	-67	133.3	21.5	-84	172.2	199	16	538.3	371	-31
Buldhana	158.1	85	-46	202.6	71	-65	211.8	267	26	147.8	258	75	720.3	681	-5
Jalna	163.7	194	19	202.3	0	-100	144.2	71	-51	134.2	211.2	57	644.4	476.2	-26
Nanadurbar	120.1	155.5	29	256	367	43	198	28	-86	187.6	192	2	761.7	742.5	-3
Pune	78.5	68.6	-13	56.7	0	-100	67.4	50	-26	150.1	168.4	12	352.7	287	-19
Ratnagiri	817.9	872.7	7	1239.8	462.1	-63	829	427.6	-48	359.7	279.2	-22	3246	2041.6	-37

Green	Normal rainfall (-19 to +19%)
Red	Deficit rainfall (> - 19 to < - 60%)
Yellow	Scanty rainfall (> - 60%)
Blue	Excess rainfall (> +19%)

Table 4: Rainfall distribution at different NICRA sites during North East monsoon season during 2015

Centre	October			November			December			Total		
	Normal	Actual	Dev. (%)	Normal	Actual	Dev. (%)	Normal	Actual	Dev. (%)	Normal	Actual	Dev. (%)
Andhra Pradesh												
Anantapur	111	89	-20	35	0	-100	10	0	-100	156	89	-43
Chittoor	116.2	91.8	-21	120.9	458.4	279	52.5	32.4	-38	289.6	582.6	101
Kurnool	117	102.5	-12	26	81	212	8	1.4	-83	151	184.9	22
Srikakaulam	177	0	-100	60	0	-100	1	0	-100	238	0	-100
West Godavari	190	104.2	-45	65	130	100	15	0	-100	270	234.2	-13
Telangana												
Khammam	114	245.2	115	25	17	-32	3	0	-100	142	262.2	85
Nalgonda	114.1	0	-100	33.9	0	-100	3.5	0	-100	151.5	0	-100
Maharashtra												
Ahmednagar	58.1	9	-85	9.1	0	-100	5.3	0	-100	72.5	9	-88
Amravati	46.4	0	-100	20.5	0	-100	8.6	15.75	83	75.5	15.75	-79
Aurangabad	69	17	-75	22.8	0	-100	11.1	0	-100	102.9	17	-83
Buldhana	49.8	0	-100	24.3	0	-100	11.1	0	-100	85.2	0	-100
Jalna	40.4	0	-100	18.1	0	-100	0	0	0	58.5	0	-100
Nanadurbar	51.8	0	-100	0	0	0	0	0	0	51.8	0	-100
Pune	72.2	87.2	21	32.1	7.8	-76	5.3	0	-100	109.6	95	-13
Ratnagiri	128.4	218.8	70	0	34	0	0	5	0	128.4	257.8	101

Green	Normal rainfall (-19 to +19%)
Red	Deficit rainfall (> - 19 to < - 60%)
Yellow	Scanty rainfall (> - 60%)
Blue	Excess rainfall (> +19%)

Table 5: Dry spells and continuous wet spells observed in NICRA centers during 2015

Centre	Rainfall during cropping season (June-Sep) (mm)	Dry spells (more than 10-20 days)	Continuous wet spells (more than 100 mm)
Andhra Pradesh			
Anantapur	314	20th June-14th July (26 days), 21-31st July (11 days), 4th-16th August (13 days), 22nd August - 4th September (14 days), 12th September -2nd October (22 days), 12th-31st October (20 days)	No wet spells were observed
Chittoor	834	5th -23rd July (21 days), 8th -29th September (22 days), 12th -31st October (20 days)	9th-11th November (186.4 mm), 16-20th November (154 mm)
Kurnool	597	20th June-13th July (10 days), 23rd August -3rd September (12 days), 23rd July to August 10th (19 days), 8th September to 2nd October (26 days)	
Srikakaulam	806	16th July- 9th August (25 days), October (31 days)	4th 18th June (139.7 mm), 10th -13th August (156 mm)
West Godavari	1178	23rd June to 8th July (17 days), 4th - 16th October (12 days)	14th-22nd June (191.6 mm), 18th-23rd July (169.2 mm), 10th-14h August (103.4 mm), 11-14th September (105.2 mm)
Telangana			
Khammam	1093	4th- 15th October (10 days), 18th – 31st October (14 days)	14-22nd June (393.3 mm)
Nalgonda	626	1st 14 July (14 days), 16th 29th July (14 days) 20th -31st August (12 days), 15th -31st September (17 days), October (31 days)	13th -18th June (167 mm)
Maharashtra			
Ahmednagar	295	5th-7th August (23 days), 19th-31st September (13 days) 4th -31st October (28 days)	No wet spells were observed
Amravati	629	17th August-6th September (20 days), 18th -31st September (14 days), October (31 days)	16-21st June (149.5 mm), 3rd-12th August (240.5 mm)
Aurangabad	388	1-20th July (20 days), 7th August-4th Septenber (29 days), 4th-31st October (28 days)	18-19th September (115.6 mm)

Centre	Rainfall during cropping season (June-Sep) (mm)	Dry spells (more than 10-20 days)	Continuous wet spells (more than 100 mm)
Buldhana	681	1-16th July (16 days), 20th-31st September (12 days), October (31 days)	16-19th September (230 mm), 4th-6th August (213 mm)
Jalna	476	17th-31st June (15 days), July (31 days), 7th-26th August (20 days), October (31 days)	11-16th June (183 mm)
Nanadurbar	743	23rd June – 20th July (29 days), 7th August – 12th September (37 days) 20th-31st September (11 days), October (31 days)	25th-30th July (355 mm), 18-19th September (123 mm)
Pune	382	July (31 days), 20th August- 6th September (17 days), 13th -31st October (19 days)	No wet spells were observed
Ratnagiri	2299	20th October-31st October (11 days)	5th-30th June (872.7 mm), 15th -31st (413.7 mm), 1-16th August (301.4 mm), 21-31st August (124.8 mm), 10th-12th September (103.8 mm), 14th-19th September (157 mm)

3. Natural Resource Management

In this module both ex-situ and in-situ rainwater harvesting and its efficient use was demonstrated in farmer's fields. Ex-situ interventions included desilting in check dams and percolation tanks, digging of farm ponds, construction of cement plugs and temporary check dams across seasonal streams. In-situ moisture conservation practices such as farm bunding, opening up of conservation furrows, broad bed/ ridge furrow planting, mulching with crop residue and plastic film and application of hydrogel.

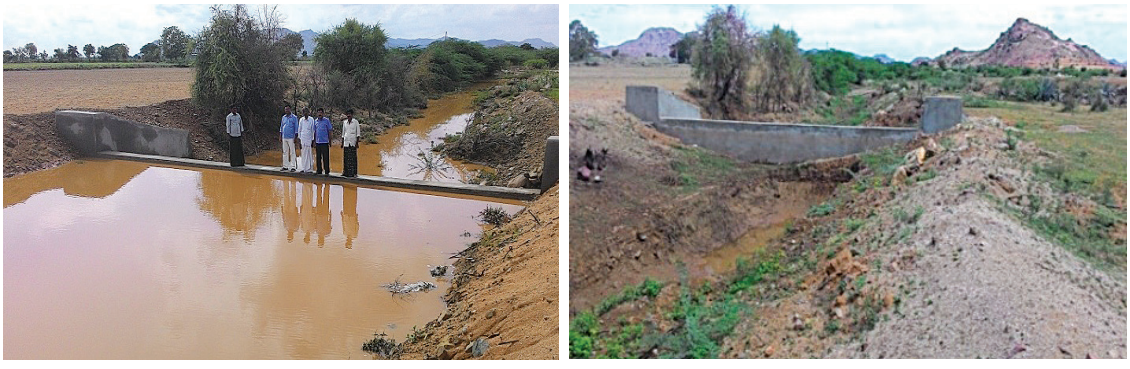
3.1 *Ex-situ* rainwater harvesting and management

Andhra Pradesh

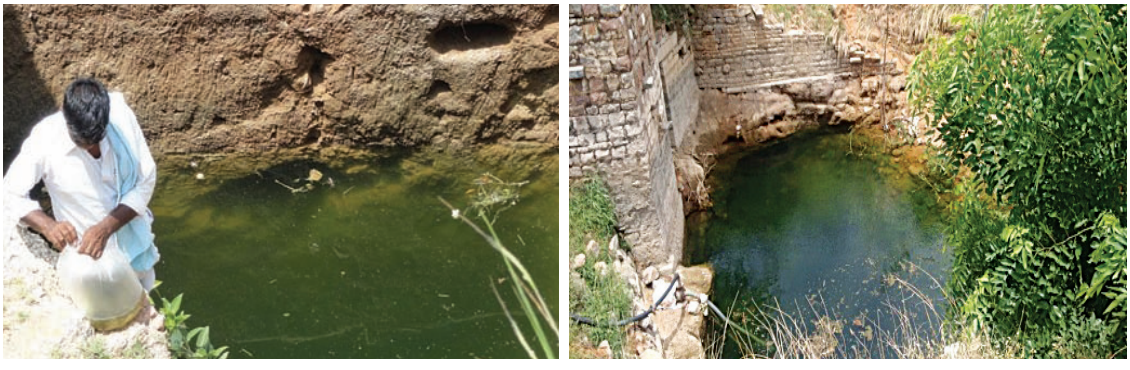
Anantapur

Desilting of check dam

Desilting of check dam was taken up during August, 2015 in NICRA village, as a result 3 open wells and 8 bore wells were recharged in the vicinity of checkdam and the harvested water was utilized for supplemental irrigation to pigeonpea, sweet orange, pomegranate and tuberose and also utilized for drinking water for livestock.



Checkdam before and after desilting



Recharged open wells in the vicinity of checkdam

Kurnool

De-silting of existing percolation tank

The de-silting of existing percolation tank (Burrakunta) was taken up during July 2012 with the water storage capacity of 12.60 lakh litres. It was noticed that recharging of defunct bore wells improved continuously during the last three years due to increase in water levels in percolation tank as a result of desilting (Table 6 & 7).

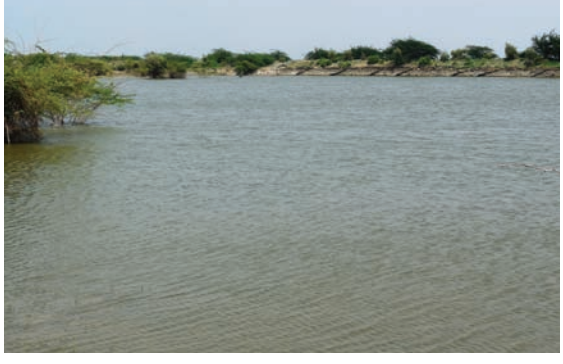
Table 6: Effect of desilting of percolation tank on recharge of bore wells during the year 2015

Month	Water table in the bore well (ft)	Availability of water in Water storage structure (ft.)	Average area irrigated (Acre / Bore well)	Rainfall received (mm)
June	110	1.5	-	32.3
July	115	1.2	2.0	84.4
August	106	5.0	3.0	78.9
September	62	10.0	4.0	216.5
October	51	10.0	4.6	102.5

Total number of borewells-40

Table 7: Year wise impact of percolation tank on recharge of borewells

Year	No. of bore wells under percolation tank	No. of defunct bore wells during summer	No. of defunct bore wells recharged during monsoon period	Depth of water table (ft.) during summer	Depth of water table (ft.) during monsoon period	Average rainfall (mm)
2013-14	110	70	64	158.4	71.4	594.3
2014-15	110	63	60	150.2	74.6	668.6
2015-16	114	26	26	145.4	106.4	621.6



Percolation tank after desilting

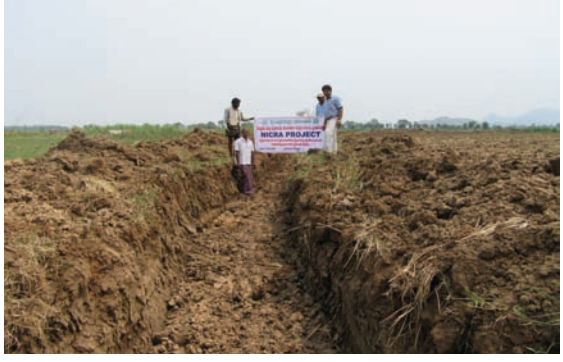
Meeting drinking water needs of livestock

Srikakulam

Renovation of drainage channel and village tank

Arrangement of field drainage channel was taken up to avoid inundation. The construction of 800 mt drainage channel was completed in the month of June, 2015 to let off the excess water either due to floods or rainfall from the fields in order to reduce the period of water stagnation from medium and high inundated fields covering 20 ha area by involving 40 farmers in the NICRA adopted village.

Due to excavation of drainage channel, 25 acres of medium inundation area and 20 acres of low inundation area has escaped inundation/floods during the month of August. Period of inundation was reduced by 1-2 days in both the areas. The drainage channel has shown its impact by letting the crop exposed to complete inundation for not more than 4 days during this year instead of 6-7 days in medium and high inundation areas during previous years, comparatively during the month of September, paddy fields were inundated for 3-7 days, but the water receded slowly due to back waters from Vamsadhara river.



Field drainage channel

Water inundation in paddy fields

Outflow of excess water into drainage channel

Flood water receding in to drainage channel

Renovation of Jagannadha Naidu Tank

Renovation of Jagannadha Naidu tank was initiated during the year 2011-12 due to low storage capacity, weakened sluices and bund leading water over flow and damage to the crops during heavy rains in tank fed areas. In order to reduce the flood in tank fed fields and to overcome water scarcity at early & later stages of the crop during kharif, the renovation of tank was taken up for benefiting 300 farmers (Table 8, 9 & 10).

Table 8: Impact of renovation of village tank during kharif 2015

S. No.	Year	Rainfall (mm)	Water Storage	Irrigated area covered (ha)	Impact
1	2011-12	1287.6	55,531 m^3	130	Due to low tank capacity, weakened sluices and bunds resulted in inundation of crops due to intense rainfall in tank catchment areas, which affected paddy yield.
2	2012-13	1134.1			
3	2013-14	1613.4	1,38,575 m^3	150	Flood intensity was reduced in the tank-fed area compared to previous years
4	2014-15	1337.5			
5	2015-16	806.2	1,38,575 m^3	150	Due to improvement of storage capacity of the tank, strengthening of bunds and sluice repairs, flood intensity was reduced in the tank-fed area.

Table 9: Impact of renovation of village tank during rabi 2015-16

S. No.	Year	Rainfall (mm)	Water Storage	Irrigated area covered (ha)	Remarks
1	2011-12	101.4	Nil	12.0	-
2	2012-13	113.6			
3	2013-14	40.0	98,722 m^3	17.0	Because of improved storage capacity of the tank, sufficient water was available for rabi crops. Cropping intensity of the village increased.
4	2014-15	30.5			
5	2015-16	-	47,500 m^3	-	Due to low rainfall experienced during the season, there was no scope for life saving irrigation during rabi season.

Impact of renovation of Jagannadha Naidu tank:

- Reduction in flood intensity after the renovation of tank
- Timely transplanting of paddy was done in 15 to 20 days earlier than previous year in tank-fed area
- Facilitated adoption of direct sown rice by farmers due to reduction in flood occurrence, improved water storage and scope of life saving irrigation. Farmers could save water, seed and labour cost incurred for raising nursery and carrying out transplanting operation.

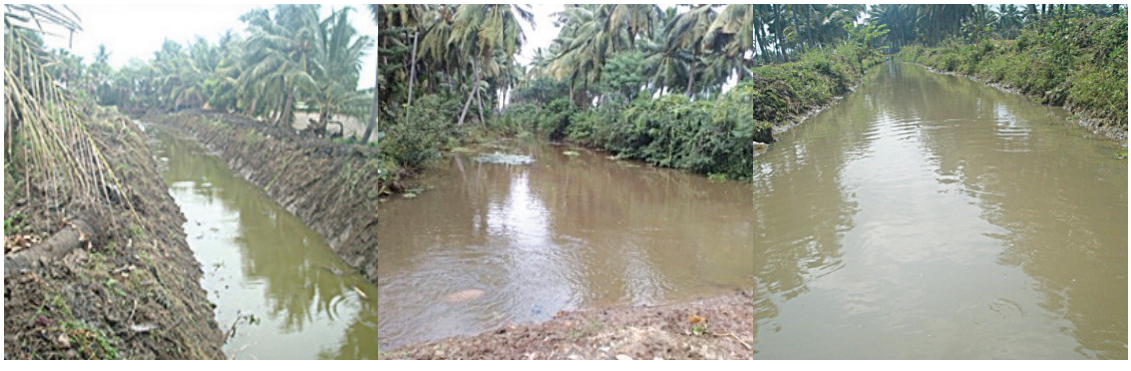
Table 10: Recharge of bore wells adjacent to Jagannadha Naidu tank

Name of the Farmer	Water depth from top (in ft)			
	Water table in Jan, 2013	Water table in Jan, 2014	Water table in Jan, 2015	Water table in Jan, 2016
K. Ramulu	14	12.5	12	11
K. Gourango	10	8	7	9
V. Laxminarayana	13	11	10	10

West Godavari

Renovation of drainage channels

Excavation of Matsyapuri drainage channel was done during the year 2013-14. The positive impact on crop inundation and water logging was observed during subsequent years. During 17-20 November 2015, heavy rainfall (111.2 mm) resulted in partial inundation of paddy crop. The excess flood water was drained out over a period of 7 days as compared to submergence of crop for 15 days prior to renovation of drainage channel.



Renovation of Matsyapuri drainage channel

Khammam

Desilting of village tank

Desilting of village tank (400 cu.m) was done in NICRA village to improve the water storage levels in the tank and to improve the ground water levels in the vicinity of the tank. As a result of desilting the groundwater recharge was about 6 meters. The tank-fed area increased to 60 ha.

Farm pond

Four farm ponds were dug during 2013-14 in Nacharam village of Khammam district. The water harvested in farm ponds was utilized for giving supplemental irrigation to cotton (6.8 ha), paddy (2.0 ha), chilly (1.1 ha), oil palm (4 ha) and fodder (1.7 ha) crops, at critical stages of crop growth during kharif season which resulted in increased productivity of these crops (Table 11).

Table 11: Impact of farm ponds in Nacharam village of Khammam district

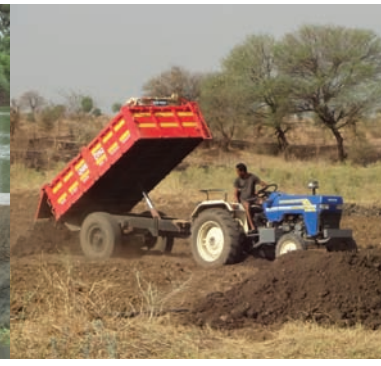
Particulars	2012	2013	2014	2015
Excavation of farm ponds (No.)	4	4	4	4
Storage capacity of farm pond (prior to and after deepening in second year) (cu.m.)	2553	6600	6200	6200
Annual Rainfall (mm)	1520	1090.4	763.20	1025.3
No of wells recharged	-	2	2	2
Area under irrigation in kharif (ha)	-	5.8	4.8	4.6
Area under irrigation in rabi (ha)	-	3.8	-	3.2

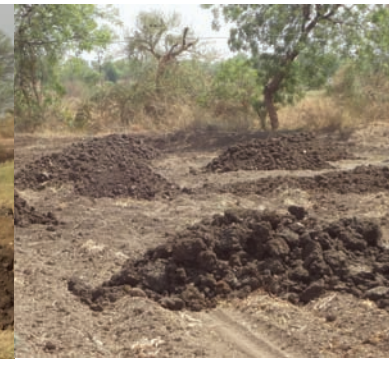
Amravati

Renovation of check dam

Renovation of of checkdams was initiated during 2011-12 for effective rainwater harvesting and utilization in NICRA village Takali BK benefitting an area of 131.7 ha covering 218 farmers. Open wells (62) in the vicinity of check dam were recharged and the harvested rainwater was utilized for supplemental irrigation to an extent of 5.2 ha area under cultivation of flower crops. The silt obtained from check dam was applied in barren lands over a period of 4 years in 54 farmers fields covering an area of 102.6 ha.

Renovated Check Dam





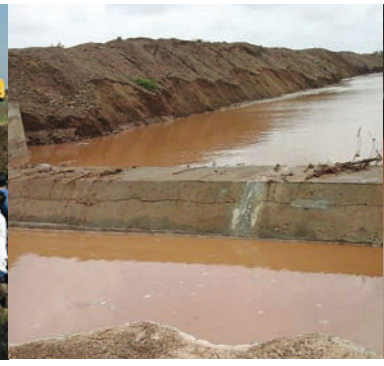
Tank silt application in farmers fields

Aurangabad

Nala desilting and construction of cement plug

Desiliting of nala (500×8×3 m^3) was done during 2015 in NICRA village Shekta of Aurangabad district and cement plug was constructed. Nala was filled twice in Kharif season (June & Sep) and the water level of wells in the vicinity of nala increased up to an average of 8 feet (Table 12). The harvested water was utilized to give protective irrigation during kharif (cotton, pigeonpea, soybean crops) and rabi (rabi sorghum) seasons.

Nala desilting



Construction of cement plug

Increased water level in nala

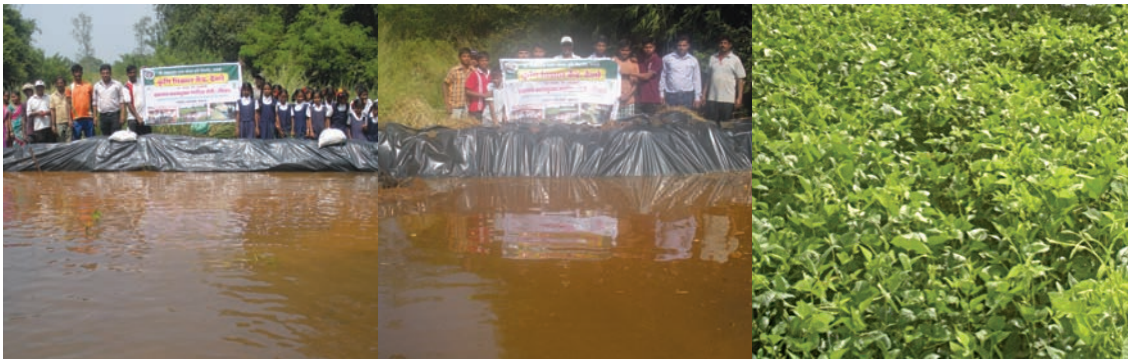
Table 12: Impact of nala desilting on groundwater recharge in 2015 (average of 9 wells)

Month	Water table level in ft	Total area irrigated by wells in the vicinityof Nala (ha)	Rainfall (mm)
June	29.5	17.2	177.0
July	20.9	13.0	33.5
August	15.5	8.0	21.5
September	26.5	18.2	198.9

Ratnagiri

Construction of Konkan Vijay Bhandaras (temporary check dams)

Farmers of Ratnagiri district are unable to cultivate rabi crops due to unavailability of irrigation water. Few small streams flowing by the village are the sources of irrigation. The streams contain much water during monsoon season which does not lost long enough to serve as a source of irrigation by November. Construction of Konkan vijay bhandaras (5 No) was taken up in NICRA village with the participation of 28 farmers and students. The harvested water was utilized for the cultivation of rabi pulses and vegetables covering 3.2 ha area. Cow pea grown with supplemental irrigation using stored water recorded an yield of 11 q/ha with a net income of Rs. 37000.



Construction of Konkan Vijay Bhandaras for rain water harvesting

3.2 *In-situ* soil moisture conservation practices

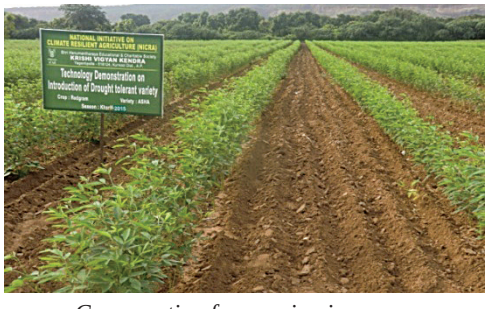
Andhra Pradesh

Anantapur

Sub soiling with chisel plough

Sub soiling breaks the hard pan on the soil surface and helps in percolation of the rainwater into the lower layers of soil from where it is not easily lost by evaporation and aids in deeper rooting. The practice helps in better exploitation of stored soil moisture and applied nutrients from the soil profile. The practice of sub-soiling was adopted in groundnut with highest pod (1330 kg/ha) and haulm yields (2650 kg/ha) compared to farmers practice (1200 kg pod/ha and 2130 kg haulm/ha). Sub-soiling also recorded higher net returns (Rs. 46325/ha) compared to farmers practice. Sub-soiling in pigeonpea gave an yield advantage of 25% and led to realization of higher net income (Rs. 16500/ha) compared to the farmers practice with a benefit cost ratio of 2.40 (Table 14).

Kurnool



Conservation furrows in pigeonpea

Kurnool district falls under the scarce rainfall zone. Frequent and prolonged dry spells at critical crop growth stages were observed leading to poor yields. To cope up with this problem, in-situ moisture conservation measures by formation of conservation furrows between rows of pigeonpea during kharif in an area of 10 ha and application of pusa hydrogel @ 2.5 kg/ha in an area of 4.0 ha were taken up. Conservation furrows in pigeonpea during early growth stages (30 DAS) of the crop resulted in 3% more storage of moisture in the soil profile (0-15 cm) and 9% more in 15-30 cm depth. This gave an additional yield of 1.0 q/ha which was 10.5% higher compared to farmers practice (9.30 q/ha) with a B:C ratio of 4.6 (Table 14).

Application of Pusa hydrogel for moisture conservation

Pusa hydrogel @ 2.5 kg/ha was applied in pigeonpea for absorption and retention and slow release of soil moisture over prolonged periods so as to lessen the adverse impact of soil moisture deficit on crop growth. The application of Pusa hydrogel recorded higher yield of 10.9 q/ha compared no application (9.7 q/ha) (Table 14).

Telangana

Khammam

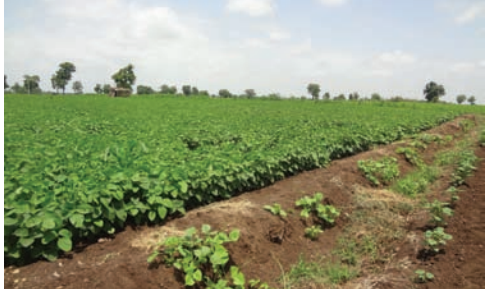
Farmers are obtaining low yields in cotton due to lack of soil moisture limiting crop performance. Ridges and furrows in cotton resulted in better moisture conservation leads to higher in higher yield (22.9 q/ha) and net income of Rs. 40054/ha with a benefit cost ratio of 1.74 compared to farmers practice (19.3 q/ha) (Table 14).

Conservation furrows in cotton

Maharashtra

Amravati

Farm bunding in soybean covering 54 farmers resulted in enhanced productivity by 5.4 q/ha compared to no bunding. Cotton crop recorded higher yield of 2.75 q/ha compared to farmers practice (12.75 q/ha) and total net returns of Rs. 27900 when farm bunding was practiced with a benefit cost ratio of 1.63 compared to no bunding (Table 14).



Farm bunding in soybean

In-situ moisture conservation practices *viz*., broad bed furrow, ridge and furrow, sowing across the slope were demonstrated and compared to no conservation measures to compare the performance of soybean under rainfed conditions. Among different conservation measures adopted, sowing on broad bed furrow recorded highest yield of 17.5 q/ha followed by ridge and furrow (15.5 q/ha) and sowing across the slope (14.8 q/ha). Farmer's practice i.e., without conservation measures recorded lowest yield (10.75 q/ha). The Broad bed furrow system not only resulted in higher yields but also gave highest net returns of Rs. 34950 compared to other methods with highest benefit cost ratio of 2.32 (Table 13).

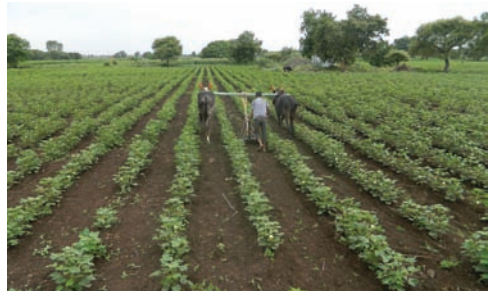
Broad bed furrow in soybean

Table 13: Effect of different in-situ moisture conservation practices in soybean

Treatments	Seed yield (q/ha)	Fodder Yield (q/ha)	Cost of cultivation (Rs/ha)	Gross returns (Rs/ha)	Net returns (Rs/ha)	B:C ratio
Farmers practice (land preparation but no conservation measures adopted)	10.8	21.5	24375	37625	13250	1.54
Sowing on Ridge & Furrow	15.5	31.0	25600	54250	28650	2.11
Sowing on broad bed furrow	17.5	35.0	26300	61250	34950	2.32
Sowing across the slope	14.8	29.5	24375	51625	27250	2.11

Aurangabad

Opening of furrow after every fourth row in pigeonpea gave additional seed yield of 1.6 q/ha compared to pigeonpea without conservation furrows. In cotton, conservation furrows enhanced the yield by 8.3% with a net income of Rs.47300/ and B:C ratio of 2.73 (Table 14).



Conservation furrows in cotton

Jalna

The NICRA village in Jalna experienced erratic rainfall during the season. The village did not receive any rain in July against a normal of 202 mm and experienced 50% deficit rainfall during August and excess rainfall in September. Cotton with conservation furrows performed better with an yield of 15.3 q/ha over farmers practice (8.8 q/ha). Broad bed furrow system of sowing in soybean gave an yield advantage of 18.4% over flat bed method of sowing (9.4 q/ha). Conservation furrow in rabi sorghum gave higher yield and net returns (Table 14).

Nandurbar

Generally farmers sow maize crop behind the plough along the slope resulting in increased run off and soil erosion from agricultural fields. Ridge and furrow planting across the slope using short duration maize cultivar GM-6 by 10 farmers in 4 ha area resulted in increased yield of 24.3% (18.90 q/ha) compared to farmers practice (15.20 q/ha) (Table 14).

Ridges and furrows in Maize

Pune

Adoption of compartmental bunding (10×10 m) in kharif fallows prepared across the slope in medium black soils in 50 farmers fields covering 20 ha area led to conservation of soil moisture and successful raising of rabi sorghum with increased productivity of 15.6 q/ha compared to 11.6 q/ha no compartmental bunding (Table 14).

Effect of Compartmental bunding in rabi sorghum

In-situ conservation practices through broad bed furrow planting in soybean resulted in an yield of 15.8 q/ha compared to 12.3 t/ha in conventional practice with a net income of Rs. 46375/ha. Ridge and furrow planting in chickpea resulted in 25.6% increase in yield over conventional practice with a B:C ratio of 2.80 (Table 14).

Chickpea crop sown on broad beds

Table 14: Effect of in-situ moisture conservation practices on productivity and profitability of kharif crops in the semi-arid tropics

KVK	Practice	No. of demon strations	Area (ha)	Yield (q/ha)		Economics of demonstration (Rs/ha)			
				Improved Practice	Farmers Practice	Gross Cost	Gross Returns	Net Returns	BC Ratio
Andhra Pradesh									
Anantapur	Sub-soiling with chisel plough in groundnut	8	20	13.3	12.0	24150	70457	46325	2.92
	Sub-soiling with chisel plough in pigeonpea	8	20	4.0	3.2	11500	28000	16500	2.43
	Mechanized intercultivation in groundnut	4	4	14.0	12.4	22000	74020	52020	3.36
Kurnool	Conservation furrows in pigeonpea	15	50	10.3	93.1	19865	92520	72655	4.66
	Moisture conservation through Pusa hydrogel in pigeonpea	10	4	10.9	9.7	22506	97785	75279	4.34
Telangana									
Khammam	Conservation furrows in cotton	5	5	22.9	19.3	53918	93972	40054	1.74
Maharashtra									
Ahmednagar	Conservation furrows in soybean	10	10	4.0	4.0	18632	15200	3433	0.82
	Conservation furrows in pearl millet	10	20	8.3	8.3	18359	14850	3509	0.81
Amravati	Farm bunding in soybean	54	75	10.1	4.7	27325	35438	8113	1.30
	Farm bunding in cotton	20	30	15.5	12.8	44950	72850	27900	1.62
Aurangabad	Conservation of furrow in cotton	40	30	17.0	15.7	27300	64600	37300	2.37
	Conservation of furrow in pigeonpea	25	15	12.0	10.4	24900	50400	25500	2.02
Jalna	Conservation furrows in cotton sowing	30	12	15.3	8.8	22250	62525	40275	2.81
	BBF in soybean	30	12	11.3	9.5	21000	40320	19320	1.92
	Conservation furrows in rabi sorghum	50	20	10.3	9.4	6750	21525	14775	3.19
Nandurbar	Ridges and Furrows in maize	10	4	18.9	15.2	14700	27405	12705	1.86
Pune	Compartmental bunding in rabi sorghum sowing	50	135	15.6	11.6	19650	47764	28114	2.43
	Broad Bed Furrow in chickpea sowing	10	4	15.8	12.3	26075	72450	46375	2.78
	Ridges and Furrows in chickpea sowing	10	4	12.5	10.0	25950	57500	31550	2.22
Ratnagiri	Mulching in watermelon	11	3	17.6	9.0	117650	247000	129350	2.10

3.3 Supplemental irrigation using harvested water

Andhra Pradesh

Kurnool

Pigeonpea is grown under rainfed situations in Kurnool. Prolonged dry spells at critical stages of crop growth leads to crop failure or very low yields. Rainwater harvesting in farm pond and recycling of harvested rainwater to provide irrigation through drip irrigation at critical growth stages in pigeonpea (flowering and grain filling) increased the productivity by 39.8% compared to rainfed pigeonpea with a benefit cost ratio of 2.4. Similarly, supplemental irrigation with sprinkler system at ear head emergence stage in sorghum resulted in improved productivity by 28.9% (Table 16).

Telangana

Khammam

Farm pond brought about predictable change in crop production during kharif season in NICRA village in Khammam. Water harvesting through farm ponds and recycling of harvested water in cotton, enhanced the crop yield by 24.8% with increased net income of Rs.13391/ha over farmers practice. Supplemental irrigation in paddy enhanced the yield by 9.7% compared to conventional method with a benefit cost ratio of 1.6. Similarly supplemental irrigation with farm pond water in fodder variety Tanzania showed 30.4% yield increase with a B:C ratio of 2.20 (Table 16).

3.4 Enhanced water productivity - micro-irrigation systems

Low water use efficiency with surface methods of irrigation is one of the problems faced by the farming community in different NICRA centers. In this context demonstrations were organized focusing on micro irrigation systems to avoid water loss and to improve water use efficiency in crops.

Andhra Pradesh

Kurnool

Drip irrigation system was installed in collaboration with APMIP in jasmine in 10 farmer's fields covering 4 ha area. Irrigation through drip system enhanced the flower yield by 7.2 q/ha compared to conventional method of irrigation with a net income of Rs. 220400/ha and a benefit cost ratio of 2.10 (Table 17).

Nalgonda

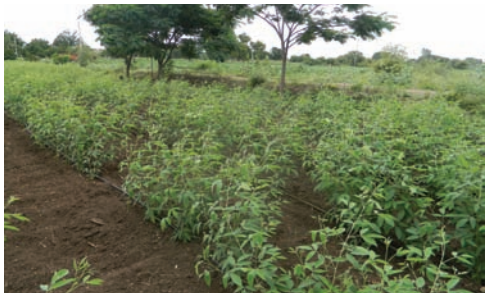
The farmers are growing vegetables like chillies and tomatoes with available water from bore wells through flood irrigation, leading to much wastage of water and decreased water levels in bore wells over the time. Drip irrigation in chillies not only enhanced the water use efficiency but also enhanced the productivity of chilies by 12.5 q/ha with a benefit cost ratio of 5.43 (Table 17).

Drip irrigation in chillies

Maharashtra

Aurangabad

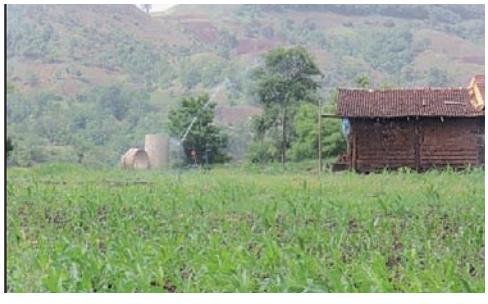
Supplemental irrigation with drip system in cotton with 20 farmers covering 28 ha area resulted in increased yield of 4.1 q/ha over conventional irrigation with a benefit cost ratio of 2.18. Drip irrigation in pigeonpea gave enhanced productivity of 7.50 q/ha with a net income of Rs.39450/ha (Table 17).



Drip irrigation in pigeonpea

Nandurbar

Sprinkler irrigation in maize in 25 farmers fields, covering 10 ha area resulted in 73.2% yield advantage over farmers method with a B:C ratio of 2.59 (Table 17).



Sprinkler irrigation in maize

Jalna

Chickpea showed increased productivity when sprinkler irrigation was given in 16 farmers fields covering 8 ha area with net returns of Rs.10000/ha (Table 17).

3.5 Soil quality and fertility management practices

Reclamation of low fertile/saline soils by green manuring: Khammam

Excessive accumulation of alkali salts in the soils is injurious to plant growth. To reduce the percentage of salts to optimum or normal level so that plants may grow normally in such soils, reclamation of saline or low fertile soils by growing green manure crops like dhaincha (*Sesbania aculeata*) was demonstrated in 10 farmers fields covering 10 ha area which resulted in improved yields of paddy with a benefit cost ratio of 1.87 (Table 18).

Green manure incorporation

Soil test based nutrient application: Nalgonda

Soil tests measure the relative nutrient status of soils and are used as a basis for profitable and environmental friendly fertilizer application. Nutrient application in Bt cotton based on soil test demonstrated was practiced to avoid imbalance and excess use of chemical fertilizers in 12.0 ha involving 30 farmers. Soil test based nutrient application resulted in a saving Rs.1500/ha towards the cost of fertilizers and recorded an additional yield of 2 q/ha (Table 18).

Tank silt application: Anantapur & Nalgonda

Silt application enhanced the productivity of groundnut by 23.13% with a B:C ratio of 3.30 and cotton crop recorded improved yield of 25.30 q/ha over no silt application (22.50 q/ha) in NICRA villages of Anantapur and Khammam districts. In high value crops, application of vermicompost was promoted in NICRA villages by establishing 43 vermicompost preparation units for conversion of organic wastes into valuable manure enriched with nutrients (Table 18).

Nalgonda

The tank silt was applied in 36 ha for cotton under rainfed shallow red soils for benefiting 34 farmers in NICRA adopted village to improve the soil status and for better crop growth. The cotton crop realized increased yield of (2.8 q/ha) with the application of tank silt over farmers practice.

Desilting of village tank

Tank silt applied cotton field

Crop residue recycling- Amravati

Incorporation of crop residues of cotton instead of burning was practiced in NICRA village since 4 years (2011-12 to 2015-16). Initially the farmers were burning the crop residues but after the launch of NICRA project the farmers are incorporating the residues in-situ. The area under incorporation was increased from 14 ha (2011-12) to 221 ha (2015-16). The rate of incorporation was also increased from 14 t/ha-269 t/ha from 2011-2015. As a result of residue incorporation 5090.5 tones of nitrogenous fertilizer is saved during 2015-16 (Table 15).

Table15: Impact of crop residue recycling in NICRA village

Category	2011-12	2012-13	2013-14	2014-15	2015-16
Crop residues	Burning	Burning	Crop residue incorporated in soil	Crop residue incorporated in soil	Crop residue incorporated in soil
Area brought under incorporation (ha)	-	07	94	120	221
Rate of residue incorporation (t/ha)	14	88	140	242	269
Extent of crop residue burning prevented (ha)	20	25	32	77	96
Saving on nitrogenous fertilizer (ton)	3091	4251	5690	13031	5091

Table 16: Enhanced performance of crops provided with supplemental irrigation using harvested water

KVK	Crop	No. of demon strations	Area (ha)	Yield (q/ha)		Economics of demonstration (Rs/ha)			
				Improved Practice	Farmers Practice	Gross Cost	Gross Returns	Net Returns	BC ratio
Andhra Pradesh									
Kurnool	Jowar	2	2.0	23.6	18.3	15750	37800	22050	2.40
	Pigeonpea	2	2.0	12.9	9.2	24400	115250	90850	4.72
Telangana									
Khammam	Paddy	2	4.0	59.3	54.0	53143	85913	32770	1.62
	Cotton	2	4.0	23.8	17.1	57229	97703	40474	1.71
	Fodder grass	2	4.0	150.0	90.0	33750	75000	41250	2.22

Table 17: Enhanced water use efficiency through micro irrigation systems in NICRA villages

KVK	Technology demonstrated	No. of demonstrations	Area (ha)	Yield (q/ha)		Economics of demonstration (Rs/ha)			
				Improved Practice	Farmers Practice	Gross Cost	Gross Returns	Net Returns	BC Ratio
Andhra Pradesh									
Kurnool	Drip irrigation in jasmine	10	4	42.2	35.0	201600	422000	220400	2.09
Telangana									
Nalgonda	Drip irrigation in chilly	05	2	75.0	62.5	145000	787500	642500	5.43
Maharashtra									
Aurang-abad	Drip irrigation in cotton	20	28	18.4	14.3	40400	88320	47920	2.19
	Drip irrigation in pigeon pea	20	13	7.5	6.5	24300	63750	39450	2.62
Nandurbar	Sprinkler irrigation in maize	25	10	30.3	17.5	16950	43935	26985	2.59
Jalna	Sprinkler irrigation in chickpea	16	8	7.5	5.3	14000	24000	10000	1.71

Table 18: Soil quality and fertility management in different NICRA centers

KVK	Technology demonstrated	No. of Demon strations	Area (ha)	Yield (q/ha)		Economics of demonstration (Rs/ha)			
				Improved Practice	Farmers Practice	Gross Cost	Gross Returns	Net Returns	BC Ratio
Andhra Pradesh									
Anantapur	Tank silt application in groundnut	04	10	16.5	13.4	26150	87150	61000	3.33
Telangana									
Khammam	Reclamation of low fertile and saline soils by green manuring for paddy cultivation	10	10	62.5	61.8	48337	90724	42387	1.88
Nalgonda	Tank silt application in cotton	34	36	25.3	22.5	42500	101200	58700	2.38

4. Crop Production Systems

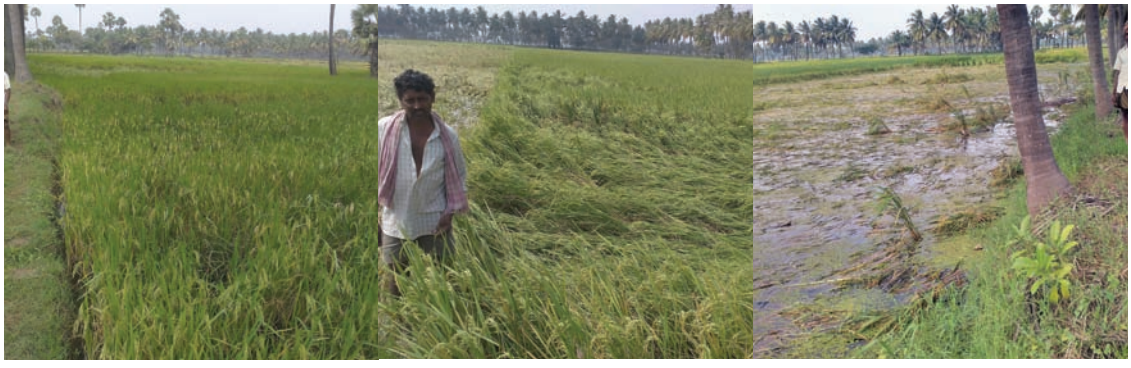
4.1 Climate resilient crop cultivars

Andhra Pradesh

West Godavari

Submergence tolerant varieties of paddy

Heavy rains received during the cyclonic period (17-20 November) resulted in submergence of 75% of paddy area (438.6 ha) in NICRA village of West Godavari District. Demonstrations on submergence tolerant varieties of paddy (MTU-1064 & MTU-1061) were taken up along with traditional susceptible variety Swarna (MTU-7029). The variety Swarna was completely lodged during floods whereas the improved submergence tolerant varieties MTU-1064 & MTU-1061 were partially lodged and recorded additional yield advantage of 39.9 and 31.9% respectively over swarna (Table 19).



MTU-7029 **MTU-1061** **MTU-7029**

Table 19: Performance of flood tolerant varieties MTU 1061, MTU 1064 vs MTU 7029

Treatments	Variety	Grain yield (kg/ha)	% increase in yield	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	31.9	43950	91000	47050	1.93
	MTU-1064	6188	39.9	41458	84150	42692	1.97

Performance of drought tolerant varieties

Anantapur

Drought tolerant groundnut variety (Dharani)

Groundnut is the major crop grown in Anantapur distict. Its performance is dependent on monsoon rainfall. Assessment of improved varieties of groundnut tolerant to drought was taken up in 20 ha area by 8 farmers. Drought tolerant variety Dharani (TCGS-1043) recorded higher yield (1.5 q/ha) and net returns of Rs.7425/ha over traditional variety K-6 (13.5 q/ha) with benefit cost ratio of 3.40. Medium duration variety of pigeonpea PRG-158 recorded higher yield (4.50 q/ha) with 45% increase in yield than long duration variety LRG-41 (3.1 q/ha) and realized higher B:C ratio (3.0) (Table 20).

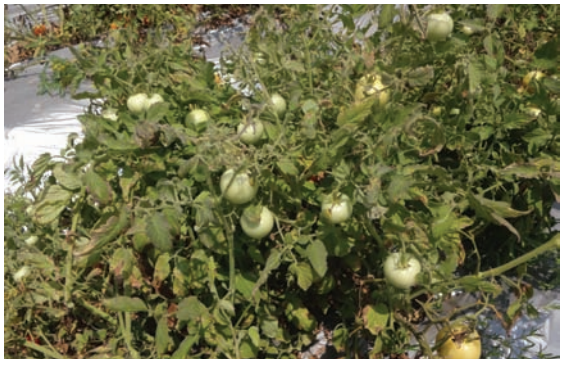
Cold tolerant varieties of paddy

Sheetal (WGL-283)

Cold tolerant variety of paddy Sheetal (WGL-283) was introduced as the low night temperatures were causing pollen abortion, resulting in reduced yields in the traditional variety (MTU-1010) of paddy in Anantapur. The improved variety Sheetal recorded 14.3% additional yield with additional net returns of Rs. 14070/ha (Table 20).

Chittoor

Performance of drought tolerant groundnut variety Dharani was superior to the traditional variety with an additional yield and income of 2.7 q/ha and Rs.11731/ha respectively. Introduction of improved hybrid Co-3 of tomato gave improved yield comapared to local variety with additional net incomeof Rs. 19500/ha with a benefit cost ratio of 2.39 (Table 20).



Co-3 variety of tomato

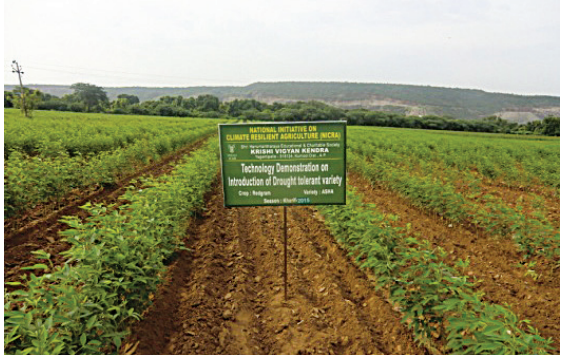
Grading of harvested produce

Kurnool

Drought tolerant variety of pigeonpea (Asha-87119) suitable for medium to light soils with 150 days duration was taken up in place of long duration (180 days) variety as an adaptation to overcome terminal moisture stress at flowering and pod development stages. The improved variety Asha recorded higher grain yield (10.3 q/ha), which was 32.2 per cent higher over the long duration variety (LRG-41) with a BC ration of 3.8 in red soils under rainfed situation (Table 20).

Improved drought tolerant variety Nandyala Sanaga-1 of chickpea recoded higher yield (12.5 q/ha) over farmers variety (JG-11) (11 q/ha) with 13.6% increase in yield. The performance of Nandyala Sanaga-1 was superior to conventional variety because of heat tolerance and rooting traits.

Demonstrations on medium duration variety of pigeonpea ICPL-87119 was taken up in 50 farmers fields covering an area of 20 ha, resulting in higher yield (2.5 q/ha) with additional net returns of Rs. 20377/ha over the conventional practice of growing long duation variety (LRG-41) (Table 20).



Medium duration pigeonpea

Heat tolerant chickpea cultivar (Nandyala Sanaga-1)

Telangana

Khammam

Chilly (LCA-625)

Drought conditions that prevailed during 2015 were congenial for the increased incidence of sucking pests which act as vector for transmission of viruses like cucumber mosaic virus, gemini virus, peanut bud necrosis virus. Wide spread occurrence of viral diseases emerged as a major bottleneck for profitable cultivation of chillies in several districts. Introduction of virus resistant variety (LCA- 625) was a key adaptation which resulted in improved performance of the crop. Farmers realized 11.9% additional yield and increased net returns of Rs. 73,650/ha over conventional susceptible variety Tejaswini (56.8 q/ha) (Table 20).

The soils in surrounding mandals of Nacharam (NICRA village) are saline in nature which is resulting in poor crop yields. Demonstration of short duration (140 days) and salinity tolerant fine grain paddy variety Siddi (WGL-44) along with tolerance to gall midge and lodging in 8 farmers fields in 5.6 ha area showed productivity gains (average of 8.2%) with an additional net returns of Rs.11116/ha (Table 20).

Nalgonda

PRG-158

Increased frequency of rainfall changes leading to early/mid/late season droughts are affecting the production of crops grown under rainfed situations in the district. To combat these situations short duration varieties of pulses were taken up during drought situations in rainfed red soils of Nalgonda district. Short duration pigeonpea (PRG-176) and green gram variety (WGG-42) recorded enhanced yields of 3.61 and 1.0 q/ha over traditional varieties with an additional net income of Rs. 27400/ha and Rs. 4415/ha, respectively (Table 20).

Maharashtra

Ahmednagar

Early maturing soybean: JS 95-60 vs JS-335

To cope with terminal drought under rainfed conditions, short duration variety of soybean (JS-95-60) was demonstrated in NICRA village. Farmers realized higher yield (4.4 q/ha) as compared to the traditional variety (JS-335) (4.1 q/ha) (Table 20).

Amravati

JS-9305

Introduction of short duration and drought tolerant variety of soybean JS-93-05 recorded higher yield (21.1 q/ha) compared to JS-335 (12.6 q/ha) with additional net income of Rs. 18000/ha and a B:C ratio of 2.47. In cotton, improved short duration drought tolerant variety (Ajeet) recorded higher yield with a benefit cost ratio of 2.28 (Table 20).

Aurangabad

Short duration variety of pigeonpea (BDN-711) recorded higher yield (1.5 q/ha) over the traditional variety in rainfed black soils of Marathwada region. Improved short duration variety of green gram (BM-2003-2) and short duration variety of chickpea (BDNG-797) gave yield advantage of 2.0 and 3.5 q/ha, respectively, over traditional varieties with additional net returns of Rs. 7500 and 11300/ha, respectively (Table 20).

BDN-711

Short duration variety of soybean MAUS-71 performed better than traditionally grown JS-335 in terms of additional yield (2 q/ha) and net returns (Rs.1900/ha). Parbhani Moti a short duration variety of rabi sorghum performed better under drought situations with net gain of Rs. 17650 over popular variety with a B:C ratio of 2.70 (Table 20).

Jalna

Improved variety of pigeonpea BDN-711 recorded an additional yield of 0.7 q/ha over local variety (9.58 q/ha). Digvijay variety of chickpea gave 32.5% higher yield over traditional variety with a B:C ratio of 2.22. Drought tolerant variety of rabi sorghum Parbhani Moti gave an out performed over the traditional variety conventional variety (10.4 q/ha) (Table 20).

Chickpea cultivar Digvijay

Nandurbar

To mitigate intermittent and terminal drought during the cropping season, short duration variety of maize (GM-6) was evaluated against farmer's variety in 10 farmers' fields. Increased yield (by 14.4%) was recorded with a benefit cost ratio of 1.77. Drought tolerant desi cotton (JLA-505) was demonstrated in 10 farmers fields covering 4 ha area resulting in an additional net returns of Rs.8780/ha with a B:C ratio of 2.52.

GM-6

Multiple disease tolerant variety of green gram (PKVM-4) showed better performance over local with higher productivity (advantage of 1.6 q/ha) (Table 20).

Pune

The NICRA village in Baramati has been facing the problem of continuous dry spells and water shortage at critical growth stages of crops. Improved rabi sorghum variety Phule Anuradha was assessed for its performance in medium black soisl under rainfed conditions. The improved variety recorded a yield advantage of 3.7 q/ha over the local variety Maldandi (7.6 q/ha) with an additional net returns of Rs. 13145/ha. Similarly, farmers cultivating rabi sorghum variety Phule Vasudha realized an additional net returns of Rs. 12977/ha over local variety Maldandi (Rs.15650/ha) (Table 20).

Phule Anuradha

Phule Vasudha

Table 20: Performance of crop cultivars for adaptation to climate variability

KVK/ District	Interventions	Crop cultivars	No. of demon strations	Area (ha)	Yield (q/ha)		% increase in yield	Economics of demonstration (Rs./ha)				Economics of Local (Rs./ha)			
					Demo	Local		GC	GR	NR	BCR	GC	GR	NR	BCR
Andhra Pradesh															
Anantapur	Short duration variety of pigeonpea PRG-158	PRG-158	15	10.0	4.5	3.1	45	10500	31500	21000	3.00	10500	21700	11200	2.07
	Drought tolerant groundnut variety	Dharani (TCGS-1043)	8	20.0	15.0	13.5	12	23150	79125	55975	3.42	23150	71700	48550	3.10
	Cold tolerant variety of paddy	Sheethal (WGL-283)	6	6.0	75.0	65.6	14.0	35000	112500	77500	3.21	35000	98430	63430	2.81
Chittoor	Improved hybrid of tomato	Hybrid Tomato Co-3	12	2.5	551.0	503.0	9.5	65125	220500	155375	3.39	68250	201000	132750	2.95
	Drought tolerant groundnut variety	Dharani	7	1.4	26.5	23.8	11.3	71050	124219	53169	1.75	70125	111563	41438	1.59
Kurnool	Drought tolerant variety of chickpea	Nandyala Sanaga-1	40	16.0	12.5	11.0	13.6	25450	58750	33300	2.31	26600	51700	25100	1.94
	Short duration variety of pigeonpea	(ICPL-87119)	50	20.0	10.3	7.8	32.2	24341	92081	67740	3.78	25566	72930	47364	2.85
Telangana															
Khammam	Salinity tolerant variety of paddy	Siddi (WGL-44)	8	5.6	64.3	59.4	8.2	53520	93249.5	39729.5	1.74	57560	86174	28614	1.50
	Virus resistant variety of chilli	LCA- 625	2	0.8	63.5	56.8	11.9	253800	635200	381400	2.50	259950	567700	307750	2.18
Nalgonda	Short duration variety of pigeonpea	PRG-176	30	12.0	12.4	8.8	41.3	22300	98880	76580	4.43	20500	69680	49180	3.40
	Short duration variety of greengram	WGG-42	25	10.0	5.4	4.4	22.4	11250	40125	28875	3.57	10500	34960	24460	3.33

KVK/ District	Interventions	Crop cultivars	No. of demon strations	Area (ha)	Yield (q/ha)		% increase in yield	Economics of demonstration (Rs./ha)				Economics of Local (Rs./ha)			
					Demo	Local		GC	GR	NR	BCR	GC	GR	NR	BCR
Maharashtra															
Ahmednagar	Short duration variety of soybean (JS 95-60)	JS 95-60	20	4.0	4.4	4.1	6.1	18625	16625	-2000	0.89	18869	15675	-3194	0.83
Amravati	Short duration & drought tolerant variety of soybean	JS-93-05	50	20.0	21.1	12.6	68.0	17000	42000	25000	2.47	15500	25000	9500	1.61
	Short duration & drought tolerant variety of cotton	Ajit	25	10.0	13.6	7.8	35.5	21000	48000	27000	2.29	19000	36000	17000	1.89
Aurangabads	Short duration variety of pigeonpea	BDN- 711	20	8.0	9.0	7.5	20.0	26000	76500	50500	2.94	23500	63750	40250	2.71
	Short duration variety of green gram	BM-2003-2	20	8.0	8.0	6.0	33.3	13400	33600	20200	2.51	12500	25200	12700	2.02
	Short duration variety soybean	MAUS-71	20	8.0	9.0	7.0	28.6	22900	36000	13100	1.57	17000	28000	11000	1.65
	Short duration variety of rabi sorghum	Parbhani Moti	35	14.0	14.0	12.0	16.7	10350	28000	17650	2.71	9870	24000	14130	2.43
	Short duration variety of chickpea	BDNG-797	32	8.0	15.0	11.5	30.4	29900	60000	30100	2.01	27200	46000	18800	1.69
	Short duration variety of wheat	Netravati	5	2.0	8.0	6.5	23.1	15110	20000	4890	1.32	13980	16250	2270	1.16
	Short duration variety of safflower	PBNS-12	10	4.0	8.5	6.0	41.7	11220	34000	22780	3.03	11000	24000	13000	2.18

KVK/ District	Interventions	Crop cultivars	No. of demon strations	Area (ha)	Yield (q/ha)		% increase in yield	Economics of demonstration (Rs./ha)				Economics of Local (Rs./ha)			
					Demo	Local		GC	GR	NR	BCR	GC	GR	NR	BCR
Jalna	Short duration variety of pigeonpea	BDN- 711	20	8.0	10.3	9.6	17.4	18740	82000	63260	4.38	18300	76640	58340	4.19
	Short duration variety of chickpea	Digvijay	10	4.0	10.4	7.9	32.5	17680	39520	21840	2.24	16900	29830	12930	1.77
	Drought tolerant variety of rabi sorghum	Parbhani Moti	50	20.0	15.6	10.4	50.0	14700	20280	5580	1.38	13900	13520	-380	0.97
Nandurbar	Drought tolerant variety of desi cotton	JLA-505	10	4.0	8.0	6.2	29.3	14500	36570	22070	2.52	15000	28290	13290	1.89
	Multi disease resistant variety of green gram	PKVM-4	14	6.0.	5.9	4.1	39.2	14100	33988	19888	2.41	13800	24418	10618	1.77
	Short duration variety of maize	GM-6	10	4.0	17.4	15.2	14.1	14150	25158	11008	1.78	13950	22040	8090	1.58
Pune	Drought tolerant variety of jowar	Phule Anuradha	25	10.0	11.3	7.6	47.7	16925	43350	26425	2.56	16040	29320	13280	1.83
	Drought tolerant variety of rabi sorghum	Phule Vasudha	20	8.0	13.6	10.5	29.1	22925	51552	28627	2.25	22050	37700	15650	1.71
Ratnagiri	Short duration variety of paddy	Sahyadri-3	26	4.0	45.5	26.7	41.3	36400	54600	18200	1.50	34600	36710	2110	1.06
	Drought tolerant variety of paddy	Karjat-8	50	11.0.	33.7	26.7	20.8	35800	45810	10010	1.28	34600	36710	2110	1.06
	flood tolerant variety of paddy	Sahyadri-3	5	1.0	52.3	45.5	13.0	40000	62760	22760	1.57	34600	36710	2110	1.06

GC: Gross cost, GR: Gross returns, NR: Net returns, BCR: BC ratio

Table 21: Performance of climate resilient cropping systems

KVK	Cropping system	No. of demonstrations	Area (ha)	Yield* (q/ha)		Economics of demonstration (Rs./ha)				Economics of Local (Rs./ha)			
				IP	FP	GC	GR	NR	BCR	GC	GR	NR	BCR
Andhra Pradesh													
Kurnool	Foxtail millet+pigeonpea (5:1)	50	20.0	21.5+401	21.7	21432	79123	57691	3.69	16290	45254	28964	2.78
Telangana													
Khammam	Cotton+pigeonpea (6:1)	5	2.0	18.3+ 5.0	21.3	64993	114825	49832	1.77	61843	87125	25282	1.41
Nalgonda	Cotton+ pigeonpea (6:1)	7	4.0	22.8+4.0	25.3	44200	122600	78400	2.77	41800	101000	59200	2.42
Maharashtra													
Ahmednagar	Pearl millet+ moth bean	10	4.0	8.9+0.87	8.6	20024	22013	1989	1.10	18686	15525	-3161	0.83
Aurangabad	Cotton+green gram (1:1)	10	4.0	12.5+1.9	13.8	35000	76464	41464	2.18	33620	67200	33580	2.00
	Cotton+black gram (1:1)	10	4.0	13.0+1.7	13.3	34700	76800	42100	2.21	33120	63840	30720	1.93
	Soybean +pigeon pea (4:2)	10	4.0	5.0+1.8	7.1	21200	35280	14080	1.66	20350	28400	8050	1.40
	Rabi sorghum + safflower (3:3)	30	12.0	12.0+4.0	14.0	15500	40000	24500	2.58	13000	28000	15000	2.15

IP:Improved Practice, FP:Farmers Practice, GC: Gross cost, GR: Gross Returns, NR: Net Returns, BCR: BC ratio

4.2 Efficient cropping systems

Adverse weather conditions like delayed onset of monsoon and prolonged dry spells during the crop growth period are very common under rainfed farming situation, resulting in economic loss to the farmers due to the partial or total failure of the sole crops. In order to insure against crop failure efforts were made to demonstrate climate resilient inter cropping systems for the benefit of farming community.

Andhra Pradesh

Kurnool

Intercropping of foxtail millet+pigeonpea (5:1) in black soils of Kurnool district resulted in higher gross income of Rs. 79123/ha than sole foxtail millet (Rs. 45254/ha). The results indicated that inter cropping systems are economically advantageous than sole crops under rainfed situations. The fertility and microbial activity of the soil also increases with addition of biomass from pigeonpea (Table 21).

Telangana

Khammam & Nalgonda

The intercropping system cotton+pigeonpea (6:1) realized additional net returns of Rs. 19200/ ha over sole cotton (Rs. 59200) with a benefit cost ratio of 2.80. Similarly in NICRA village of Khammam district also cotton+pigeonpea (6:1) system recorded higher net returns (Rs.49833/ ha) compared to sole cotton (Rs. 25283/ha) (Table 21).

Maharashtra

Aurangabad

Climate resilient intercropping systems are of much importance in NICRA village of Aurangabad district. Cotton+ greengram (1:1) inter cropping system with varieties Bt cotton & TAU-1 was demonstrated with 10 farmers covering 4 ha area. An additional income of Rs. 7884/ha over sole cotton (Rs. 33580/ha) was obtained. Similarly cotton+black gram (Bt cotton +BM-2003-2) also obtained higher net income of Rs. 42100/ha over sole cotton (Rs. 30720). Soybean +Pigeon pea (4:2) system with varieties MAUS-71 + BDN-711 also realized additional net income of Rs. 6030/ha compared to sole soybean (Rs. 8050/ha). Intercropping system of rabi sorghum + safflower (3:3) recorded higher net returns (Rs. 24500/ha) over sole rabi sorghum (Rs. 15000/ha) with a benefit cost ratio of 2.50 (Table 21).

Foxtail millet+pigeonpea (5:1)

Cotton+greengram (1:1)

Cotton+blackgram (1:1)

Pearl millet+mothbean

Soybean+pigeonpea (4:2)

4.3 Crop diversification

Crop diversification is a key adaptation strategy for food and nutritional security and income generation during vulnerable climatic situations.

Andhra Pradesh

Anantapur

Foxtail millet is taken up as alternative crop to groundnut in Anantapur because of dry spells and late onset of monsoon. Millets are cultivated as rainfed crops and always have been crops of drought prone areas ensuring reliable harvests. Foxtail millet (*Setaria italica*) grown as an alternative crop to groundnut, produced the yield of 12.5 q/ha with net returns of Rs. 27557/ha with a benefit cost ratio of 3.40 where as groundnut recorded a benefit cost ratio of 2.90 (Table 22).

Kurnool

Foxtail millet is preferred for crop diversification in place of desi cotton, in view of its drought tolerance, minimum requirement of water, short duration, higher market price and additional benefit of fodder. Foxtail millet realized additional net returns of Rs. 30285/ha over the farmers practice with a benefit cost ratio of 3.40. In view of its superior performance the crop area increased from 40 to 1200 acres in the villages during kharif 2015. Area expansion under this crop is expected during ensuing season too (Table 22).

Telangana

Khammam

Due to prolonged drought conditions during kharif 2015 and non availability of water for cultivation of paddy during rabi season, crop diversification with greengram was taken up because of higher market prices for pulses. Improved virus tolerant variety of green gram (MGG-295) recorded an yield advantage of 26.6% with a benefit cost ratio of 2.5 over the control. Sunhemp seed production was also taken up as crop diversification due to non availability of water during rabi season with a benefit cost ratio of 6.60 (Table 22).

Nalgonda

Crop diversification with vegetables instead of paddy was practiced, as vegetable cultivation gives sustainable income during drought situations with low cost of cultivation and higher returns. Crop diversification with ridge gourd realized very high yields (200 q/ha) with higher net returns of Rs. 192500/ha with a benefit cost ratio of 5.7. Crop diversification with tomato resulted in higher B:C ratio of 4.3 compared to paddy (1.9). Onion realized additional net income of Rs. 57750/ha over cultivation of paddy with a benefit cost ratio of 3.86 over the control (1.9) (Table 22).

Maharashtra

Nandurbar

Crop diversification with pea (variety Malav) was taken up due to low productivity of wheat (variety Lok-1) under limited irrigation in light soils. Pea cultivation realized higher yield of 29.8% and additional net returns of Rs.45330/ha over cultivation of wheat. Crop diversification with potato was also practiced instead of wheat which resulted in additional net income of Rs. 116230/ha with a benefit cost ratio of 2.76. Onion seed production with variety Phule Samartha instead of wheat also realized a benefit cost ratio of 3.2 over the control (1.53).

Jalna

Crop diversification with drumstick variety PKM-1 realized higher net income of Rs.140000/ha with a benefit cost ratio of 4.18 (Table 22).

Greengram MGG-295

Foxtail millet (Setaria Italica)

Pea (Malav)

Potato (Kufri Jyothi)

Onion (Phule Samartha)

Table 22: Crop diversification for sustainability in different NICRA centers

KVK	Interventions	No. of demon strations	Area (ha)	Yield* (q/ha)		Economics of demonstration (Rs./ha)				Economics of Local (Rs./ha)			
				Demo	Local	GC	GR	NR	BCR	GC	GR	NR	BCR
Andhra Pradesh													
Anantapur	Crop diversification with foxtail millet	12	18.0	1253.0	1301.0	11250	38807	27557	3.45	23150	68081	44931	2.94
	Crop diversification with castor	2	2.0	1156.0	1451.0	16250	34680	18430	2.13	23150	76472	53322	3.30
Kurnool	Crop diversification with foxtail millet	55	22.0	24.8	5.1	14820	51699	36879	3.49	13800	20394	6594	1.48
Telangana													
Khammam	Crop diversification with green gram	5	2.0	950.0	750.0	24369	62700	38331	2.57	26748	49500	22752	1.85
Nalgonda	Crop diversification with ridge gourd	5	0.4	200.0	70.0	52500	300000	247500	5.71	60000	115000	55000	1.92
	Crop diversification with tomato	15	2.0	500.0	65.0	57700	250000	192300	4.33	56000	107500	51500	1.92
	Crop diversification with bitter gourd	6	0.6	160.0	62.5	53000	320000	267000	6.04	55000	103750	48750	1.89
	Crop diversification with onion	20	0.6	180.0	60.0	37250	144000	106750	3.87	57000	106000	49000	1.86
Maharashtra													
Nandurbar	Crop diversification with pea	8	1.3	31.8	24.5	34300	95400	61100	2.78	29230	45000	15770	1.54
	Crop diversification with onion seed production	8	1.3	4.8	24.5	74850	240000	165150	3.21	29230	45000	15770	1.54
	Crop diversification with potato	8	1.3	138.0	24.5	75000	207000	132000	2.76	29230	45000	15770	1.54
Jalna	Drumstick (PKM-1)	20	2.0	92.0	75.0	44000	184000	140000	4.18	38000	150000	112000	3.95

GC: Gross cost, GR: Gross Returns, NR: Net Returns, BCR: BC ratio

Table 23: Effect of advancement of planting dates in rabi crops in areas with terminal moisture stress in Maharashtra

KVK	Interventions	No. of farmers	Area (ha)	Yield* (q/ha)		% increase in yield	Economics of demonstration (Rs./ha)				Economics of Local (Rs./ha)			
				Demo	Local		GC	GR	NR	BCR	GC	GR	NR	BCR
Amravati	Advancement of planting dates in chickpea-JAKI-92-18	25	10.0	20.0	16	25	25000	70000	45000	2.80	25000	56000	31000	2.24
	Advancement of planting dates in chickpea-Vijay	37	15.0	18.5	15	23	25000	64000	39000	2.56	25000	52000	27000	2.08
	Advancement of planting dates (onion-PKV safed)	10	2.0	200.0	146	37	23000	70000	47000	3.04	23000	51000	28000	2.22

GC: Gross cost, GR: Gross Returns, NR: Net Returns, BCR: BC ratio

4.4 Adjustments in planting dates

Amravati

Changes in rainfall pattern are affecting the crop yields even when they are sown timely. Hence advancement of planting dates helps the crops in escaping the ill effects of drought and results in additional yields. Chickpea variety JAKI-92-18 realized additional yields of 4 q/ha over farmers practice with higher net returns of Rs. 18000/ha at NICRA village of Amravati district in Maharashtra. Similar results were observed in Vijay variety of chickpea with a yield gain of 3.5 q/ha with a benefit cost ratio of 2.56. Demonstration of onion (PKV-Safed) realized additional net returns of Rs. 19000/ha with advancement of planting dates in NICRA village of Amravati district (Table 23).

4.5 Farm mechanization for adoption of resource conservation technologies

Srikakulam

Direct seeding of paddy with ferti cum seed drill

The performance of flood tolerant varieties was observed to be better with 53.54 q/ha (RGL-2537), 52.8 q/ha (MTU-1061) and 52.26 q/ha (PLA-1100) when sown with fertilizer cum seed drill in 12 farmers fields covering 4.6 ha area when compared to that of MTU-7029 (47.68 q/ha) (Table 24).

Sowing with fertilizer cum seed drill

Paddy crop sown with fertilizer cum seed drill

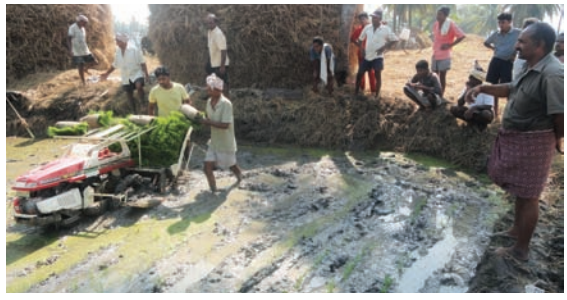
Table 24: Direct seeding of paddy with ferti cum seed drill

S. No.	Observations	Improved varieties			Farmers variety
		RGL-2537	PLA-1100	MTU-1061	MTU-7029
1	Yield (q/ha) (Medium inundation area)	110.8	54.2	-	95.9
2	Yield (q/ha) (High inundation area)	209.9	102.6	105.6	190.2
3	Average yield (q/ha)	**53.5**	**52.3**	**52.8**	**47.7**
4	Cost of cultivation (Rs/ha)	31000	31000	31000	30375
5	Gross returns (Rs. 1340/- per quintal)	71743	70028	70752	63891
6	Net returns (Rs/ha)	40743	39028	39752	33516
7	B:C ratio	2.31	2.26	2.28	2.10

West Godavari

During Rabi 2015-16 machine transplanting resulted in 3.7% yield advantage and reduced the cost of cultivation by Rs. 3136/ ha over manual transplanting. The crop matured one week earlier than manual transplanting. The benefit cost ratio was also superior (2.18) in machine transplanted paddy (Table 25).

Mat nursery



Mechanical transplanting of paddy

Amravati

Seed cum fertilizer drill enhanced the productivity in crops of soybean and chickpea (8.6 q/ha, 4.0 q/ha) with higher benefit cost ratios of 2.63 and 2.89 respectively (Table 25).

4.6 Water saving cultivation methods

West Godavari

18.6% improvement in yield was observed in SRI method over manual transplanting. The cost of cultivation was reduced by Rs. 4285/ha and the crop matured one week earlier than manual transplanting.

Direct seeding of paddy with drum seeder reduced the cost of cultivation by Rs.4422/ha than manual transplanting. The crop matured one week earlier than manual planting with 9.4% higher yield advantage with a benefit cost ratio of 2.54.

Broadcasting of paddy realized an yield advantage of 3.5 q/ha with additional net returns of Rs.10764/ha. The cost of cultivation reduced by Rs. 6470/ha than manual transplanting. The crop matured one week earlier than manual planting (Table 26).

Direct sowing with drum seeder

Paddy crop sown with drum seeder

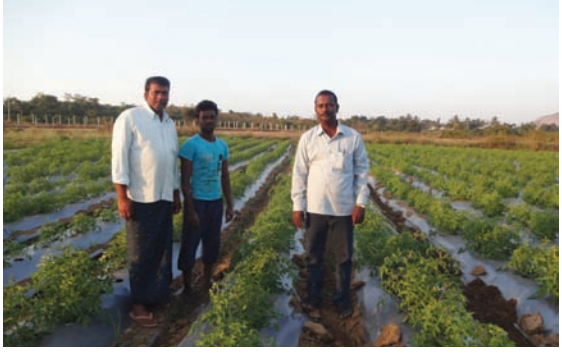
Khammam

Broadcasting of paddy resulted in yield benefit of 5.6% compared to conventional method of manual transplanting with additional net income of Rs. 14087/ha (Table 26).

Broadcasted paddy field

Chittoor & Ratnagiri

The practice of plastic mulching is demonstrated to conserve soil moisture and to suppress the weed growth in tomato with 10 farmers in 2.5 ha area. The practice of mulching recorded a yield advantage of 243.7 q/ha compared to no mulching. Mulching in watermelon was practiced to reduce water loss through evaporation in red lateritic soils of Ratnagiri with low water holding capacity. This practice gave a net income of Rs. 129350/ha over farmers practice of no mulching (Table 26).



Plastic mulching in tomato

Plastic mulching in watermelon

Table 25: Influence of farm implements on yield and economics of crops in NICRA villages

KVK	Interventions	No. of Demonstrations	Area (ha)	Yield* (q/ha)		% increase in yield	Economics of demonstration (Rs./ha)				Economics of Local (Rs./ha)			
				IP	FP		GC	GR	NR	BCR	GC	GR	NR	BCR
Andhra Pradesh														
West Godavari	Mechanical transplanting of rice	3	1.6	74.4	71.8	3.7	41660	88013	46353	2.11	44796	91233	46437	2.04
Maharashtra														
Amravati	Seed cum fertilizer drill (soybean)	40	75.5	21.1	12.6	60.0	11000	29000	18000	2.64	11000	18000	7000	1.64
	Seed cum fertilizer drill (chick pea)	25	30.0	20.0	16.0	25.0	25000	70000	45000	2.80	25000	56000	31000	2.24

IP: Improved Practice, FP: Farmers Practice, GC: Gross cost, GR: Gross Returns, NR: Net Returns, BCR: BC ratio

Table 26: Effect of water saving technologies productivity and profitability of different crops

KVK	Interventions	No. of demon strations	Area (ha)	Yield* (q/ha)		% increase in yield	Economics of demonstration (Rs./ha)				Economics of Local (Rs./ha)			
				IP	FP		GC	GR	NR	BCR	GC	GR	NR	BCR
Andhra Pradesh														
Chittoor	Plastic mulching in Tomato	10	2.5	787.5	543.8	44.8	104250	315000	210750	3.02	68250	217500	149250	3.19
West Godavari	Direct seeding of paddy with drum seeder	2	1.0	81.4	74.4	9.4	39260	99820	60560	2.54	43682	91233	47551	2.09
	Broadcasting of paddy seed	15	5.0	78.8	75.3	4.7	44450	96628	52178	2.17	50920	92332	41412	1.81
	SRI (Paddy cultivation)	2	2.0	89.3	75.3	18.6	46635	109510	62875	2.35	50920	92332	41412	1.81
Telangana														
Khammam	Broadcasting of paddy seed	2	1.0	61.8	58.5	5.6	44810	89610	44800	1.99	54112.5	84825	30712.5	1.56

IP: Improved Practice, FP: Farmers Practice, GC: Gross cost, GR: Gross Returns, NR: Net Returns, BCR: BC ratio

Table 27: Effect of Crop protection measures on productivity and profitability of different crops

KVK	Interventions	No. of demons trations	Area (ha)	Yield (q/ha)		% in-crease in yield	Economics of demonstration (Rs./ha)				Economics of Local (Rs./ha)			
				IP	FP		GC	GR	NR	BCR	GC	GR	NR	BCR
Andhra Pradesh														
Chittoor	INM in groundnut	10	2.0	25.3	22.8	11.0	70100	123337	53237	1.76	67875	111150	43275	1.64
Kurnool	Sucking pest management in Bt cotton	25	12.0	1689.0	1455.4	16.1	39908	67560	27652	1.69	42968	58216	15248	1.35
Srikaku-lam	Weed management in direct sown paddy with herbicides in flood prone area.	20	5.0	53.7	52.9	1.5	30375	71998	41623	2.37	34000	70913	36913	2.09
	Strategic management of BPH in flood prone area.	4	1.6	68.6	58.7	16.9	38500	91924	53424	2.39	34500	78658	44158	2.28
	Biotic stress management in flood prone Paddy (Sheath blight, blast) in flood prone area	5	2.4	65.9	57.3	15.1	38500	112359	73859	2.92	34500	97639	63139	2.83
	Stem application in Bt cotton against sucking pests in dry weather condition.	5	2.0	22.0	20.3	8.3	30984	90200	59216	2.91	35123	83230	48107	2.37
Maharashtra														
Ahmed-nagar	Management of oily spot in pomegranate	10	4.0	162.0	142.7	13.5	460057	967140	507083	2.10	480252	844366	364114	1.76
Nandur-bar	Multi disease resistant variety of Green gram (PKVM-4)	14	6.0	5.9	4.2	39.2	14100	33988	19888	2.41	13800	24418	10618	1.77
Nandur-bar	Border plantation of castor for control of leaf eating caterpillar in (Groundnut+soybean)	10	4.0	6.3+4.1	9.1	-	15200	33530	18330	2.21	14300	25340	11040	1.77
Nandur-bar	Stem application of insecticide for cotton	10	4.0	8.3	7.5	10.6	14850	36110	21260	2.43	15800	32660	16860	2.07
Jalna	Use of yellow sticky traps for management of white fly in cotton	20	8.0	17.5	15.8	10.8	35000	71750	36750	2.05	36100	64780	28680	1.79

IP:Improved Practice, FP:Farmers Practice, GC: Gross cost, GR: Gross Returns, NR: Net Returns, BCR: BC ratio

4.7 Eco-friendly pest and disease management

Andhra Pradesh

Kurnool

Stem application in Bt cotton

Due to the occurrence of continuous dry spells during October (24 days) and continuous high temperatures during August to October months, incidence of sucking pests like jassids, aphids and whiteflies was observed in cotton**.** Stem application with imidacloprid at 40 and 60 DAS, effectively managed Aphids. Spraying of Triazophos with Neem oil 0.03% checked the incidence of whiteflies effectively in the demonstrations covering 12 ha area in 25 farmers fields and resulted in additional yield advantage of 2.3 q/ha (Table 27).

Srikakulam

Weed management in direct sown paddy with herbicides in flood prone area saved an amount of Rs.3625/ha in cost of cultivation. Initial crop vigour was observed in the herbicide treated plots. An increase of 1.5% in yield was recorded with a B:C ratio of 2.37 in herbicide treated plots over manually weeded plots.

Strategic management of brown plant hopper in flood prone area was demonstrated with prophylactic application of carbofuran 3G @ 10 kg/acre 15 DAT and formation of alleyways resulting in 16.9 per cent increase in the yield.

Biotic stress management in flood prone paddy for the control of sheath blight, blast diseases recorded an increase in yield of 15.1% in managed fields where alleyways are formed followed by timely application of tricyclozole@ 0.6 gm/lt against blast and spraying of hexaconazole@2.0 ml/lt against blight targeting the site of infection (Table 27).

Hopper burn in cotton

Sheeth blight in paddy

Leaf spot in paddy

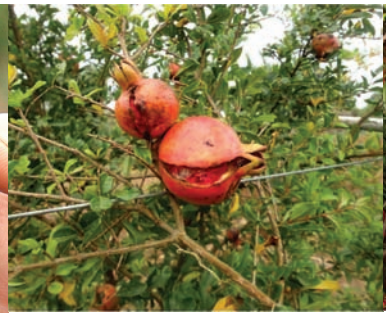
Stem application against sucking pests during dry weather was taken up in Bt cotton. Timely application of profenophos@2.0 ml/lt against mealy bug infestation resulted in the increase yield by 8.3%. Marked increase in yield was not observed due to continuous dry spell which occurred during September.

Maharashtra

Ahmednagar

Application of Chemicals like hydrogen peroxide and Copper oxy chloride is the farmers practice of controlling bacterial blight/ oily spot in pomegranate where as the improved technology involving use of bio pesticides (*Pseudomonas*, *Bacillus*) + botanicals (karanj oil + neem oil) along with chemical sprays was demonstrated to effectively control the disease, resulting in higher yields of 19.3 q/ha over farmers practice. Severity of disease was reduced by 70% and no fruit cracking was observed (Table 27).

Bacterial oily spot



Fruit craking

Healthy fruit with balanced nutrition

Nandurbar

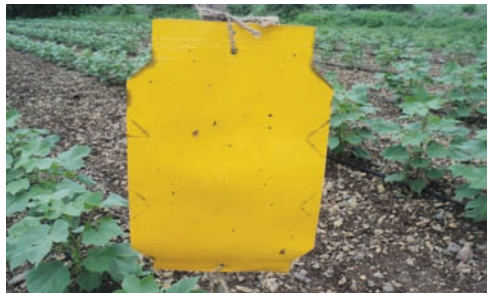
Stem application of insecticide in cotton realized increased yield of 10.5 q/ha with additional net benefit of Rs. 4200/ha over chemical sprays.

Stem application of insecticide in cotton

Castor is planted along the borders of Groundnut + Soybean system to control the damage of leaf eating caterpillar on the main crop which resulted in 66% higher net returns over the farmers practice without border plantation of castor with a B:C ratio of 2.2 (Table 27).

Jalna

Use of yellow sticky traps in cotton not only controlled the whiteflies but also realized additional yield advantage of 1.7 q/ha over conventional methods of management with a benefit cost ratio of 2.05 (Table 27).



Yellow sticky traps for control of sucking pests

5. Livestock and Fisheries Production Systems

5.1 High yielding fodder cultivars

Andhra Pradesh

Kurnool

Lucerne (MYGROW hybrid) was supplied to 10 farmers of the NICRA village with an objective of cultivating legume fodder crops during rabi and year round fodder production. Cultivation of Lucerne resulted in 8.3% increased yields than conventional fodder. Lucerne was fed to animals @ 5kg per day along with regular green and dry fodder for 30 days which resulted in 1.5% increase in milk yield with a B:C ratio of 3.72. The cost on concentrate feeding was reduced (as Lucerne contains 18% crude protein) with additional net returns of Rs.1570/ha (Table 28).

Chittoor

Demonstrations on Hybrid Napier grass, variety Co-4 were conducted in 15 ha area with 10 farmers, realized additional yield of 6.5 t/ha and net returns of Rs.10625/ha over farmers practice. Fodder sorghum CSH 24 MF realized yield benefit of 21.6 % over farmer's variety in 30 ha area in 30 farmer's fields with additional net benefit of Rs. 5400/ha (Table 28).

Telangana

Nalgonda

Improved fodder jowar variety MP Chari was demonstrated in 23 farmers fields covering 1.2 ha area, recorded a yield advantage of 5 t/ha with a benefit cost ratio of 2.74 over farmers practice. Another variety APBN-1 of Hybrid Napier grass recorded increased yield of 150 t/ha with higher net returns of Rs. 265000/ha (Table 28).

Khammam

Improved fodder variety Sugar graze of sweet sorghum recorded 42% improved yields with higher net returns of Rs.14025/ha over conventional fodder sorghum (Table 28).

Maharashtra

Ahmednagar

Cultivation of Multi cut fodder pearl millet produced a yield of 19 t/ha over conventional fodder sorghum with benefit cost ratio of 2.26. Fodder sorghum variety Sugar graze recorded 9.5 t/ha (65%) more productivity over conventional variety with a B:C ratio of 3.21 (Table 28).

Aurangabad

Demonstration on Improved fodder variety African tall of maize was carried out in 6.4 ha area with 16 farmers resulted in Rs.6600/ha additional income with 30% improved yields over the control (Table 28).

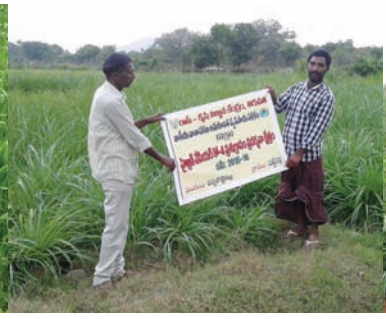
Nandurbar

Fodder Lucerne RL-88 recorded additional yield (50 %) and net returns of Rs. 38000/ha and a benefit cost ratio of 3.77 (Table 28).

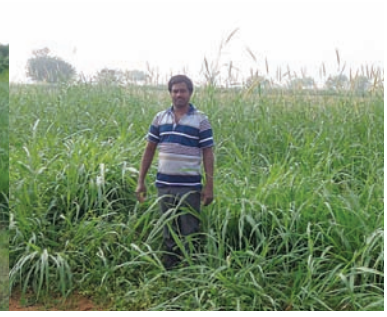
Pune

Cultivation of fodder maize recorded 36.7% increased productivity over conventional fodder with benefit cost ratio of 2.98 (Table 28).

CSH-24-MF



Co-4



MP-Chari

APBN-1

Multicut fodder Sugargraze

Multicut Lucerne

Fodder maize

Table 28: Performance of improved fodder varieties at different NICRA centers

KVK	Interventions	No. of farmers	Area (ha)	Yield (t/ha)		% increase	Economics of demonstration (Rs./ha)				Economics of demonstration (Rs./ha)			
				IP	FP		GC	GR	NR	BCR	GC	GR	NR	BCR
Andhra Pradesh														
Kurnool	Lucerne production	10	0.5	247.2	228.3	8.3	2152	8404	6252	3.90	1710	6392	4682	3.72
Chittoor	Improved hybrid napier (C0-4)	15	15.0	42.0	35.5	18.3	66175	84000	17825	1.23	63800	71000	7200	1.12
	Improved fodder sorghum (CSH 24 MF)	30	30.0	15.2	12.5	21.6	21275	30400	9125	1.45	21275	25000	3725	1.17
Telangana														
Nalgonda	Improved fodder varieties for fodder production (APBN-1)	23	1.2	220.0	70.0	267.0	86000	440000	354000	5.10	51000	140000	89000	2.74
	Improved fodder jowar (MP Chary)	35	15.2	75.0	70.0	25.0	53000	150000	970000	2.83	49000	140000	91000	2.85
Khammam	Improved fodder sorghum (Sugar graze)	05	2.0	12.8	9.0	42.2	21250	64000	42750	3.00	16875	45000	28725	2.60
Maharashtra														
Ahmednagar	Multicut fodder pearl millet	10	1.5	19.0	15.5	22.3	16400	37900	21500	2.31	13700	31000	8800	2.26
	Multicut fodder sorghum (Sugar graze)	10	1.5	24.5	15.0	65.5	15338	49167	33829	3.21	13175	30000	16825	2.29
Aurangabad	Improved fodder maize (African Tall)	16	6.4	7.0	5.2	30.0	3400	14000	10600	4.11	3000	10400	7400	3.46
Nandurbar	Improved fodder lucerne (RL-88)	10	0.4	27.0	18.0	50.0	21500	81000	59500	3.77	14500	36000	21500	2.48
Pune	Cultivation of fodder maize	30	12.0	35.5	26.0	36.7	16645	49700	33055	2.98	15940	31152	15212	1.95

5.2 Hydroponic fodder production

Hydroponic fodder production technology was demonstrated at NICRA village of kurnool district to overcome the scarcity of green fodder in drought areas with limited source of water available. 8 kg fodder can be grown from 1kg maize seed within seven days. Cost of establishment of one unit is Rs.13000. Each animal was offered 12 kg hydroponically grown maize fodder along with 7 kg jowar straw every day. The results indicated that there was an increase of 8.11% milk yield with additional net income of Rs.32 per day. It also reduced the requirement of concentrates thus lowering the cost of milk production (Table 29).

Table 29: Hydroponic fodder production at Kurnool

Particulars	Hydroponics	Farmers practice
Milk Yield (for 30 days) (L)	260	240
Gross income (Rs.)	7794	7209
Cost of concentrates (Rs.)	1430	1802
B:C ratio	5.5	4.0

Low cost hydroponics fodder production unit

Hydroponic method of fodder production was taken up at NICRA village of Ahmednagar district of Maharashtra, to make available the green nutritious fodder during scarcity periods, which reduced the cost of Rs. 1066 per 2 months with a B:C ratio of 1.38 (Table 30).

Table 30: Hydroponic fodder production at Ahmednagar

Treatments	Average green fodder cost/ kg/animal (Rs)	Gross Cost (2 months)	Gross Returns (Rs)	Net Returns (Rs)	BC Ratio
Farmers practice	3.6	11232.0	14040.0	2808.0	1.25
Hydroponics	2.2	10166.4	14040.0	3873.6	1.38

Hydroponic fodder production units at NICRA village of Ahmednagar

5.3 Green fodder preservation through silage making

Availability of green fodder is a great problem in all villages under rainfed ecosystem. To conserve the green fodder during off season, the demonstrations on silage making were introduced to 10 farmers at Yagantipalle village of Kurnool district (Andhra Pradesh). Silage bales of 400 kg were supplied to the farmers @ Rs.2.0 per kg.

Silage making was taken up at NICRA village of Ahmednagar (Maharashtra) to make available the green nutritious fodder during scarcity period. Generally farmers are purchasing green fodder from market which costs about Rs.10303 for a period of 2 months. The practice of silage making reduced the cost of fodder by Rs.687 for 2 months (Table 31).

Table 31: Effect of silage making in NICRA village of Ahmednagar

Treatments	Green fodder cost (Rs/kg)	Milk production (lit/day/ animal)	Fat %	Gross Cost (2months)	Gross Return	Net Return	BCR
Farmers practice	3.5	12.1	3.56	10302.5	14500.0	4197.5	1.41
Improved practice	2.8	12.3	3.68	9614.9	15070.5	5455.6	1.57

Silage making using polythene sheets was practiced in NICRA village of Pune district covering 22 farmers which resulted in increased milk production (11.6) due to fodder availability during off season (Table 32).

Table 32: Silage Making By Using Polythene Paper in NICRA village of Pune

Animal	Milk Yield (lit/day/cow)		% increase	Economics					
				Gross Cost per lactation (Rs)		Gross Return Per lactation		BCR	
	Demo	Local		Demo	Local	Demo	Local	Demo	Local
Cross bred HF	12.5	11.2	11.6	64846	63154	76250	68320	1.17	1.08

Silage feeding in Ratnagiri district also enhanced the milk yield with increased net returns of Rs. 71/animal/day (Table 33).

Table 33: Silage Making in NICRA village of Ratnagiri

Treatment	Milk Yield (Lit)	Gross cost (Rs./day /animal)	Gross income (Rs./day /animal) @ Rs.32 /Lit	Net income (Rs./day /animal)	B:C Ratio
Traditional method	4.1	55	131	76	2.38
Silage feeding	5.8	30	202	172	6.73

Silage making at NICRA centre of Kurnool

5.4 Introduction of superior breeds of small ruminants

Efforts were made to improve the genetic potential of local sheep by replacement of local rams with genetically superior breeding lambs at NICRA village of Srikakulam district (Andhra Pradesh). Release of genetically superior breeding lambs improved the height (11.8 cm), weight (3.5 cm) and length (1.8 cm) of lambs produced by breeding with local lamb at the age of 30 days. Similarly the lambs produced by breeding with superior breeding lambs at

60 days gained the weight of 2.6 kg against the lambs produced by breeding with local lambs. The percentage weight gained from the lambs produced by breeding of superior ones was higher over the lambs produced by breeding local ones at 30 and 60 days of age. (30.9 and 18.1). Shepherds were satisfied with the intervention and they have replaced 3 Rams in 2014-15 on their own (Table 34 & 35).

Table 34: Production of superior breeding lambs

Description	End of 2012-13	End of 2013-14	End of 2014-15	End of 2015-16
Total no. of Sheep in 3 Flocks	82	107	144	157
No of breeding Rams	3	*3+2 =5	5	5
No of Shepherds	3	3	3	3
No of Lambs born	58	87	92	95
No of sheep conceived	20	33	50	54
No of lambs Sold out (all the male lambs, some female lambs)	33	50	58	63
Present status of lambs at shepherd (3 months)	25	37	34	33

Table 35: Performance of lambs produced due to release of elite breeding rams in sheep flock (2015-16)

Age of the lamb	Number of lambs	Local lambs			Lambs produced from breeding rams		
		Height (cm)	Length (cm)	Weight (kg)	Height (cm)	Length (cm)	Weight (kg)
30 Days	1	32	40	7.5	44	43	11.5
	2	30	40	7.9	42	42	10.7
	3	32	41	8.0	42	42	10.9
	4	33	41	8.1	43	42	11.3
	5	30	41	7.6	45	43	12.2
	Average	31.4	40.6	7.8	43.2	42.4	11.3
60 Days	1	45	43	12.4	52	55	14.9
	2	44	43	11.8	50	52	14.2
	3	45	42	12.3	50	51	14.3
	4	43	40	11.6	51	54	14.6
	5	42	40	11.7	53	55	15.0
	Average	43.8	41.6	12.0	51.2	53.4	14.6
% increase at 30 days over local lambs					27.3	4.2	30.9
% increase at 60 days over local lambs					14.5	22.1	18.1

Mortality and morbidity losses occur due to abiotic stress in sheeps and goats. To develop immunity, and productivity, healthy superior breeding rams for improvement of sheep were introduced at NICRA village of Khammam district (Telangana). Introduction of superior breeding rams helped in production of 40 lambs per year over local (28 nos) with higher returns of Rs. 17090 than local (Rs. 28500) (Table 36).

Table 36: Production of genetically superior breeding lambs

Particulars	No. of breeding rams	Cost of breeding ram+ feeding (Rs)	No. of lambs produced /year	No. of sheep sold	Income from sale of sheep (Rs)	No. of lambs / sheep keep with holder	Mortality of the sheep (%)	Total income (Rs)
Local breeding ram	1	8000 + 3500	28	20	40000	8	2.1	28500
Superior breeding ram	1	9850 + 4560	40	28	60000	12	0.8	45590

5.5 Feed enrichment techniques

Azolla production

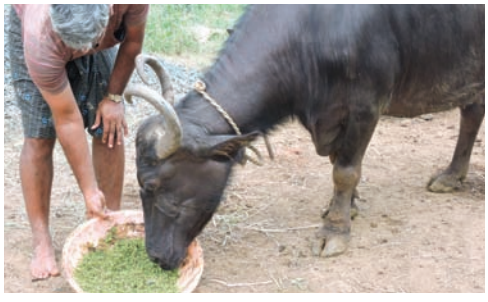
Enrichment of feed with azolla in Ratnagiri with 3 azolla production units enhanced the milk productivity (26%) compared to farmers practice of feeding without azolla with a benefit cost ratio of 12.70 (Table 37).

Azolla Production unit

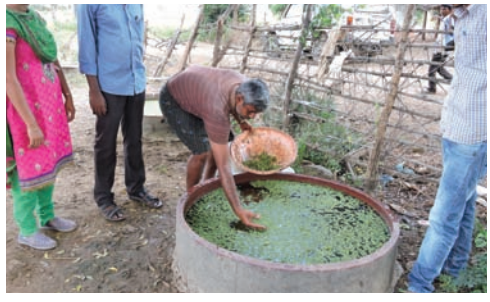
Table 37: Effect of azolla feeding on milk yield and net income in dairy animals (Ratnagiri)

Treatment	Milk Yield (l)	Gross cost (Rs./day /animal)	Gross income (Rs./day /animal) @ Rs.32 /Lit	Net income (Rs./day /animal)	B:C Ratio
Without Azolla	4.1	11	131	120	12.00
With Azolla feeding	5.2	13	166	153	12.70

Demonstrations on improvement of nutrients through azolla production were carried out at NICRA village of Khammam district (Telangana) which resulted in increase in fat content of milk in dairy animals (Table 38).



Azolla production



Azolla feeding to cattle

Table 38: Effect of azolla feeding on milk yield and net income in dairy animals (Khammam)

Treatments	Fodder Yield (kg/month)	Fat percentage before intervention	fat percentage after intervention	Net income (Rs/month)
Azolla production	20 (5 months)	6.5	8.5	200 Rs/month 1000 per cattle

Supplementation of Urea Molasses Mineral Blocks to milch buffaloes

Protein and energy are the major factors influencing milk yield in milch animals. Supplementation of protein and energy along with minerals through Urea Molasses Mineral Blocks is very effective and economical in low and medium production animals. The demonstration was conducted selecting 10 milch buffaloes. The animals were allowed to lick the block twice daily for 30 minutes at the time of milking. The results indicated that increase of 19.4% in milk yield along with increase in fat content in milk (9.3%) was observed with additional income of Rs.26/per day (Table 39).

Table 39: Supplementation of nutrients through urea molasses mineral blocks to milch buffaloes

Particulars	Farmers practice	Demonstration
Milk yield/day	3.1	3.7
% fat in milk	7.0	7.7
Total milk yield for 60 days	186	222
Gross income (Rs.)	6770	9990
Cost (Rs.)	1395	1965
BC ratio	4.85	5.08

Area Specific Mineral Mixture

Demonstrations on feeding of area specific mineral mixture was taken up in NICRA village of Pune with 250 animals. Improved practice of feeding includes feeding of mineral mixture 200 g/day along with paddy straw which resulted in 10.3 % increase in milk yield with a B:C ratio of 1.14 (Table 40).

Table 40: Effect of area specific mineral mixture in cross bred animals

No. of Animals	Particulars	Milk yield (L/day/cow)		% increase	Economics					
					Gross Cost		Gross Return		BCR	
		Demo	Local		Demo	Local	Demo	Local	Demo	Local
250	Feeding of Mineral Mixture 200 gm /day	11.8	10.7	10.3	63016	61186	71980	65270	1.14	1.06

5.6 Backyard poultry for nutritional needs and income generation

Khammam

Rearing of improved breed Rainbow rooster in 20 back yard poultry units by 20 farmers resulted in production of higher bird weight (2.8 kg) and net income (Rs. 806/bird) compared to the local breed at NICRA village of Khammam district (Telangana) (Table 41).

Table 41: Performance of improved breed rainbow rooster

Particulars	Initial wt.(g)	Weight of bird (Kg) / year	No. of eggs/ year	Total expenditure (Rs)	Income from eggs (Rs)	Income from meat (Rs)	Total income (Rs)
Local Breed	650	2.0	52	615	208	450	658
Rainbow roster	700	4.8	150	950	600	864	1464

Rearing of Giriraja breed over conventional breed recorded reduced mortality rate (7.7%), with more weight (0.8 kg/bird) and higher net income of Rs. 6479 at NICRA village of ratnagiri district (Maharashtra) (Table 42)

Table 42: Performance of improved breed Giriraja

Particulars	Local breed (T1)	Giriraja Birds (T2)
No of Families	1	1
Unit Size	70 Birds	65 Birds
Mortality	29 Birds (41.4 %)	5 Birds (7.7 %)
No of Birds sold	41	60
Avg. Weight /Bird(Age 6-7month) (kg)	1.6	2.4
Price /kg	180	125
Price /Bird (Rs)	281	300
Total income (Rs.)	11521	18000

Jalna

Rearing of improved backyard poultry breeds like Srinidhi and Vanaraja was found to be beneficial over rearing of local birds. Rearing of improved birds is taken up with 11 farmers in 11 units of backyard poultry. Vanaraja (Broiler) recorded 1.2 kg more weight/bird with a B:C ratio of 1.78 where as another superior breed srinidhi (Layer) produced more number of eggs per bird (70) with higher net returns of Rs. 270/bird.

Nandurbar

Rearing of improved breed vanaraja realized more number of eggs (131/year) and net income (Rs 656) over local breed (Table 43).

Table 43: Performance of improved breed vanaraja

Particulars	Mortality %	Initial wt. (gm)	No. of eggs per year	Total expenditure (Rs)	Income from eggs (Rs)	Income from meat (Rs)	Total income (Rs)
Local Breed	9.2	22.7	33	85	165	200	365
Vanraja	1.9	35.6	164	85	821	200	1020

Giriraja Birds-Aurangabad

Giriraja birds-Ratnagiri

Vanaraja birds-Jalna

Rainbow rooster-Khammam

5.7 Conservation of cattle

Calf registration programme was initiated under NICRA project in Yagantipalle village of Kurnool district during 2011 and continued every year with an objective to reduce the calf mortality and to improve growth rate in the calves. During 2015-16, 50 buffalo calves were registered under the programme in Meerapuram village. Health camps were organized every month and medication was given as per the schedule given below (Table 44 & 45).

Table 44: Schedule of medication

Age of the calf	Medication
7th Day	Deworming
1 month	Dewoming + Vit. A
2 months	De worming + Vit. A FMD Vaccination
3 months	Deworming + Vit A + B Complex
4 months	Deworming + Vit A + B Complex
5 months	Deworming + Vit A + B Complex
6 months	Deworming + Vit A + B Complex FMD vaccination

Table 45: Result of calf registration

Particulars	Registered calves	Control
Body weight gain (in 150 days)	76.8	64.4
% increase in body weight	22 %	
Mortality (%)	3%	18%

The registered calves recorded more body weight (22%) with reduced mortality rate (3%) over the control calves (18%).

5.8 Livestock shelter management for stress tolerance

Improved shelters to reduce heat/cold stress in livestock

Shelter management in sheds with zinc sheet roof is practiced with provision of foggers during high temperature periods at Yagantipalle village of Kurnool district. The cost of intervention is Rs.5000 per shed. Duration of fogging per day is 30 minutes which required 40 liters of water per day. This practice reduced the temperatures in the shed with enhanced milk production by 8.5% during high temperature (Table 46).

Table 46: Effect of protection measures during extreme weather

Type of animal	No of animals	Type of material used	% increase in milk production	
			With intervention	Without intervention
Buffalo	30	Foggers	116.4	107.3

Table 47: Loose House System – Pune

Observations	Demo	Control
Milk Yield (L/cow/day)	13.8	12.6
Labour	3 hrs	5.5 hrs
Gross Cost/lactation/cow	69346	64870
Gross returns (Rs./cow)	84180	76860
Net returns per cow(Rs./cow)	14834	11990
B:C ratio	1.21	1.18

5.9 Intensive goat rearing on raised platform

Continuous heavy rainfall leads to incidence of pneumonia and mortality of goats in Ratnagiri. Demonstrations of Intensive goat rearing on raised platform with improved breed Konkan Kanyal which is resistant to heavy rains resulted in reduced mortality rate compared to local goats with increased herd size (Table 48).

Goat rearing on raised platform

Table 48: Intensive goat rearing on raised platform

Particulars	Treatments	
	Local breed On Plain surface (T_1)	Konkan Kanyal on raised platform system (T_2)
No of Families	2	2
Initial Size of herd	5+1	5+1
Mortality due to heavy rain (No)	2	NIL
Present size of herd	10+2	17+4
No of Males sold	2	2
Price /male (Rs.)	7000	12000
Total income (Rs.)	14000	24000
Employment gain	Throughout year employment for 2 person	Throughout year employment for 2 person

5.10 Promotion of fisheries

Captive rearing of fish seed i.e., rearing of fish fry up to fingerling stage in nursery pond was practiced at Srikakulam to reduce the loss of mortality during acclimatization. Captive rearing not only increases the percentage of survival but also reduces the cost of seed when purchased directly from the market. Net benefit Rs.10800 was obtained in captive rearing of fish in 20 days period (Table 49).

Table 49: Captive rearing of fish seed (Rearing of fish fry up to fingerling stage in nursery pond)

Input	Cost of Cultivation	
Seed: 19,000 no. of fish seed at fry stage (2-3 cm size). Feed: Ground nut cake & rice bran Hapa net	Captive rearing:	
	Cost of fish fry	Rs. 6900.0
	Feed cost for 20 days	Rs. 1500.0
	Labour charges	Rs. 1000.0
	Hapa (pen) charges	Rs. 2000.0
	Total cost of cultivation	Rs. 11400.0
	No. of fingerlings released in tank (@58% survival)	11100 No's
	Price of each finger ling in captive rearing	Rs. 1.0
	Farmers practice:	
	Total cost of fingerlings (11100 no's) if purchased directly @ Rs.2/ fingerling	Rs. 22200.0
	Amount saved in 20 days period through captive rearing	Rs. 10800.0

Captive rearing of fish

Optimization of stocking density of grass carp in IMC (Indian Major Carp) culture

Optimization of stocking density of grass carp in IMC (Indian Major Carp) culture was demonstrated with 4 farmers at Srikakulam. It is observed that higher fish yields (900 kg/ha.) were realized upon optimizing the stocking density through addition of grass carp @ 250 numbers per acre over control (717 kg/ha), as the grass carp devours the weed and thus encouraging the growth of plankton that helps in the growth of IMC (Table 50).

Table 50: Optimization of stocking density of grass carp in IMC culture

Parameters	Indian major carps +Grass carp	Indian major carps
No. Released	11100+2,500	11100
Growth rate	IMC-460 gm, Grass carp-565 gm	IMC-410 gm
Yield (kg/ha)	900	717
Cost of cultivation (Rs.)	18250	16250
Gross returns (Rs.)	63000	50225
Net returns (Rs.)	44750	33975
B:C Ratio	3.45	3.09

Usage of lime and fertilizers for plankton development

Usage of lime and fertilizers for plankton development after stocking of fingerlings was demonstrated with 4 farmers and it was observed that monthly growth rate of 70 gm/month in IMC has resulted in increase of fish yield (360 kg/acre) in Jagannadha Naidu tank due to application of lime and fertilizers for plankton development over control ponds where monthly growth rate was observed to be of 60gm/month, that resulted in fish yield of 266 kg/acre (Table 51).

Table 51: Usage of lime and fertilizers for plankton development after stocking of fingerlings

Parameters	Demo	Check
Yield (kg/ha)	900	665
Per cent increase	35.3	-
Cost of cultivation (Rs.)	18250	13750
Gross returns (Rs.)	63000	46550
Net returns (Rs.)	44750	32800
B:C Ratio	3.45	3.38

Fish species of different feeding habits were released into the tank. The species Rohu was a column feeder while catla and big head carp were found to be surface feeders (Table 52).

Table 52: Feeding habit of different types of fish varieties released

Species name	Feeding Habit	No. Released
Catla	Surface feeder	4000
Big head carp	Surface feeder	3000
Rohu	Column feeder	8000

Monitoring of water quality in fish ponds

Monitoring of water quality viz., oxygen depletion (OD), ammonia content and pH in fish ponds and adoption of correction measures on need basis resulted in 6.7% increase in yield and gave an additional income of Rs. 55000/- per ha. This is due to decrease in cost of cultivation in demo ponds compared to control (Table 53).

Table 53: Water quality management in fish ponds

Treatments	Yield Kg/Ha	Gross Income	Cost of Cultivation	Net Income	B:C	% increase in yield
Water quality managed ponds	6750	540000	343000	197000	1.57	6.7%
No regular water quality management	6325	506000	354000	142000	1.39	

6. Institutional Interventions

6.1 Custom hiring center for farm machinery

Indian agriculture is undergoing a gradual shift from dependence on human and animal power to mechanical power because of increasing cost for upkeep of animals and growing scarcity of human labour. Further, use of mechanical power has a direct bearing on the productivity of crops apart from reducing the drudgery and facilitating timeliness of agricultural operations. Mechanical power is largely consumed in big land holdings and is still beyond the reach of small/marginal holdings which constitute around 80% of the total land holdings. This is due to the fact that the small/marginal farmers, by virtue of their economic condition are unable to own farm machinery on their own or through institutional credit. Therefore in order to make farm machinery available within the reach of farmers with small/marginal holdings, collective ownership or Custom Hiring Centers (CHC) need to be promoted in a big way.

CHC is basically a unit comprising a set of farm machinery, implements and equipment meant for custom hiring by farmers. Though certain implements and equipment are crop specific, the traction units like tractors, power tillers etc and self-propelled machinery like combined harvesters etc., are used commonly in all crops. Therefore, an ideal model envisaged in this project comprises of farm machinery that are commonly used for tillage operations for all crops, multi crop equipment and a minimum of crop specific machinery.

Objectives:

- ✓ To make available various farm machinery/equipment to small and marginal farmers
- ✓ To offset the adverse economies of scale due to high cost of individual ownership
- ✓ To improve mechanization in places with low farm power availability
- ✓ To provide hiring services for various agricultural machinery/implements applied for different operations.
- ✓ To expand mechanized activities during cropping seasons in large areas especially in small and marginal holdings.
- ✓ To provide hiring services for various high value crop specific machines applied for different operations.

Operationalization of Custom hiring centers in NICRA villages

For implementing climate resilient technologies, interventions proposed in various NICRA villages in 100 vulnerable districts, suitable farm implements were made available in the Custom Hiring Centers depending upon the need of the farmers for various farm operations. The custom hiring centers will give farm machinery on rental basis to farmers who cannot afford to purchase high-end agricultural machinery and equipment apart from servicing old machinery.

A committee of farmers nominated by the gram sabha manages the custom hiring centre in each project village. The rates for hiring the machines/implements are decided by the committee itself depending upon the socio economic condition and cropping intensity of the village. Every farmer in the village can hire the machines from these centers; The modalities can be decided by the committee members and amended from time to time as per the local situation and needs. This committee also uses the revenue generated for repair and maintenance of the implements and remaining amount goes into revolving fund. The main objective in selecting particular farm implement in CHCs is to enable any farm operation timely without losing a favourable window of rainfall or soil moisture available. The VCRMC decides the price of hiring of each farm implement on consensus basis and it is displayed at the CHC. Registers are maintained for each farm implement for recording number of hours, farmers benefitted, amount paid towards hiring. The income generated out of CHCs goes to common account.

Progress of NICRA centers

Andhra Pradesh

Anantapur

Groundnut is an important oilseed crop grown in NICRA village of Anantapur district. Timeliness and precision in sowing and other operations are essential to raise the productivity of this crop. But farmers are sowing the crop even up to the end of August due to non availability of labour and draft power. Efforts were made to establish custom hiring centre for providing timely services for various agricultural operations to the farmers during 2011. The machinery required for this center was provided with financial support of the project during 2012-13. The centre provided services to 25 ha area of groundnut and realized income of Rs 4200. In 2013, the custom hiring centre provided hiring services to 44.8 ha area of groundnut and earned net income of Rs14500. During rabi, it helped to provide services on hire basis to chilies and tomato in 10.5 ha area. The total net income realized providing services in NICRA village is Rs 21500. The centre is managed by Village Climate Risk Management Committee (VCRMC). In 2014, center provided hiring services to 25 ha of groundnut and realized the service charges to an extent of Rs 3900. Thus the center generated Rs 23000 by providing services to105 ha from 2011 to 2014. During 2015-16 the centre realized a net income of Rs. 24100 covering crops over 120.4 ha in 48 farmer's fields using the implements viz., duck foot five row cultivator, Sub-soiler for moisture conservation and seed drill for ground nut, green gram, foxtail millet.

Chittoor

Custom hiring centre was established during 2015-16. 30 farmers utilized the hiring services covering an area of 10.4 ha. The list of equipment procured by the centre during 2015-16 is as follows:

S.No.	Item	No. of units
1	Sub soiler	2
2	Taiwan sprayers	3
3	Portable sprayers	3
4	Power weeders	2
5	Knapsack sprayers	10
6	Disc plough	1
7	Tarpaulins	20
8	Brush cutter	1
9	Pole pruner	2
10	Tractor mounted sprayer	2
11	Star weeders	10
12	Mango harvesters	14
13	Sprinkler system	2
14	GPS	1
15	Weather instruments	1 (Rain gauge, Cup anemometer, Wind vane, Steven screen)
16	Rice mill machine	1
17	Paddy row seeders	5
18	Chain saw	1

Kurnool

Custom hiring center was established in 2011 with an investment of Rs 6.25 lakh as a group activity. The centre consists of seed drills, rotavator, drum seeders, taiwan sprayer, sprinklers with pump set and sheep de-worming gun etc. During 2012, the custom hiring center provided hiring services for various operations in crops like pigeonpea, castor, chickpea and sorghum. The area covered under different crops was 79.4 ha. The centre realized an income of Rs.12000 in 2011-12. About Rs.1575 was incurred towards the maintenance of tools in the centre. The net amount realized by the centre was Rs 10425/year.

During 2013-14, the centre provided services to various farmers' fields covering 85.4 ha and realized the income of Rs12772. About Rs 2500 was incurred towards the maintenance of tools. The net amount realized due to providing need based services was Rs 12272/year. The progress of the centre was monitored by the VCRMC of the village. During 2014-15, center provided hiring services to the crops of pigeonpea, castor, chickpea and sorghum to the extent of 62.4 ha and realized Rs 8300 as hiring charges. During 2015-16, the centre provided services to various farmers' fields by providing rotavator, Drum seeders, Taiwan sprayer, and sprinklers with Pumpset covering 104 ha and realized an income of Rs 8400.

Srikakulam

The custom hiring centre was established in NICRA village of Srikakulam district to provide community based hiring services with agricultural implements for timely agricultural operations during 2012-13. About 60 families became the members of the center. The management committee was formed in the village to guide the operations of the centre on 20th November 2011. The project supported the center with the investment of 6.25 lakhs. The committee assessed the needs of mechanization for different crops before finalizing action plan in each year.

The center provided hiring services to the crops of paddy, cotton, vegetables in kharif, pulses, maize and vegetables during rabi season covering 20 ha area during 2012. The center realized a net amount of Rs.12180 during 2013. The center provided hiring services to the crops of paddy (7.0 ha), Cotton (2.0 ha), vegetables (3.0 ha) in Kharif season and Pulses (3.0 ha), vegetables (2.0 ha) and maize (0.5 ha) in rabi season. The center realized the net amount of Rs 8300 during 2013. The VCRMC suggested for proper utilization of the equipments, prompt collection of services charges and timely repairs of the equipments.

During 2014-15, the center provided need based hiring services in the crops of paddy, pulses, groundnut and vegetables and collected the rental charges of Rs.7405. Among the equipment power sprayer was used in 150 ha and winnowing fan in 25 ha and sprinkler unit was used in 85 ha. During 2015-16 the centre realized a net income of Rs. 1500 in 50 farmers fields. Among the various constrains, frequent repair of power tiller, non-utilization of paddy reaper due to advent of combined paddy harvester, use of power operated winnowing fan only in places where power is available, lack of skill power for repairs at village level and village level political system.

West Godavari

The custom hiring centre was established in NICRA village of Undi in West Godavari district on 25.10.11 with investment of Rs 482077. The centre provided hiring services in various agricultural crops like paddy and vegetable to the extent of 31ha in 2012. The centre realized the net income of Rs 3100 for the year 20012-13. The centre provided hiring services for paddy covering 31 ha and earned the net profit of Rs 3000 during 2013. The centre is operated under the guidance of village climate risk management committee. The committee meetings were held for every month to monitor the progress of the work and performance of the centre. During 2014-15, the center preceded hired services paddy (29 ha) and realized the net income of Rs 3140. During 2015-16 the centre got an income of Rs. 3600 covering 15.5 ha area.

Telangana

Khammam

The centre was established in Nacharam village (NICRA village) of Khammam district during 2010-11 with the investment of Rs. 55047 for providing hiring services for different agricultural

operations to the farmers. About 9 persons were engaged in running the centre. In the process of operation, different commodity groups are formed to identify and assess the demand of various crops and various operations, formation of schedule to be implemented during the year. This centre is operated by VCRMC voluntarily formed in the village. The centre procured Taiwan Sprayer (1), seed cum- fertilizer drill (1), paddy reaper (1), multi-crop thresher (1) and 2-M.B. plough (1). It provided hiring services for 52.8 ha and realized the amount of Rs. 20041. During 2013, the centre provided hiring services for paddy, cotton, chilies and maize covering 18.2 ha and realized the amount of Rs 3400. In 2014-15, the center provided the equipment on rent basis in 26.0 ha area covering the crops of paddy.

25.4 ha area was provided with hiring services covering 16 farmers fields and realized an income of Rs. 6070 During 2015-16.

Nalgonda

The centre was established in Nandyalagudem and Boring Thanda villages in Atmakur Mandal of Nalgonda district during 2011-12. About 6.71 lakh rupees were invested in establishment of the centre. The amount taken as loan from the bank for support of the centre was Rs 44000. About 12 members were engaged to run this centre. About 155 families are the members in the centre. During 2011-12, the centre provided hiring services for kharif groundnut, paddy, cotton, green gram and vegetables and covered the area of 92 ha. It earned the net amount of Rs 23720 in 2011-12. During 2013, the centre provided the hiring services for 57.8 ha and realized the net amount of Rs 26000/year. The VCRMC met five times in 2012 and one time in 2013 to suggest various measures for improvement.

During 2014-15, custom hiring center provided services to the village farmers covering 80.0 ha and collected the amount of Rs 42000/year as service charges. The net amount realized from this centre for the current year was Rs 31000. During 2015-16 Rs.7300 was realized from custom hiring of farm implements in 23 farmers fields covering an area of 15.6 ha.

Maharashtra

Ahmednagar

The custom hiring center was estabilished in NICRA village of Ahmednagar to provide hiring services for agricultural operations during 2011-12. A Financial support of Rs 6.25 lakhs was received from the project to establish the centre. The center intiated the operation activities of hiring services and covered an area of 29.4 ha in 2011-12 and earned the net profit of Rs 21980. During 2012-13, the centre provided hiring charges for the crops of soybean, pearl millet, chickpea, onion, pomegranate, lucerne, fodder maize covering 16.4 ha and realized the net income of Rs 12130. In 2013-14, the center provided hiring services for the crops of soybean (25.8 ha), pearl millet (9.8 ha), Chickpea (20 ha), onion (42.6 ha), pomegranate (18.2 ha), Lucerne (17.8

ha) and fodder maize (2 ha). It realized a net amount of Rs 64140 by covering 145.6 ha. During 2014-15, the center extended hiring services with various farm tools to the crops of soybean (17.8 ha), pearl millet (12 ha), fodder sorghum (19 ha), chickpea (7 ha) and pomegranate (3.0 ha).The center generated a net income of Rs 31740/year. The centre generated an income of Rs. 17310 in 29 farmers fields covering an area of 37.1 ha during 2015-16.

Amravati

As a part of institutional innovations, the center established community based custom hiring center with an investment of 9.40 lakhs with involvement of 294 family members in NICRA village during October 2010. The space for the establishment was provided by the farming community in the village. Two persons were engaged in running the center. During 2012, the centre provided services for various agricultural operations to the crops of soybean, cotton and chickpea. It covered a total area of 633.7 ha and realized net amount of Rs. 60728. The center helped farmers in performing timely operations for the crops of soybean, cotton and chickpea and earned net profit of Rs. 33100 by covering 480.5 ha in 2013. In 2014-15, the custom hiring center helped the farmers in raising cotton (256 ha), soya bean (290 ha), chickpea (220 ha) during the year. The centre realized the amount of Rs. 40750/year and incurred an expenditure of Rs17249/ year. Among various equipments, the center has more demand for seed drills, Rotavator, BBF planter and sprinkler sets. The center earned a net amount of Rs.17429/year. 401 ha area is covered under hiring of farm implements realizing an income of Rs. 24430.

Aurangabad

The center was established to provide custom hiring services to the farmers of NICRA village during 2012 with an investment of Rs. 328845 with 7 implements. The centre has realized an income of Rs. 95000 covering an area of 52 ha in crops of cotton, soybean and chickpea during 2014-15. During 2015-16 a net profit of Rs.58000 was obtained covering 60 ha area. Maximum number of farmers utilized sprinkler irrigation sets which not only saved water but increased profit.

Jalna

The custom hiring centre is established during 2015-16 with the following implements.

1. Tractor operated BBF planter
2. Tractor operated shredder
3. Rotavator
4. Sprinkler sets /Raingun
5. Bullock drawn seed cum fertilizer drill (02 Nos)
6. Battery operated power sprays (02 Nos)
7. Power operated chaff cutter
8. Village level small weather station
9. GPS

The centre realized a net income of Rs. 11425 covering 30 ha area in 71 farmers fields during the year.

Nandurbar

The center was established to provide custom hiring services to the farmers of NICRA village with an investment of 6.24 lakhs on 20th June 2011. About 257 families in the village are the members of the center. The center provided hiring services for different agricultural operations covering the crops of sorghum, soybean, chickpea, wheat, maize, ground nut and Mango in 2012. It realized the net income of Rs 7000 by covering the cropped area of 110 ha. An amount of Rs.1200 was incurred towards maintenance of tools. In 2013, the center realized the amount of Rs. 2315 as hiring charges by covering the total cropped area of 99 ha. An amount of Rs.1630 was incurred as repairing and maintenance charges of tools. The important crops covered during 2013 were maize, sorghum, soybean, chickpea, wheat, garlic, groundnut, mango and vegetables. The activities of the center were monitored by VCRMC of the village. The recommendation of the committee for improved functioning of the centre was to place the implements at 4-5 places for easy accessibility since villages are scattered in hilly areas. About 12 farmers purchased their own allen cultivator for their use. Small hand tools are also purchased by the farmers. The key issues realized for the sustainability of this center are: 1. The implements which are light in weight, have been preferred by the farmers due to easy transportability. 2. The implements should be kept at 4-5 places for easy accessibility 3. Implements which are suitable for small bullocks are preferred by the farmers. The CHC gave hiring services for the crops like maize, sorghum and soya bean in kharif and chickpea, wheat and garlic in rabi and also mango, groundnut and vegetables in summer. Thus the center covered a total area of 16 ha and earned net profit of Rs.1070 besides earning total gross income of Rs. 5480/year. During 2015-16, 33 ha of area is covered in 93 farmers field with an income of Rs.980.

Pune

Custom hiring center was established in NICRA village with an investment of Rs 6 lakhs during 2011. About 115 farm families are the members in the center. The center helped in providing hiring services for pearl-millet, onion and rabi sorghum in 64.4 ha and realized hiring charges of Rs10090. An amount of Rs 10900 was incurred towards repair and maintenance charges of tools. The centre helped the farmers in providing hiring services on 36.1 ha area and realized the amount of Rs. 6960.The CHC provided hiring services in 33.4 ha covering the crops of pearlmillet, onion, rabi sorghum, chickpea and maize realizing an amount of Rs 5130 during 2014-15. An amount of Rs 2700/year was incurred as expenditure to maintain the center. During 2015-16, 59.5 ha area is covered under custom hiring of farm implements in 114 farmers fields with a net income of Rs. 7750.

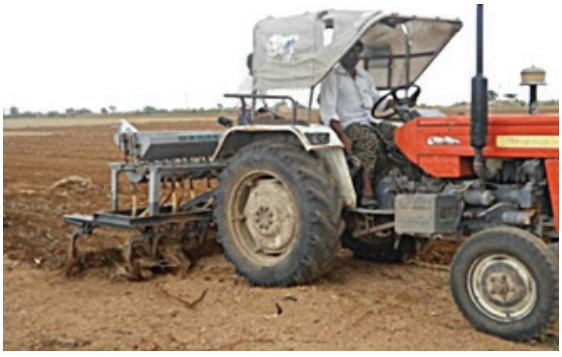
Ratnagiri

The Custom hiring center was established as a group based activity to provide hiring services of agricultural operations in NICRA village in 2011with the project support of Rs. 6.25 lakhs. About 13 VCRMC members are engaged in running the center. The center helped in providing hiring services for paddy over 170 ha and realized a net amount of Rs. 2200 after incurring maintenance charges of Rs. 3500 in 2012. In 2013, the center earned a net profit of Rs. 14000 by covering 172 ha. An amount of Rs. 4000 was incurred for repairing the tools of the center. During 2014-15, CHC helped in providing hiring services on 19 ha area and realized a income of Rs.14560. The important crops covered with hiring services were paddy (14.0 ha), cowpea (1ha) and cashew (5 ha).The center realized an amount of Rs.12080/year due to custom hiring services. During 2015-16 custom hiring of implements realized an income of Rs.10550 covering 10.1 ha area.

Table 54: Performance of custom hiring center at different NICRA centers during 2015-16

KVK	Area covered (ha)	Farmers covered	Revenue generated through CHCs (Rs.)
Anantapur	120.4	48	24100
Chittoor	10.4	30	11572
Kurnool	104.0	48	8400
Srikakulam	77.8	50	1500
West Godavari	15.5	33	3600
Khammam	25.4	16	6070
Nalgonda	15.6	23	7300
Ahmednagar	37.1	29	17310
Amravati	401.0	419	24430
Aurangabad	119.0	86	58000
Jalna	30.0	71	11425
Nandurbar	33.0	93	980
Pune	59.5	114	7750
Ratnagiri	10.1	38	10550
Total	**1058.8**	**1098**	**192987**

Custom Hiring Equipment

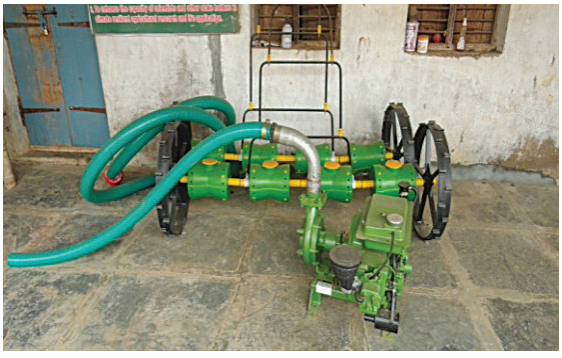


Ananta planter

Groundnut thresher

Seed cum fertilizer drill

Rotavator



Paddy drum seeder

Multiple thresher

Thresher

Seed cum fertilizer drill

6.2 Seed bank

NICRA seed bank at Pune

Quality seed of improved varieties is an important basic input for enhancing productivity of any crop species. The existing mechanisms are not adequate to meet the seed requirement of small farmers at affordable prices and at the right time which would enhance crop productivity and household food security. The baseline studies in the project areas identified key problems related to seed supply system. Lack of timely availability of good quality seed of high-yielding varieties is one of the major constraints contributing to stagnant yields of crops in the project area.

The project devised alternative seed systems, which ensure availability of quality seed of improved varieties at local level. The concept of village seed banks was promoted and successfully validated in the project villages. It not only ensured timely availability of quality seed of farmer-preferred varieties at affordable prices at local level but also enhanced crop productivity and higher incomes to farmers through local seed enterprises.

Andhra Pradesh

During kharif 2015 seed production in paddy (BPT-5204), pigeonpea (Asha-87119) and foxtail millet (SIA-3088) and chickpea (NBeG-3) was taken up to establish seed bank in the NICRA village of Kurnool district. The NICRA farmers produced 120 q of foxtail millet, 40 q pigeonpea and 22 q of chickpea. 4.5 Tones of paddy seed of varieties RGL-2537, MTU-1061 & PLA-1100 was produced involving 3 farmers in the NICRA village of Srikakulam district.

Telangana

Sunhemp seed (6400 kg) was produced from 8 ha area with 26 farmers to conserve the seed and the same was distributed to local farmers in NICRA village of Khammam district. 0.5 q seed of short duration pigeonpea (Variety-PRG-176) was produced involving 2 farmers in 0.4 ha area in NICRA village of Nalgonda district.

Maharashtra

124.5 q of Soybean seed of variety JS-9305 was produced and utilized during next year for sowing purpose covering an area of 100 ha approximately in NICRA village of Amravati district. In NICRA village of Jalna 50 q of rabi sorghum seed is produced by 50 farmers contributing 1 q seed each (Total 50 q) with technical assistance of KVK. 5 q of Chickpea seed of variety Digvijay was produced by 9 farmers in 20 ha area. Each farmer produced about 50 q of seed with technical support from the KVK. Breeders seed of pigeon pea (ICPL-87), chick pea (Digvijay), maize (GM-6) has been provided to farmers for seed production. Seed was collected from 50 farmers in 20 ha area.

6.3 Fodder bank

Fodder bank at Kurnool

In Kurnool district of Andhra Pradesh Co-1, Co-3, APBN-1 fodder varieties are grown producing 720 q of fodder. In Khammam district of Telangana state Tanzania, Co-3, Co-4, Nutrifed and Sugar graze fodders were produced (5-6 tonnes /ha), the slips are conserved and distributed to 24 farmers of NICRA village covering an area of 6 ha. In NICRA village of Pune district, cultivation of fodder maize (Var. African Tall) is taken up for silage making with 10 farmers in 4 ha area.

6.4 Climate Literacy

Climate literacy was provided through a village level weather station, which helped in daily monitoring of the weather and created awareness among village farmers regarding climatic events like rainfall, temperature, humidity, wind speed and direction etc., mobile SMS on weather forecasting, prediction of rainfall and forewarning of pests and diseases etc.

6.5 Village Climate Risk Management Centres (VCRMC)

Shetkari Suvidha Kendra (Farmers Facility Centre) was established in NICRA village of Nandurbar district which provides small tools, biofertilizers, poultry chicks, mineral mixture and other agricultural inputs etc., KVK identified a small grocery owner (NICRA farmer) to start Shetkari Suvidha Kendra (Farmers Facility Centre) to make available agricultural inputs and products for farmers of the NICRA as well as adjoining villages. All these inputs are made available by KVK on cost basis.

Farmers facility centre at Nandurbar

7. Capacity building of farmers & youth on climate resilience in agriculture

There is need to focus on skill oriented training programmes to farmers of NICRA villages pertaining to on-farm technological demonstrations on participatory mode, so that they can extend their cooperation in recording need based data on technologies in respect of raising crops and livestock, NRM activities and crop production in different districts of Andhra Pradesh, Telangana and Maharashtra. The NICRA centers working in the state of Andhra Pradesh organized 94 skill oriented training programmers with the active participation of 2962 participants, while the NICRA centers in the state of Telanaga, organized 19 need based training programmes on improving the productivity of agricultural and horticultural crops, livestock, and Custom hiring centers with active involvement of 613 participants. In Maharashtra, the NICRA centers organized 135 training programmes with the participation of 3883 farmers. Thus the Programme Coordinators in the states of Andhra Pradesh, Telangana, and Maharashtra organized 248 training programmes with the participation of 5944 farmers and 1514 farm women. The list of training programmes organized includes: Natural resource management, resource conservation technologies, soil productivity improvement, climate resilient intercropping systems, contingency crop planning, crop diversification, nutrient management, integrated pest management, soil test based fertilizer application, farm implements, fodder and feed management, livestock management, seed banks, fodder banks and integrated livestock Management etc (Table 55 & 56).

Table 55: Statewise Summary of capacity building activities

State	No. of courses	No. of beneficiaries		
		Male	Female	Total
Andhra Pradesh	94	2432	530	2962
Telangana	19	532	81	613
Maharashtra	135	2980	903	3883
Grand Total	**248**	**5944**	**1514**	**7458**

Table 56: Capacity Building Activities

KVK	Thematic area	No. of Courses	No. of beneficiaries		
			Male	Female	Total
Andhra Pradesh					
Anantapur	Natural resource management	5	102	29	131
	Crop diversification	2	120	35	155
	Crop management	4	126	21	147
	Pest and disease management	5	130	22	152
	Live stock management	2	97	28	125
	Fodder and feed management	3	103	20	123
	Farm implements and machineries	3	69	7	76

KVK	Thematic area	No. of Courses	No. of beneficiaries		
			Male	Female	Total
Kurnool	Crop management	5	109	16	125
	Soil health management	1	31	6	37
	Contingency crop planning	1	35	7	42
	Livestock management	3	67	24	91
	Hydroponic fodder production	1	35	5	40
	Pest and disease management	4	90	23	113
	Nursery raising	1	18	6	24
	Farm implement of machineries	1	22	6	28
	Nutrient management	1	28	9	37
	Natural resource management	3	63	26	89
	Fodder and feed management	1	21	4	25
Chittoor	Natural resource management	2	136	24	160
	Resource conservation technologies	2	37	9	46
	Crop diversification	1	25	13	38
	Crop management	3	93	19	112
	Nursery raising	1	21	4	25
	Nutrient management	4	91	18	109
	Pest and disease management	2	50	2	52
	Weed control	2	26	11	37
	Live stock management	1	21	14	35
	Fodder and feed management	3	67	14	81
	Farm implements and machineries	2	69	20	89
	Value addition	1	17	-	17
	Employment generation	4	56	11	67
Srikakulam	Water saving technologies	1	15	5	20
	Zero tillage maize	1	20	5	25
	Critical interventions in flood paddy cultivation.	1	25	5	30
	Contingency measures and risk management strategies in flood and cyclone affected agriculture	1	25	5	30
	Pest and disease management	2	50	10	60
	Nursery pond management and identification of quality fish seed	1	18	6	24
	Crop diversification	1	22	8	30
	Crop management	2	43	16	59

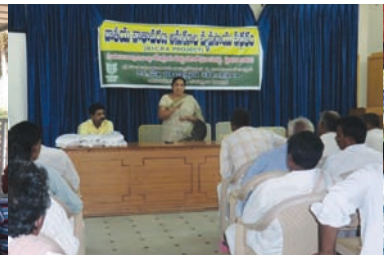
KVK	Thematic area	No. of Courses	No. of beneficiaries		
			Male	Female	Total
	Weather based prophylactic measures to avoid incidence of pests and diseases in pulses	1	25	5	30
	Good management practices in fresh water fish culture	1	8	2	10
	Weed management	1	20	4	24
	Summer vegetable cultivation technology	1	24	6	30
West Godavari	Nutrient management	1	23	-	23
	Weed management	1	32	-	32
	Pest and disease management	1	22	-	22
	Crop management	1	25	-	25
	Mechanical transplanting of paddy	1	30	-	30
	Paddy-Paddy-Pulses cropping pattern	1	30	-	30
	Andhra Pradesh Total	**94**	**2432**	**530**	**2962**
Telangana					
Khammam	Integrated farming system	1	29	9	38
	Pest and disease management	1	28	7	35
	Live stock management	1	27	5	32
	Soil and water conservation practices	1	37	8	45
	Fish management	1	36	4	40
Nalgonda	Natural resource management	3	81	14	95
	Resource conservation technologies	2	68	6	74
	Crop diversification	3	67	10	77
	Nutrient management	2	52	-	52
	Fodder management	2	49	10	59
	Farm Implements and mechanization	2	58	8	66
	Telangana Total	**19**	**532**	**81**	**613**
Maharashtra					
Ahmed-nagar	Contingency crop planning	1	34	-	34
	Disease management	1	30	-	30
	Silage making	1	38	-	38
	Goat raring for self employment generation	1	52	-	52
	Agri-allied enterprises management under drought condition	1	62	-	62
	Livestock management	1	30	-	30

KVK	Thematic area	No. of Courses	No. of beneficiaries		
			Male	Female	Total
Amravati	Natural resource management	3	191	31	222
	Live stock management	2	55	12	67
	Farm implements and machineries	2	17	19	36
	Resource conservation technologies	1	19	2	21
	Crop diversification	1	35	11	46
	Crop management	2	58	22	80
	Integrated Nutrient management	1	119	35	154
	Pest and disease management	2	25	20	45
	Contingency crop planning	2	105	37	142
	Live stock management	2	198	41	239
Aurang-abad	Soil and water conservation measures	10	200	61	261
	Crop management	11	172	53	225
	Nutrient management	4	94	15	109
	Pest and disease management	3	55	16	71
	Weed management	3	81	18	99
	Live stock management	3	94	13	107
	Azolla production	4	54	14	68
	Farm implements and machineries	2	32	11	43
	Dal mill A tool of income	1	17	-	17
	Management of vegetable garden	1	10	19	29
Buldhana	Natural resource management	1	33	-	33
	Crop management	5	31	118	149
	Nutrient management	2	39	3	42
	Pest and disease management	1	35	-	35
	Farm implements and machineries	2	48	5	53
	Soil testing	1	25	3	28
Jalna	Crop management	2	40	-	40
	Livestock management	1	14	8	22
	Backyard poultry	2	29	38	67
	Processing and value addition	3	35	40	75
	In-situ moisture conservation technologies	1	22	-	22
	Rain water management	1	46	7	53
	Sericulture	1	18	14	32
	Nursery raising	1	26	-	26
	Farm Implements and Machineries	2	42	-	42
	Goat Farming for SHG Women	1	11	21	32

KVK	Thematic area	No. of Courses	No. of beneficiaries		
			Male	Female	Total
Nandurbar	Natural resource management	3	39	17	56
	Resource conservation technologies	6	68	30	98
	Crop management	3	47	20	67
	Crop diversification	1	7	8	15
	Pest and disease management	6	83	25	108
	Nutrient management	3	51	4	55
	Weed control	2	18	7	25
	Nursery raising	1	10	-	10
	Live stock management	1	14	12	26
	Fodder and feed management	4	47	16	63
	Farm implements and machineries	2	31	12	43
Pune	VCMRC meeting	1	28	-	28
	Protected cultivation	1	19	-	19
	Livestock management	1	8	-	8
Ratnagiri	Resource conservation technologies	1	27	15	42
	Crop management	2	47	13	60
	Fodder and feed management	1	17	3	20
	Pest and disease management	1	14	8	22
	Farm implements and machineries	1	17	3	20
	Live stock management	1	17	3	20
	Maharashtra Total	**135**	**2980**	**903**	**3883**

Training programmes organized by NICRA KVKs

Chittoor



Kurnool

Khammam

Nalgonda

Pune

Ratnagiri

8. Extension activities for popularization of climate smart agricultural practices

Transfer of climate resilient agricultural technologies was done with the involvement of KVK staff located in respective districts of NICRA villages of Andhra Pradesh, Telangana and Maharashtra states through various extension activities. The extension activities organized by different KVKs in NICRA centers during 2015-16 include awareness programmes on climate resilient agriculture, field days, kisan melas, method demonstrations, health camps, diagnostic visits, agro-advisory services, exposure visits etc., During 2015-16, 630 extension activities were taken up with the participation of 14577 farmers. Among these, 315 activities were organized with 6227 farm men and1641 farm women in the state of Andhra Pradesh: while in Telangana state, 51 extension activities were organized with the participation of 1005 farm men and women. About 5694 farm women and men participated in 264 extension activities in the state of Maharashtra during 2015-16. The details are presented below: (Table 57 & 58).

Table 57: Statewise Summary of extension activities

State	No. of courses	No. of beneficiaries		
		Male	Female	Total
Andhra Pradesh	315	6227	1641	7878
Telangana	51	818	187	1005
Maharashtra	264	4722	935	5694
Grand Total	**630**	**11767**	**2763**	**14577**

Table 58: Extension Activities

KVK	Name of the activity	Number of programmes	No. of beneficiaries		
			Male	Female	Total
Andhra Pradesh					
Anantapur	Exposure visits	4	80	15	95
	Method demonstrations	7	134	28	162
	Field days	4	60	12	72
	Awareness on climate resilient technologies	8	120	45	165
	Diagnostic visits	18	124	18	142

KVK	Name of the activity	Number of programmes	No. of beneficiaries		
			Male	Female	Total
Kurnool	Method Demonstrations	6	155	27	182
	Agro advisory services	96	3312	984	4296
	Awareness on climate resilient technologies on climate resilient technologies	4	106	23	129
	Diagnostic visits	20	422	88	510
Chittoor	Method demonstrations	4	216	9	225
	Agro advisory services	22	196	98	294
	Awareness on climate resilient technologies	5	104	50	154
	Exposure visits	1	23	-	23
	Field Days	2	53	18	71
	Group discussion	6	52	36	88
	Diagnostic visits	22	70	23	103
Srikakulam	Agro advisory services	20	120	28	148
	Group discussions	14	139	48	187
	Diagnostic field visits	25	184	39	223
	Method demonstrations	8	175	26	201
	Field days	6	149	26	175
	Exposure visits	2	37	0	37
West Godavari	Method demonstrations	8	176	0	176
	Diagnostic visits	3	20	0	20
	Andhra Pradesh Total	**315**	**6227**	**1641**	**7878**
Telangana					
Khammam	Method demonstrations	9	185	80	265
Nalgonda	Method demonstrations	6	56	15	71
	Agro Advisory Services	12	78	20	98
	Exposure visits	3	46		46
	Field days	2	77	5	82
	Group discussions	8	86	13	99
	Diagnostic visits	10	64	13	77
	World Soil Day	1	226	41	267
	Telangana Total	**51**	**818**	**187**	**1005**

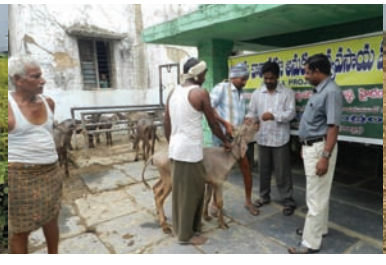
KVK	Name of the activity	Number of programmes	No. of beneficiaries		
			Male	Female	Total
Maharashtra					
Ahmednagar	Field days	1	38	0	38
	Technology exhibition	1	88	36	124
	Mobile alert system	-	530	121	651
	Seminars	1	414	30	444
	Group meeting	1	21	-	21
	Exposure visits	1	35	-	35
Amravati	Method demonstrations	6	126	30	156
	Agro advisory services	50	104	26	130
	Awareness on climate resilient technologies	3	94	17	111
	Exposure visits	2	25	6	31
	Group discussion	10	155	22	177
Aurangabad	Exposure visits	3	52	22	74
	Field days	3	38	5	43
	Method demonstrations	16	295	65	360
	Awareness on climate resilient technologies	18	314	73	387
Buldhana	Method demonstrations	2	23	2	25
	Awareness on climate resilient technologies	1	25	2	27
Jalna	Method demonstrations	6	178	-	178
	Agro advisory services	11	180	30	210
	Awareness on climate resilient technologies	2	47		47
	Exposure visits	3	22	56	78
	Field Day	1	62	6	68
	Group discussion	23	407	90	497
	Diagnostic visit	9	60	6	66
	Visits of Dignitaries	1	150	50	200
	NICRA Launch Workshop	1	110	15	125

KVK	Name of the activity	Number of programmes	No. of beneficiaries		
			Male	Female	Total
Nandurbar	Method demonstrations	11	138	76	214
	Agro advisory services	18	131	9	140
	Awareness on climate resilient technologies	1	18	0	18
	Exposure visit	6	105	6	111
	Field days	2	26	14	40
	Group discussions	17	218	47	265
	Kisan mela	2	34	40	74
	Diagnostic visits	3	27	0	27
Pune	Exposure visit	1	18	-	18
	Integrated farming system	1	5	-	5
	Field days	3	106	3	109
	Method demonstrations	7	158		158
	Awareness on climate resilient technologies	10	116	2	118
Ratnagiri	Group discussions	2	-	7	44
	Diagnostic visits	3	17	4	21
	Field Days	1	12	17	29
	Maharashtra Total	**264**	**4722**	**935**	**5694**

Group discussion-Anantapur

NICRA Project Launch-Chittoor

Field visit-Kurnool



Animal health camp-Kurnool

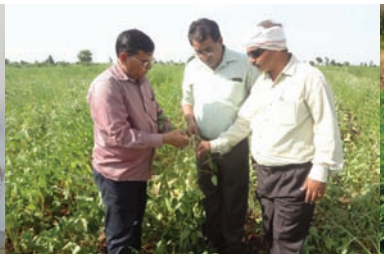
Method demonstration-Srikakulam

Group Discussion-Srikakulam

Field day-Khammam

Meeting-Ahmednagar

VCRMC meeting-Amravati



Diagnostic visit-Amravati

Field visit-Nandurbar

Method demonstration-Pune

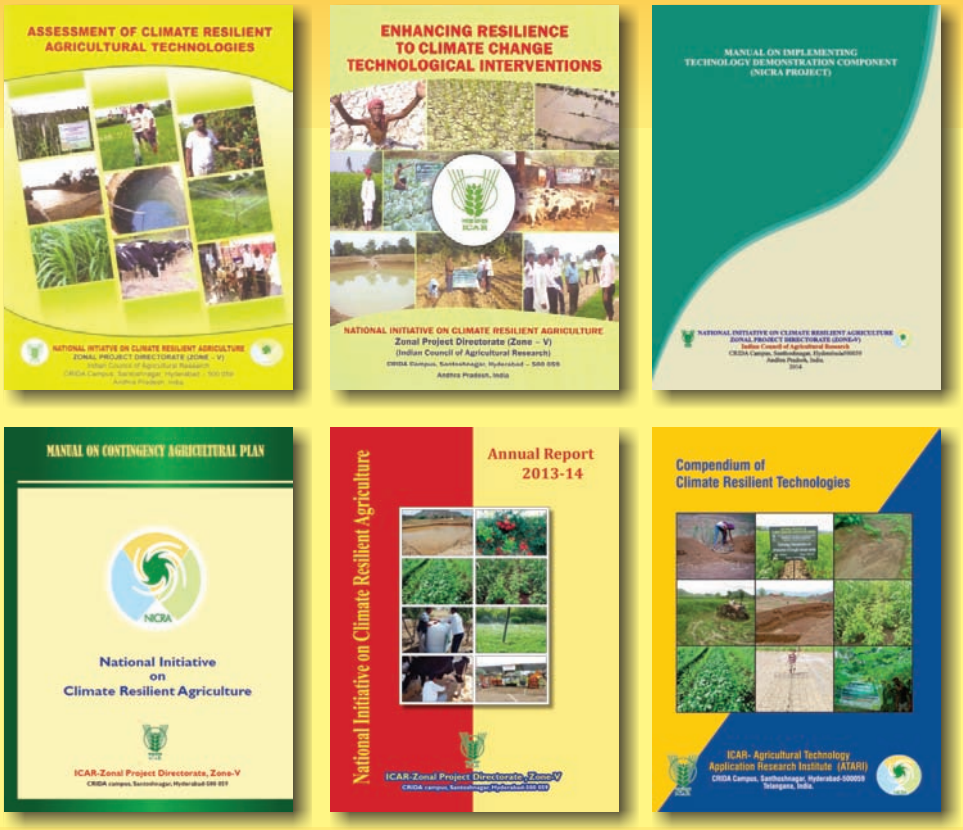
Exposure visit-Pune

Diagnostic visit-Jalna

List of Contributors

S.No.	KVK	PI	Co PI	Address
Andhra Pradesh				
1	Anantapur	Dr. P. Lakshmi Reddy	Dr. Narayana Swami	Krishi Vigyan Kendra, B.K. Samudram (M) Reddipalli - 515 701, Anantapur (Dist.) Tel: 08554-200418 E-mail: pc.atp@yahoomail.com
2	Chittoor	Dr. S. Srinivasulu	Dr. P.S. Sudhakar	RASS – Acharya Ranga Krishi Vigyan Kendra, Vanasthal Karakambadi post Renigunta Mandal - 517520 Chittoor district, Andhra Pradesh E-mail:arkvk@yahoo.co.in
3	Kurnool	Mrs. G. Dhanalakshmi	Mr. M. Sudhakar	KrishiVigyan Kendra, PO:Yagantipalli, Via:Banaganapalli, Distt. Kurnool – 518124 Tel: 08515 200340 Email: pendekantikvk@rediffmail.com
4	Srikakulam	Dr. D. Chinnam Naidu	Dr. D. Anil Kumar	KrishiVigyan Kendra, Agril. Research Station, Amdalavalsa, Distt. Srikakulam-532185 Tel: 08942286210 E-mail: kvk_adv2006@yahoo.co.in
5	West Godavari	Dr. D. Jagannadha Raju	Dr. A. Srinivasa Rao	Krishi Vigyan Kendra, Opp:Civil Supply Godowns, Post: Undi, Distt. West Godavari – 534199 Tel: 08816 228322 E-mail: kvkundi@yahoo.co.in
Telangana				
6	Khammam	Dr. J. Hemantha Kumar	Dr. N. Kishore Kumar	Krishi Vigyan Kendra, ARS Wyra Distt. Khammam - 507165 Tel: 08749-251803 E-mail: kvkwyra@yahoo.co.in
7	Nalgonda	Dr. Narasimha Reddy	Mr. T. Yadagiri Reddy	Krishi Vigyan Kendra, PO:Gaddipalli Garedapalli Mandal, Distt. Nalgonda -508201 Tel: 08683-237443 E-mail: saird_gaddipalli@yahoo.com

S.No.	KVK	PI	Co PI	Address
Maharashtra				
8	Ahmednagar	Dr. Bhaskar Gaikwad	Mr. Shailesh Deshmukh	Krishi Vigyan Kendra, PO: Babhaleshwar Tal: Rahata, Dist: Ahmednagar-413 737 Tel: 02422 252414 E-mail: kvkahmednagar@yahoo.com
9	Amravati	Dr. K.A. Dhapke	Mr. P. S. Jayle	KrishiVigyan Kendra (Durgapur), PO: Badnere Dist. Amravati– 444 701 Tel: 0721 2580606 E-mail: pc_kvka@yahoo.co.in
10	Aurangabad	Dr. S.B. Pawar	Dr. K.K. Zade	KrishiVigyan Kendra, Paithan Road Dist: Aurangabad – 431517 Tel: 0240 2376558 E-mail: pckvkmau@rediffmail.com
11	Buldhana	Dr. C.P. Jaybhaye	Dr. M.D. Giri	KrishiVigyan Kendra, Ajintha Road Buldhana E-mail:kvkbuldhana@gmail.com
12	Jalna	Dr. S.V. Sonune	Mr. P.V. Wasmik	KrishiVigyan Kendra Marathwada Sheti Sahayya Mandal Jalna-431 203, Maharashtra E-mail: pckvkjalna@gmail.com
13	Nandurbar	Dr. R.S. Dahatonde	Mr. J.N. Uttarwar	KrishiVigyan Kendra,A/P : Kolde, Tal&Dist. Nandurbar – 425 412 Tel: 02564 240544 E-mail: kvk_ndb@yahoo.com
14	Pune	Dr. Sayed Shakir Ali	Dr. S. Karanje	KrishiVigyan Kendra Sharadanagar, Dist: Baramati Pune-413115, Maharahstra E-mail: kvkbmt@yahoo.com
15	Ratnagiri	Dr. Vishal S. Sawant	Dr. Sandip Patil	KrishiVigyan Kendra, Post- Deodhe Tal. Lanja, Dist. Ratnagiri- 416712 Tel: 02351-231361 E-mail: kvkratnagiri@rediffmail.com



ICAR-Agricultural Technology Application Research Institute (ATARI)

CRIDA Campus, Santhoshnagar, Hyderabad-500059, Telangana, India.