Participatory Technology Demonstrations - Catalyzing Climate Resilience in Agriculture

Prasad YG, Singh A K, Prasad JV, Reddy GR, Akila N, Srinivasulu S, Dhanalakshmi G, Chinnam Naidu D, Lakshmi Reddy P, Mallikarjuna rao N, Hemantha Kumar J, Yadagiri Reddy T, Sudhakar M, Sudhakar PS, Parameswari K, Kavitha, Baskaran A, Himabindu T and Madhuri Thinnaluri

ICAR-Agricultural Technology Application Research Institute (ATARI)

Zone-X, CRIDA Campus, Santoshnagar, Hyderabad-500 059

Telangana, India

Citation: Prasad YG, Singh A K, Prasad JV, Reddy GR, Akila N, Srinivasulu S, Dhanalakshmi G, Chinnam Naidu D, Lakshmi Reddy P, Mallikarjuna rao N, Hemantha Kumar J, Yadagiri Reddy T, Sudhakar M, Sudhakar PS, Parameswari K, Kavitha, Baskaran A, Himabindu T and Madhuri Thinnaluri. 2018. Participatory Technology Demonstrations - Catalyzing Climate Resilience in Agriculture. ICAR-Agricultural Technology Application Research Institute, Hyderabad-59. p. 112

Copies: 300

***Contributors**:*
Principal Investigators, Co-PIs and Research Fellows of NICRA KVKs of Zone X (Andhra Pradesh, Telangana and Tamil Nadu), All climate smart farmers of NICRA.

Published by
The Director
ICAR-Agricultural Technology Application Research Institute
CRIDA Campus, Santoshnagar, Saidabad PO, Hyderabad-500059
Ph: 040-24006500, 24530300, 24536517, Fax: 040-24533543
Website: http://zpd5hyd.nic.in
E-mail: zcu5hyd@gmail.com

Front Cover: Climate Smart Practices

Back Cover: Capacity Building and Extension Activities

Printed at:
Balaji Scan Pvt. Ltd.,
11-2-1145, Beside Matas Temple, Opp: Subhan Bakery,
Nampally, Hyderabad-500001,Tel: 23303424/25, 9848032644

PREFACE

Technology Demonstration Component (TDC) under the NICRA (National Innovations in Climate Resilient Agriculture) project is in operation in 11 climatically vulnerable districts in the states of Andhra Pradesh, Telangana and Tamilnadu (Zone-X). Location specific best bet innovative practices to address major climatic vulnerabilities such as drought, flood, heat stress and other extreme weather events were demonstrated during 2017-18 in a participatory mode in farmers' fields in representative village clusters. Technology interventions in natural resource management, crop production, livestock and fisheries production systems were assessed for imparting resilience to climate vulnerabilities faced by the farmers in the adopted villages. Capacity building programmes and extension activities were also taken up in NICRA villages for bringing awareness among farmers on climate smart practices for encouraging wider adoption and spread.

During 2017-18, the NICRA centers located in Chittoor and Kurnool districts of Andhra Pradesh and Namakkal , Thiruvarur and Villupuram districts in Tamil Nadu received excess rainfall in the range of 14.96-77.64 % compared to the respective annual rainfall. The centers located in Anantapur , Srikakulam and West Godavari (Andhra Pradesh), Khammam and Nalgonda (Telangana) and Ramanathapuram (Tamil Nadu) districts received deficit rainfall (-7.8 to – 77.11 %) during 2017. Continuous wet spells were observed at Chittoor, Kurnool, West Godavari, Khammam, Namakkal and Villupuram. Longest dry spell of 100 days was recorded in Ramnad followed by Namakkal (57 days) and Kurnool (45 days). In-situ soil moisture conservation practices and ex-situ rainwater harvesting and recharging of wells for supplemental micro irrigation enhanced resilience with higher productivity in groundnut, cotton, pigeonpea, paddy, tomato, groundnut, greengram , blackgram and mango. Soil test based fertilizer application, mulching and green manuring and recycling of crop residues through composting enhanced soil quality, water holding capacity and fertility.

Drought tolerant , short duration and disease tolerant varieties in crops such as groundnut, pigeonpea, bengal gram, millets, paddy, tomato, jowar, greengram and blackgram and flood tolerant varieties of paddy in West Godavari , Srikakulam and Tiruvarur gave stable yields. Intercropping systems of millets, cotton with pulses and tomato with marigold gave higher returns over sole crops under deficit rainfall conditions. Mechanical transplanting in Paddy at West Godavari, weeding using power weeder at Chittoor and

improved seed drill in Bengalgram and Jowar at Kurnool not only saved the cost of labour but also increased area of operation over traditional practices.

Improved breeds, fodder, feed and shelter management practices in livestock, poultry, captive rearing of fish seed enhanced productivity and resilience. Capacity development and skill trainings in climate smart agricultural practices and technologies were imparted to 3588 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 covering 8349 farmers.

This publication documents farm innovations and evidences of resilient practices and technologies in predominantly rainfed districts in the three states of Andhra Pradesh, Telangana and Tamilnadu. We gratefully acknowledge the guidance and constant support received from Dr. Trilochan Mohapatra, Secretary, DARE & DG, ICAR; members of the High Level Monitoring Committee (HLMC), Director, ICAR-CRIDA and PI & Co-PI, NICRA. We appreciate the valuable contributions of farmers and KVK project scientists for contributing to the practice of climate resilient agriculture in this zone.

Authors

CONTENTS

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 was implemented through Krishi Vigyan Kendras (KVKs) during 2017-18 in 11 climatically vulnerable districts located in the states of Andhra Pradesh, Telangana and Tamil Nadu under ATARI, Hyderabad. These include KVKs of Anantapur, Chittoor, Kurnool, Srikakulam and West Godavari in Andhra Pradesh (5 KVKs), Khammam and Nalgonda in Telangana (2 KVKs) and Namakkal, Ramanathapuram, Thiruvarur and Villupuram in Tamil Nadu (4 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 11 districts across the semi-arid tropics in Zone X.

Under the project, the KVKs implemented Natural Resource Management (NRM), crop production, livestock and fisheries, institutional interventions, capacity building and extension activities with the involvement of 892, 1934, 2265, 4602, 3588 and 8175 farmers respectively. Under the project demonstrations were organized covering an area of 937.2 ha under NRM and 1082.9 ha under crop production modules.

Rainfall Pattern

The NICRA centers located in Chittoor (316.6 mm) and Kurnool (186.5 mm) districts of Andhra Pradesh and Namakkal (128.0 mm), Thiruvarur (170.6 mm) and Villupuram (640.3 mm) districts in Tamil Nadu received excess rainfall compared to the respective annual rainfall. The centers located in Anantapur (68.4 mm), Srikakulam (205.6 mm) and West Godavari (286.9 mm) (Andhra Pradesh), Khammam (197.2 mm)and Nalgonda (66.0 mm) (Telangana) and Ramanathapuram (632.7 mm) (Tamil Nadu) districts received deficit rainfall during 2017. Continuous wet spells were observed at Chittoor, Kurnool, West Godavari, Khammam, Namakkal and Villupuram.

Natural Resource Management (NRM)

Under natural resource management interventions, renovation of percolation tanks (Chinnakothaccheruvu, Karanamvaricheruvu and Guttayanacheruvu tanks) in Chittoor district facilitated cultivation of paddy, tomato, groundnut and fodder crops as a result of water recharge in the borewells located in the vicinity. Desilting of Burra kunta in Kurnool district resulted in increased water levels (110-120 ft) in the borewells located in the vicinity. Renovation of percolation tank (Jagannadha Naidu tank) in Srikakulam district, increased the area under cultivation and yield of Paddy.

Conservation of rainwater was achieved through *in-situ* moisture conservation technologies like conservation furrows in redgram (Kurnool & Nalgonda) and Cotton (Nalgonda), sub soiling in groundnut (Anantapur)**,** plastic mulching in tomato (Chittoor), ridges and furrows in cotton (Khammam), compartmental bunding in groundnut, greengram and blackgram (Namakkal) and Trench cum bunding in Mango (Chittoor) resulted in increased yield, net returns and finally B:C ratio compared to local practices. Supplemental irrigation at NICRA villages of Khammam (Cotton, paddy and fodder grass), Chittoor (groundnut) and Ramanathapuram (Paddy) enhanced the yield due to provision of irrigation at critical stages of crop growth. Green manuring in mango (Chittoor), onion (Namakkal) and paddy (Nalgonda) and recycling of domestic field waste through vermicompost at Khammam helped in improving the soil physical and chemical properties besides considerable increment in the crop yields.

Crop Production

In NICRA village of Srikakulam, MTU-1061 (Flood tolerant variety) performed best followed by RGL- 2537 and MTU-1075 at low to medium inundation areas. In West Godavari improved variety MTU 1061 (Submergence & lodging tolerant variety) showed higher yield followed by MTU-1064 (Submergence & lodging tolerant variety) in flood prone area. In Thiruvarur, CR 1009 SUB 1 (Long duration) performed best (high B:C ratio) followed by Swarna Sub 1(Medium duration). Improved varieties Dharani (Groundnut) at Anantapur, Arka Samrat (Tomato) & Dharani (Groundnut) at Chittoor, PRG-176 (Pigeonpea), NBeG-3 (Bengal gram), NJ-2446 & NJ-2647 (Jowar) at Kurnool, MTU 1156 and MTU 1121 (Paddy) at West Godavari, Siddi- WGL -44 (Paddy), LCA- 625 (Chilli) and MGG- 295 (greengram) at Khammam, PRG-176 (redgram) & TBG-104 (Blackgram) at Nalgonda, Dharani (groundnut), VBN-8 (blackgram) &CO-8

(greengram) at Namakkal, CO (R) 51& Anna (R) 4 (Paddy) at Ramanathapuram and CO-8 (greengram), TMV-1 (Moth bean), VBN-6 (blackgram) & TMV-13 (groundnut) at Villupuram, gave stable yields despite exposure to climate risks.

Among cropping systems, intercropping systems of mango+field bean and tomato+ marigold at Chittoor, Foxtail millet + redgram (5:1) at Kurnool, Cotton (Sarpanch)+ redgram(WRG- 65) at Khammam and Cotton+ pigeon pea (6:1) at Nalgonda performed better than sole crops. Under delayed sowings, short duration variety of foxtail millet (SIA 3085) proved to be a better alternative and was profitable than desi cotton at Kurnool under rainfed situation. At Nalgonda due to non availability of sufficient water for paddy cultivation, PSV-2 (Jowar variety) was taken as an alternative crop for better income. In West Godavari, to maintain soil health and productivity in the paddy-paddy system and to increase the net income of farmers by taking third crop in the cropping system after *rabi,* cultivation of summer pulses was successfully demonstrated.

Crop diversification with brinjal (PLR 2) at Villupuram, foxtail millet at Ananthapur, and redgram at Khammam was found remunerative compared to traditional crops. Mechanical transplanting in paddy at West Godavari, weeding using power weeder at Chittoor and improved seed drill in Bengalgram & Jowar at Kurnool not only saved the cost of labour but also reduced the cost of cultivation and increased area of operation over traditional practices.

Water saving technologies viz., zero tillage in maize at Anantapur and Srikakulam, conservation tillage in Sunhemp at Khammam, direct sowing with drum seeder in paddy at Chittoor and West Godavari and SRI cultivation in paddy at Thiruvarur and Pani pipe technology in Paddy at Villupuram not only improved the water use efficiency but also productivity and profitability of the crops.

Nutrient management practices viz., soil test based fertilizer application in cotton at Nalgonda, fertigation schedule in tomato at Chittoor, spraying of micronutrient mixture in mango at Chittoor and cotton at Nalgonda and use of liquid bio-fertilizers in paddy at West Godavari gave higher economic benefits than corresponding farmers practices.

Stem application of pesticides instead of foliar sprays in cotton at Khammam, IPM practices in paddy (Srikakulam & West Godavari), onion at Namakkal and tomato at Chittoor were found as profitable crop protection measures.

Livestock and Fisheries

In livestock based interventions, improved fodder varieties Hybrid Napier Co-4 and CoFS-31 at Chittoor, African Tall maize, COFS-29, COBN-5 and GG-3 at Villupuram, Velimasal (*Desmanthus*) at Ramanathapuram, APBN-1 at Nalgonda and CO – 4 at Khammam and CoFS – 29 and 31 at Anantapur recorded higher fodder yields.

Silage making intervention made available the green, nutritious fodder during off season and registered higher milk productivity than farmers practice in dairy animals at NICRA villages of Namakkal and Villupuram. Feed enrichment through *Azolla* enhanced the milk productivity and fat content of milk at Chittoor. Supplementation of protein and energy through mineral block increased the milk yield at NICRA villages of Kurnool, Khammam, Villupuram and Ramanathapuram. Improved poultry breeds viz., Rajasree (Chittoor, Kurnool, Khammam & Nalgonda), Vanaraja, Gramapriya and Srinidhi at West Godavari and Nandanam-2 at Villupuram were found superior to desi breeds in terms of bird weight, number of eggs and net income. Calf registration at Kurnool district of Andhra Pradesh increased body weight of calves and decreased mortality rate. Captive rearing of fish from fry stage to fingerling stage in nursery pond, reduced the investment on fingerling cost and increased survival rate at Srikakulam district of Andhrapradesh.

Capacity Building

Need based training programmes (135) were organized with the participation of 3588 farmers by NICRA KVKs in Zone-X. In Andhra Pradesh 90 training programmes were organized with the participation of 2212 farmers. In Telangana, 13 training programmes were organized with the participation of 550 farmers. In Tamil Nadu, 32 training programmes were conducted with active participation of 826 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 (338) were organized across the zone with active participation of 8175 farmers. Among these 174 activities were conducted with the participation of 5833 farmers in Andhra Pradesh. About 1132 farmers participated in 66 extension activities in Telangana State. About 98 extension activities were conducted with the involvement of 1210 farmers in Tamil Nadu.

कार्यकारी सारांश

राष्ट्रीय जलवायु समुत्थान कृषि मे नवप्रवर्तन (निक्रा) वर्ष 2011 मे भाकृअनुप द्वारा आरंभ की गई एक बहु-संस्थागत एवं बहु-विषयक नेटवर्क परियोजना है। इस परियोजना का उद्देश्य अनुकूल अनुसंधान एवं प्रौद्योगिकी के प्रदर्शनों द्वारा जलवायु परिवर्तन एवं जलवायु विविधता से भारतीय कृषि के समुत्थान को बढ़ावा देना है। प्रौद्योगिकी प्रदर्शन अवयव निक्रा जीवनाधार है एवं इसे कृषि तकनीकी एवं अनुप्रयोग संस्थान (अटारी), हैदराबाद द्वारा आंध्रप्रदेश, तेलंगाना एवं तमिलनाडु के राज्यों में स्थित 11 जलवायुवीय रूप से अतिसंवेदनशील जिलों में वर्ष 2017-18 के दौरान कृषि विज्ञान केंद्रों द्वारा कार्यान्वित किया गया। इसमें आंध्रप्रदेश (5 कृषि विज्ञान केंद्र) में स्थित अनंतपुर, चित्तूर, कर्नूल एवं श्रीकाकुलम; तेलंगाना (2 कृषि विज्ञान केंद्र) में स्थित खम्मम एवं नलगोंडा; तमिलनाडु (4 कृषि विज्ञान केंद्र) में स्थित नमक्कल, रामानाथापुरम, तिरूवरूर एवं विल्लापुरम के कृषि विज्ञान केंद्र शामिल हैं।

हैदराबाद में स्थित भाकृअनुप- कृषि तकनीकी एवं अनुप्रयोग संस्थान (अटारी), जो पहले क्षेत्रीय परियोजना निदेशालय कहलाता था। इसे क्षेत्र x के 11 जिलों में फैले अर्ध-शुष्क उष्णकटिबंधीय क्षेत्रों में निक्रा कृषि विज्ञान केंद्रों द्वारा योजना, मॉनिटरी एवं चलाए जा रहे जलवायु अनुकूल हस्तक्षेपों के प्रभाव की रिपोर्टिंग की जिम्मेदारी सहित क्षेत्र स्तरीय समन्वयन का कार्य भी सौंपा गया है।

परियोजना के अंतर्गत, कृषि विज्ञान केंद्रों ने क्रमश: 892, 1934, 2265, 4602, 3588 एवं 8175 किसानों के सहयोग से प्राकृतिक संसाधन प्रबंधन, फसल उत्पादन, पशु पालन एवं मछली पालन, संस्थागत हस्तक्षेप, क्षमता निर्माण एवं प्रसार गतिविधियों को कार्यान्वित किया। परियोजना के अंतर्गत प्राकृतिक संसाधन प्रबंधन के अंतर्गत 937.24 हेक्टेयर क्षेत्र एवं फसल उत्पादन नमूनों के अंतर्गत 1082.90 हेक्टेयर क्षेत्र में प्रदर्शनों का आयोजन किया गया।

वर्षा पैटर्न

संबंधित वर्षा की तुलना में आंध्र प्रदेश के चित्तूर (316.6 मि.मी) एवं कर्नूल (186.5 मि.मी) जिलों में ; तमिलनाडु के नमक्कल (128.05 मि.मी), तिरूवरूर (170.6 मि.मी) एवं विल्लुपूरम (640.32 मि.मी) जिलों में स्थित निक्रा केंद्रों में अतिरिक्त वर्षा हुई। वर्ष 2017 के दौरान आंध्र प्रदेश के अनंतपुर (316.6 मि.मी), श्रीकाकुलम (205.6 मि.मी) एवं पश्चिम गोदावरी (286.99 मि.मी) ; तेलंगाना के खम्मम (197.2 मि.मी) एवं नलगोंडा (66 मि.मी); एवं तमिलनाडु के रामानाथपुरम (632.68 मि.मी) जिलों में स्थित केंद्रों में कम वर्षा प्राप्त हुई। चित्तूर, कर्नूल, पश्चिम गोदावरी, खम्मम, नमक्कल एवं विल्लुपूरम में लगातार नम दौर देखा गया।

प्राकृतिक संसाधन प्रबंधन

प्राकृतिक संसाधन प्रबंधन हस्तक्षेपों के अंतर्गत, चित्तूर जिले के अंत:स्रवण तालाबों (चिन्नकोत्तचेरूवु, करनमवारीचेरूवु एवं गुट्टयानाचेरूवु) नवीकरण से समीपवर्ती बोरवेलों में जल के रीचार्ज के परिणामस्वरूप धान,

टमाटर, मूंगफली एवं चारा फसलों की खेती संभव हो सकी। कर्नूल जिले के बुर्रकुंटा में गाद निकालने से समीपवर्ती क्षेत्रों में स्थित बोरवेलों के जल स्तर (110-120 फीट) में वृद्धि हुई। श्रीकाकुलम जिले के अंत:स्रवण तालाब (जगन्नथ नायुडु तालाब) के नवीकरण से धान की खेती का विस्तार एवं उत्पादन में वृद्धि हुई।

अरहर (कर्नूल एवं नलगोंडा) तथा कपास (नलगोंडा) में संरक्षण कूंड ; मूंगफली (अनंतपुर) में अवभूमि गहरी जुताई; टमाटर (चित्तूर) में प्लास्टिक पलवार; कपास (खम्मम) में मेंढ एवं कूंड ; मूंगफली, मूंग एवं उडद (नमक्कल) में उपखंडीय मेंढ एवं आम (चित्तूर) में खाई व मेंढ जैसे स्व-स्थाने नमी संरक्षण प्रौद्योगिकियों द्वारा वर्षा जल का संरक्षण किया गया। जिससे स्थानीय प्रक्रियाओं की तुलना में अधिक उत्पादन, कुल लाभ एवं बीसी अनुपात प्राप्त किया गया। फसल उगाऊ के क्रांतिक स्तरों पर सिंचाई के प्रावधान के कारण खम्मम (कपास,धान एवं चारा), चित्तूर (मूंगफली) एवं रामानाथपुरम (धान) के निक्रा गांवों में अतिरिक्त सिंचाई देने से पैदावार में बढोत्तरी हुई। आम (चित्तूर), प्याज (नामाक्कल) एवं धान (नलगोंडा) में हरी खाद एवं वर्मीकंपोस्ट द्वारा घरेलु खेत की अवशिष्टों के पुन:चक्रण से खम्मम में मृदा भौतिकी एवं रासायनिक गुणों में सुधार के अलावा फसलों के उत्पादन में यथेष्ट वृद्धि हुई।

फसल उत्पादन

श्रीकाकुलम के निक्रा के गांवों में, एमटीयू-1061 (बाढ प्रतिरोधी किस्म) ने श्रेष्ठ निष्पादन दिया इसके बाद कम से मध्यम बाढ़ग्रस्त क्षेत्रों के लिए आरजीएल-2537 एवं एमटीयू-1075 अच्छे पाए गए। पश्चिम गोदावारी में उन्नत किस्म एमटीयू 1061 (जलमग्नता एवं अवशयन सहीष्णु किस्म) ने अधिक उत्पादन दिया। इसके बाद बाढ़ग्रस्त क्षेत्र में एमटीयू-1064 (जलमग्नता एवं अवशयन सहीष्णु किस्म) का स्थान था। तिरूवरूर में, सीआर 1009 एसयूबी 1 (लंबी अवधि) ने श्रेष्ठ (अधिक बीसी अनुपात) निष्पादन दिया । इसके बाद स्वर्णा एसयूबी 1 (मध्य अवधि) का स्थान था। अनंतपुर में उन्नत किस्म धरणी (मूंगफली); चित्तूर में अरका साम्राठ (टमाटर) एवं धरणी (मूंगफली); कर्नूल में पीआरजी-176 (अरहर), एनबीईजी-3 (चना), एनजे-2446 एवं एनजे-2647 (ज्वार); पश्चिम गोदावरी में एमटीयू 1156 एवं एमटीयू 1121 (धान); खम्मम में सिध्धी –डब्ल्यूजीएल44 (धान), एलसीए-625 (मिर्च) एवं एमजीजी-295 (मूंग); नलगोंडा में पीआरजी-176 (अरहर) एवं टीबीजी-104 (उड़द); नामाक्कल में धरणी (मूंगफली), वीबीएन-8 (उड़द) एवं सीओ-8 (मूंग); रामनाथापुरम में सीओ (आर)51 एवं अन्ना (आर)4 (धान); विल्लापुरम में टीएमवी-1 (मोठ), वीबीएन-6 (उड़द) एवं टीएमवी-13 (मूंगफली) ने जलवायु जोखिमों के बावजूद स्थिर उत्पादन दिया।

सस्ययन प्रणालियों में, एकल फसल की तुलना में, चित्तूर मे आम+ग्वार एवं टमाटर+गेंदे का फूल; कर्नूल में कंगनी+अरहर (5:1); खम्मम में कपास (सरपंच)+अरहर (डब्ल्यूआरजी-65); नलगोंडा में कपास+अरहर (6:1) के अंतरा सस्ययन प्रणालियों ने बेहतर निष्पादन दिया। देर से बोई गई फसलों के अंतर्गत, कर्नूल के वर्षा आधारित फसलों के अंतर्गत कंगनी (एसआईए 3085) का लघु अवधि किस्म एक बेहतर विकल्प सिद्ध हुआ एवं देसी कपास की तुलना में लाभदायक था। नलगोंडा में धान की खेती के लिए समुचित जल की उपलब्धता के न होने के कारण, अधिक आय के लिए वैकल्पिक फसल के रूप में पीएसवी-2 (ज्वार किस्म) को अपनाया गया। पश्चिम गोदावरी में, मृदा स्वास्थ्य एवं धान-धान प्रणाली में उत्पादकता को बनाए रखने एवं रबी की खेती के बाद सस्ययन

प्रणाली में तीसरी फसल के द्वारा किसानों की आय बढाने में ग्रीष्म दलहनों के विकल्प को सफलतापूर्वक प्रदर्शित किया गया।

पारंपरिक फसलों की तुलना में, विल्लापुरम में बैंगन (पीएलआर 2), अनंतपुरम में कंगनी एवं खम्मम में अरहर से फसल विविधता करने से अधिक आय प्राप्त हुआ। पारंपरिक प्रक्रियाओं की तुलना में, पश्चिम गोदावरी के धान के खेतों में यांत्रिक प्रतिरोपण, चित्तूर में निकौनी के लिए पावर वीडर का उपयोग एवं कर्नूल में चना एवं ज्वार की खेतों में उन्नत बीज ड्रिल के उपयोग से न केवल श्रम की लागत में बचत हुई बल्कि खेती की लागत में कमी एवं कृषि के क्षेत्र में विस्तार हुआ।

जल बचत प्रौद्योगिकियां जैसे कि अनंतपुरम एवं श्रीकाकुलम के मक्का के खेतों में शून्य कर्षण, खम्मम के सनई के खेतों में संरक्षण कर्षण, चित्तूर एवं पश्चिम गोदावरी में ड्रम सीडर से धान की सीधी बोवाई, तिरूवरूर की धान की खेतों में एसआरआई कृषि एवं विल्लुपुरम के धान की खेती में पानी पाईप की प्रौद्योगिकी को अपनाने से न केवल जल उपयोग क्षमता में सुधार हुआ बल्कि फसलों की उत्पादकता एवं लाभों में भी वृद्धि हुई।

पोषक प्रबंधन प्रक्रियाएं जैसे कि नलगोंडा के कपास में मृदा जांच आधारित उर्वरकों का प्रयोग, चित्तूर के टमाटर में उर्वरक एवं सिंचाई की समय सूची, चित्तूर के आम एवं नलगोंडा के कपास में सूक्ष्म पोषक मिश्रण का छिडकाव एवं पश्चिम गोदावरी के धान में द्रव जैव-उर्वरकों के उपयोग ने संबंधित किसानों की प्रक्रियाओं की तुलना में आर्थिक रूप से अधिक लाभदायक सिद्ध हुआ।

खम्म्म के कपास में कीटनाशकों का पर्ण छिडकाव की तुलना में तना पर प्रयोग, श्रीकाकुलम एवं पश्चिम गोदावारी जिलों के धान में, नामक्कल के प्याज एवं चित्तूर के टमाटर में समेकित नाशीजीव प्रबंधन प्रक्रियाएं लाभदायक फसल संरक्षण प्रक्रियाएं सिद्ध हुई।

पशु एवं मछली पालन

पशु पालन आधारित हस्तक्षेपों में, चित्तूर में संकर नैपियर, सीओ-4 एवं सीओएफएस-31; विल्लुपुरम में अफ्रीकन टॉल मैज़, सीओएफएस-29, सीओबीएन-5 एवं जीजी-3; रामनाथापुरम में वेलीमासाल(देसमंनथस); नलगोंडा के एपीबीएन-1; खम्मम में सीओ-4; अनंतपुर में सीओएफएस-29 एवं 31 उन्नत चारा किस्मों से अधिक चारा उत्पादन दर्ज किया गया।

ऑफ सीजन के दौरान सीलेज निर्माण हस्तक्षेपों से हरा, पोषक चारा उपलब्ध कराया गया एवं नमक्कल एवं विल्लुपुरम के निक्रा के गांवों में किसानों द्वारा डेरी पशुओं को दिए जाने वाले दाना की तुलना में अधिक दूध का उत्पादन दर्ज किया गया। चित्तूर में ओजोल्ला द्वारा चारा संवर्धन से दूध का उत्पादन एवं दूध मे वसा की मात्रा में वृद्धि हुई। कर्नूल, खम्मम, विल्लुपुरम एवं रामनाथापुरम के निक्रा गांवों में खनिजों से प्रोटीन एवं ऊर्जा की अतिरिक्त मात्रा पशुओं को मिलने से दूध की मात्रा में वृद्धि हुई। उन्नत पोल्ट्री नस्लों जैसे कि राजश्री (चित्तूर, कर्नूल,खम्मम एवं नलगोंडा), पश्चिम गोदावरी में वनराज, ग्रामप्रिया एवं श्रीनिधि तथा विल्लुपुरम में नंदनम-2 पक्षी भार, अंडों की संख्या एवं कुल लाभ के मामले में देसी नस्लों की तुलना में उन्नत पाए गए। आंध्र प्रदेश के कर्नूल जिला के बछड़ा

पंजीकरण से बछड़ों के शारीरिक भार में वृद्धि एवं मृत्यु दर में कमी आई। आंध्र प्रदेश के श्रीकाकुलम के नर्सरी तालाबों में पोना स्तर से आंगुलिक स्तर तक मछलियों का संरक्षण पालन से आंगुलिका लागत पर होने वाले निवेश में कमी आई एवं इससे मछलियों की उत्तरजीविता दर में वृद्धि हुई।

क्षमता निर्माण

क्षेत्र-x के निक्रा कृषि विज्ञान केंद्रों द्वारा 3588 किसानों की भागीदारी से आवश्यकता आधारित प्रशिक्षण कार्यक्रमों (135) का आयोजन किया गया। आंध्र प्रदेश में 2212 किसानों की भागीदारी से 90 प्रशिक्षण कार्यक्रमों का आयोजन किया गया। तेलंगाना में, 550 किसानों की भागीदारी से 13 प्रशिक्षण कार्यक्रमों का आयोजन किया गया। तमिलनाडु में, 826 किसानों की सक्रियभागीदारी से 32 प्रशिक्षण कार्यक्रमों का आयोजन किया गया। इन प्रशिक्षण कार्यक्रमों में प्राकृतिक संसाधन प्रबंधन, संसाधन संरक्षण प्रौद्योगिकियां, सस्ययन प्रणालियां, फसल विविधिकरण, समेकित नाशीजीव एवं रोग प्रबंधन, मृदा स्वास्थ्य सुधार, जल बचत प्रौद्योगिकियां, कृषि उपकरण एवं यंत्र, पशुधन प्रबंधन आदि शामिल किए गए।

प्रसार गतिविधियां

8175 किसानों के सक्रिय भागीदारी से संपूर्ण क्षेत्र में प्रसार गतिविधियां (338) आयोजित की गई। इनमें से आंध्र प्रदेश में 5833 किसानों की भागीदारी से 174 गतिविधियां आयोजित की गई। तेलंगाना राज्य में 66 प्रसार गतिविधियां आयोजित की गई, जिसमें करीब 1132 किसानों ने भाग लिया। तमिलनाडु में 1210 किसानों की भागीदारी से करीब 98 प्रसार गतिविधियां आयोजित की गई।

1. INTRODUCTION

There is a growing concern about the adverse effects of climate change on agriculture and allied sectors among researchers, policy makers and farmers. Increase in mean seasonal temperatures, erratic rainfall patterns and increased frequency of extreme weather events pose a serious threat to agriculture and in turn to the food and nutritional security of resource poor small and marginal farmers. Changes in temperature and precipitation can indirectly impact productivity of crops in the form of outbreaks of pests and diseases thereby reducing harvest. Rainfed crops which occupy 60 per cent of cultivated area take the brunt of impact of climate change and farmers in these regions being less endowed in terms of financial, physical, human and social capital are the worst affected. Delayed onset of monsoon, mid-season and terminal droughts in rainfed areas cause huge losses to agriculture and livestock production. Incessant and unseasonal rains that occur in fewer rainy days cause heavy losses to standing crops and also to the harvested farm produce in the fields.

Prudent management of resources like soil, water and bio-diversity can help cope with the impact of climate change on agriculture. Increasing the resilience and adaptive capacity of small land holders can be achieved by incorporating various adaptation measures in agricultural systems. To sustain the productivity of crops and allied enterprises in the context of increasing climatic vulnerabilities, climate resilient technologies that would increase production and productivity need to be evolved, assessed and demonstrated. Keeping this in view, National Innovations in Climate Resilient Agriculture (NICRA) has been implemented as a network project of Indian Council of Agricultural Research (ICAR) and was 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 Demonstrations under NICRA

To address the concerns associated with climate change through enhancing resilience of production systems and adaptive capacity of farmers, extensive demonstrations of location-specific best bet practices were organized in 11 districts in Andhra Pradesh, Telangana and Tamilnadu during 2017-18. The project is implemented in these districts by respective Krishi Vigyan Kendra (KVK) located in the district.

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 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 a village/village cluster 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 gives input in selection of an appropriate village, identification of climatic vulnerabilities with regard 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 (PRA) in selected villages was organized to understand major farming systems, resource situation, socio-economic, institutional and infrastructural status.

6. The multidisciplinary team in each KVK analyzed the constraints related to climatic variability and identified the points of intervention focusing largely on resource poor groups addressing resource conservation which gives long term and sustainable benefits.

The technological interventions were implemented in 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 ICAR- ATARI, Hyderabad and Zonal Monitoring Committee (ZMC) constituted by ICAR- CRIDA , Hyderabad. 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, diversification with resilient crops.

Module III: Livestock and Fisheries

This module consists of use of community lands for fodder production during droughts/ floods, demonstration of improved fodder varieties / crops, improved fodder/feed storage methods, preventive vaccination, nutrition management in livestock, 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. Basic Resources of NICRA Villages

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 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 belonging 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, pigeon pea, mango 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 other NICRA 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 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. 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 is irregular and the crops are 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.

The village has 520 village households with total cultivated area of 160 ha. The major soil types are red sandy and red sandy loams with clay base. The mean annual rainfall received is about 989.4 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 MarripaduGedda or water from Vamsadhara river.

Ponnam and Veera Narayanapuram are newly selected to implement the NICRA activities in 2017. Ponnam belonging to Srikakulam Mandal has 350 households with 250 acres of cultivated area under which 125 acres is flood affected. Mainly paddy is grown during *kharif* season. Maize, paddy and some vegetable crops like ridge gourd and bhendi are grown in *rabi*. Main sources of irrigation are Vamsadhara canal, wells and ponds (Batteru pond). The village has predominantly medium sized land holdings. Veera Narayanapuram situated in Kothuru mandal, has 100 households with 120 acres of cultivated area under which 30 acres are flood affected from vamsadhara channel. Paddy, maize and chillies are the major crops

grown in the project village. Major sources of irrigation includes Vamsadhara canal, Baljivanigedda Aayakattu and borewells.

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 under fish and prawn ponds. It receives a mean annual rainfall of 1185 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 viz., Khammam, Kothagudem, Palvoncha and Bhadrachalam. It is one of the agriculturally important districts in the state with a total geographical area of 1602900 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, Muniyatanda 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 1161 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 and red soils. Major sources of irrigation include streams and bore wells. The major component of livestock constitutes white cattle-997, black cattle-1018, sheep-1023 and goat-1734.

Nalgonda

Nalgonda district falls under southern Telangana region. The villages Nandyalagudem and Boring Thanda and Kothathanda of Atmakoor (S) Mandal are selected for implementing NICRA project activities. The village has 441.6 ha total cropped area with 264 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 740 mm. The distribution of rainfall is erratic. The major crops grown in these villages are cotton, pigeon pea, greengram, 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 and farm machinery and poor livestock services are major institutional limitations for enhanced livelihoods in this village.

Tamil Nadu

Namakkal

The NICRA programme is implemented in two villages namely Vadavathur and Jambumadai. Vadavathur in Erumaipatty block of Namakkal district is a drought-prone village with annual rainfall of less than 400 mm. The mean maximum and minimum temperatures are 46 and 12º C respectively. Undulating and slopy lands aggravate the drought condition due to lack of scope for percolation of rainwater in the catchment and water storage areas. This has led to monocropping (October to January) during northeast monsoon. The village is having 525 ha total cropped area under which 320 ha under rainfed cultivation with 829 households. Sandy clay loam is the major soil type. Small onion, groundnut and sorghum are the main crops grown in this village. Major sources of irrigation include openwells (135) and borewells (354).

Jambumadai has a total cultivated area of 553 ha under which 340 ha under rainfed cultivation. Small onion, groundnut, sorghum, Jasmine, vegetables, greengram, blackgram and redgram are mainly cultivated in this village. The village has 475 bore wells and 137 open wells. Major soil type is sandy clay loam. The major climatic vulnerability of the village is drought.

Ramanathapuram

Ramanathapuram district is situated in the southeast corner of Tamil Nadu state and falls in the rain shadow region and there by is a highly drought prone and most backward in development. It is surrounded by Pudukottai district in the North, Sivagangai and Virudunagar districts in the Northwest and West, Tirunelveli, Thoothukudi and Gulf of Mannar on the South and Palk Strait on the East. The unique feature of this district is the longest coastal line measuring about 271 km accounting for nearly 1/4th of the total length of coastal length of the State. The NICRA programme is implemented in Kombuthi village of Ramanathapuram district. Drought is the major climatic challenge in the cluster village. Agriculture in this cluster village is mainly dependent on the north-east monsoon and the available water in the Kalari tank. It receives an annual rainfall of 850 mm. Kombuthi village has a population of 1000 with 200 households with 242 ha of total cultivated area under which 200 ha come under rainfed cultivation. The major soil type of the village is sandy clay loam. Paddy and chilli are mainly cultivated in this village.

Thiruvarur

The village Rayapuram has a population of 3170 (887 farm families/households) with a geographical area of about 960 ha. Paddy is the main crop cultivated during *Samba* season (September- January). The total cultivated area of this village is 774.02 ha under which 565.74 ha is wetland and remaining 208.28 ha is dry land. The farmers of the village are also engaged in livestock and goatery as subsidiary enterprise. It has 250 milch animals and 650 goats. The main problem encountered in the village during monsoon season (Oct-Nov) is submergence of paddy crop due to high intensive rainfall and cyclones during the period. As a result the farmers in the village lose about 75 per cent of paddy production besides total wastage of paddy straw and live stock also is affected due to floods. The major sources of

irrigation are Kuyavan canal, Nallore canal and Odai canal. Drought may occur during April and May sometimes it may extend upto July.

Villupuram

Villupuram district is basically agrarian and has bimodal pattern of rainfall. The district is prone for cyclical drought. The NICRA village selected by the KVK is a true representative of the district. The village has wetland, garden land and dry land systems. The village is noted for erratic monsoon. Bulk of precipitation is received in the North East monsoon as has been for the district. The village suffers due to intense heat during summer. The crops raised during *Kharif* and summer face intermittent drought. Due to the effects of temperature, the livestock suffer heavily during summer.

The villages Kattusivri and Agoor of Mailam Mandal were selected for implementing NICRA project activities. The villages receive an annual rainfall of 1067 mm. Major soil types is Sandy clay loam. Paddy, groundnut and sugarcane are the major crops cultivated in this area. Agoor has total cultivated area of 604 ha under which 245.42 comes under rainfed cultivation with 522 households. Kattusivri has 495 households with total cultivated area of 220.35 ha under which 168.35 ha is rainfed cultivation. The major climatic vulnerability of the village is drought

The Basic information regarding NICRA centers is given below (Table 1).

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

District	Name of NICRA Village	Actual rainfall (mm) 2017	Soil type	Major climatic vulnerability
Andhra Pradesh				
Anantapur	Chamaluru,Chakrayapeta and peravali	508.0	Red soils	Drought
Chittoor	Chittecharla	1034.3	Red soils	Drought
Kurnool	Yagantipalle and Meerapuram	819.5	Black soils	Drought
Srikakulam	Sirusuwada, Ponnam and Veera NarayanaPuram	989.4	Red sandy soils	Floods
West Godavari	Matsyapuri and Veeravasaram	872.5	Alluvial soils	Floods
Telangana				
Khammam	Nacharam	963.8	Black, red soils	Drought, Heat stress
Nalgonda	Nandyalagudem Boring Thanda and Kothathanda	770.9	Black soils	Drought, Heat stress
Tamil Nadu				
Namakkal	Vadavathur and Jambumadai	957.0	Sandy loam	Drought
Ramanathapuram	Kombuthi	187.8	Sandy loam and clay loam	Drought
Thiruvarur	Rayapuram	1310.6	Sandy clay loam	Drought and Floods
Villupuram	Kattusivri and Agoor	1465.0	Sandy clay loam	Drought

2.1 Rainfall pattern in different NICRA centers

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.

The NICRA centers located at Chittoor (44.00%) and Kurnool (29.46%) of Andhra Pradesh, Namakkal (15.44%), Thiruvarur (14.96%) and Villupuram (77.64%) districts of Tamil Nadu received excess rainfall compared to the normal during 2017. Whereas, the NICRA centers located at Anantapur (-11.86%), Srikakulam (-17.20%) and West Godavari (-24.75%) of Andhra Pradesh, Khammam (-16.985) and Nalgonda (-7.80%) in Telangana and Ramanathapuram(-77.11%) districts of Tamil Nadu received deficit rainfall (Table 2).

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

Name of the KVK	Normal annual rainfall (mm)	Rainfall during 2017 (mm)	Excess/deficit rainfall (mm)	% Deviation of rainfall from the normal i.e., $\frac{\text{Actual} - \text{Normal}}{\text{Normal}} \times 100$
Anantapur	576	508	-68	-11.86
Chittoor	875	1034	317	44.00
Kurnool	633	819	187	29.46
Srikakulam	1195	989	-206	-17.2
West Godavari	1160	872	-287	-24.75
Khammam	1161	964	-198	-16.98
Nalgonda	837	771	-66	-7.8
Namakkal	829	957	128	15.44
Ramanathapuram	820	188	-633	-77.11
Thiruvarur	1140	1311	171	14.96
Villupuram	825	1465	640	77.64

2.2 Rainfall distribution in different NICRA centers

The rainfall distribution in NICRA villages of Andhra Pradesh, Telangana and Tamil Nadu during the cropping season *i.e.,* during South-West monsoon and North-East monsoon is presented in Tables 3 & 4. Data regarding dry spells and continuous wet spells observed during the cropping season in various NICRA centers are given in Table 5.

Table 3: Rainfall distribution at different NICRA sites during South-West Monsoon season during 2017

Centre	June			July			August			September			Total		
	Nor-mal	Actual	Dev. (%)	Nor-mal	Actual	Dev. (%)	Nor-mal	Actual	Dev. (%)	Nor-mal	Actual	Dev. (%)	Nor-mal	Actual	Dev. (%)
Andhra Pradesh															
Anantapur	63.0	66.0	4.7	83.6	21.0	-52.9	110.9	56.0	-50.0	125.2	131.0	4.6	382.7	274.0	-28.4
Chittoor	81.2	96.6	18.9	98.4	94.0	-4.47	114.0	273.1	139.6	128.3	173.6	35.3	421.9	637.3	51.0
Kurnool	65.0	168.0	158.5	107.0	0.0	-100	115.0	136.0	18.2	120.0	272.7	127.0	407.0	576.7	41.7
Srikakaulam	102.4	145.7	42.2	250.2	238.8	-4.56	269.0	205.2	-23.7	106.2	187.9	76.9	727.8	777.6	6.8
West Godavari	114.7	174.7	52.3	250.2	232.2	-7.19	249.2	207.3	-16.8	177.8	108.3	-39.0	791.9	722.5	-8.7
Telangana															
Khammam	131	242.6	85.19	304	253.6	-16.6	300	226.8	-24.4	151.0	115.4	-24.0	886.0	838.4	-5.3
Nalgonda	102.5	205.35	100.3	185.2	159.02	-14.1	194.7	238.0	22.2	151.1	70.04	-54.0	633.5	672.4	6.1
TamilNadu															
Namakkal	19.29	0	-100	26.92	30	11.44	106.59	164.5	54.3	143.0	215.5	50.7	295.8	410.0	38.6
Ramanathapuram	10.36	0	-100	18.09	0	-100	2.44	8.0	229.9	32.2	9.0	-72.0	63.1	17.1	-72.9
Thiruvarur	35	44.6	27.43	56	53.8	-3.92	113	227.6	101.4	101.0	134.2	32.9	305.0	460.2	50.8
Villupuram	15	123	720	65	175	169.2	53.86	253.0	369.7	61.5	171.0	178.0	195.3	722.0	269.6

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

Table 4: Rainfall distribution at different NICRA sites during North East monsoon season during 2017

	October			November			December			Total		
Centre	**Normal**	**Actual**	**Dev. (%)**	**Normal**	**Actual**	**Dev. (%)**	**Normal**	**Actual**	**Dev. (%)**	**Normal**	**Actual**	**Dev. (%)**
Andhra Pradesh												
Anantapur	103.9	234	125.0	31.0	0.0	-100	4.9	0.0	-100	139.8	234.0	67.4
Chittoor	116.2	237.5	104.4	120.9	121.1	0.1	52.5	37.6	-28.4	289.6	396.2	36.8
Kurnool	117.0	221.8	89.6	26.0	0.0	-100	8.0	0.0	-100	151.0	221.8	46.9
Srikakaulam	158.2	177.3	12.0	60.0	34.5	-42.5	1.0	0.0	-100	219.2	211.8	-3.4
West Godavari	170.0	109.5	-35.6	65.0	10.0	-84.6	11.0	0.0	-100	246.0	119.4	-51.0
Telangana												
Khammam	114.0	125.4	10.0	25.0	0.0	-100	3.0	0.0	-100	142.0	125.4	-12.0
Nalgonda	114.1	4.0	-96.5	33.9	0.0	-100	0.0	0.0	0.0	148.0	4.0	-97.0
TamilNadu												
Namakkal	108.0	108.0	0	132.1	151.0	14.2	31.8	60.0	88.3	272.0	319.0	17.3
Ramanathapuram	214.4	33.1	-84.5	261.3	99.0	-62.1	134.4	36.0	-73.2	610.1	168.1	-72.0
Thiruvarur	200.0	199.4	-0.3	284.0	303.8	6.9	170.0	188.6	10.9	654.0	691.8	5.7
Villupuram	165.8	280.0	68.8	313.9	266.0	-15.3	149.5	111.0	-25.8	629.3	657.0	4.4

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

Table 5: Dry spells and continuous wet spells observed in NICRA centers during 2017

Centre	Rainfall during cropping season (mm)	Dry spells (more than 10-20 days)	Continuous wet spells (more than 100 mm)
Anantapur	508	14th June -2nd July (19days), 13th July- 10th August (29 days), 13th-31st October (19 days)	No wet spells were observed
Chittoor	875	25th June -10th July (16 days), 17th July- 30th July (14 days)	24th-25th August (115mm)
Kurnool	798	24th June- 7th August (45 days), 16th- 31st October(16 days)	28th September (111mm),14th-18th September (134.1mm), 3rd -9th October (147mm)
West Godavari	832	12th -23rd Aug (12 days)	24th-26thAugust (109mm)
Srikakulam	954	No dry spells were observed	No wet spells were observed
Khammam	963	21st -31st July (11days), 13th-31st October (19 days)	13th-20th July(161.2mm)
Nalgonda	676	19th July-4th August (17days), 7th-31st October (25 days)	No wet spells were observed
Namakkal	518	1st June-27th July (57 days), 16th -31st August (16 days), 5th-22nd September (18 days), 28thSeptember-7th October (10days)	23rd-25thSeptember (131.5mm)
Ramanathapuram	50	Ist June- 8th September (100 days),15th September-7th October (23 days),10th -25th October(16 days)	No wet spells were observed
Thiruvarur	659	21st June-4th July (15 days), 9th-27th July(19days)	No wet spells were observed
Villupuram	1002	8th-19th June(12 days), 29th June -11th July(13 days), 13th -29th July(17days),3rd-16thSeptember (14days)	13th August (134mm),15thOctober (118mm)

3. Natural Resource Management (NRM)

3.1 *Ex-situ* water harvesting and efficient use

This NRM activity is taken up to harvest rain water in existing village tanks, farm ponds, check dams and similar water storage structures which are either renovated/ desilted or newly constructed as part of the NICRA project in the adopted village. This water is put to use for various purposes like extending area under irrigation through deployment of efficient methods of irrigation, raising live stock and also production of fish. The enhanced storage of harvested rain water led to rise in the level of water in the open and bore wells in the vicinity which could be utilized for irrigation for an extended period covering more crops.

Anantapur

Desilting of check dams

Two check dams situated near NICRA village (Peravali) were desilted during 2017-18 increasing their dimensions from 75 x 14 x 1.0 m and 90 x 20 x 1.0 m to 80 x 21 x 1.8 m and 90 x 32 x 1.5 m and storage capacity to 30,24,000 and 43,20,000 l of water, respectively. The check dams got filled twice during October rains. The water stored in the check dam was used for supplemental irrigation for crops and as drinking water for livestock. Bore wells (22) and open wells (7) in the vicinity of the check dams were recharged to 20-25 feet and 16 beneficiary farmers could take up cultivation of crops like paddy, groundnut, maize, tomato and tube rose in 164 acres of area, an additional 62 acres brought under irrigation during *rabi*, 2017-18 compared to the previous year (Table 6).

Table 6: Area particulars of crops brought into Cultivation during the year 2017-18

S.No	Crop	Area (Acres)
1	Paddy	27.5
2	Groundnut	11.0
3	Lilly	5.5
4	Tomato	3
5	Castor	3
6	Curry leaf	1
7	Pumpkin	2
8	Yellow jowar	4
9	Maize	4
10	Ber	1
	Total	**62**

Check dam in Peravali (Anantapur) before desilting

Check dam in Peravali(Anantapur) after desilting

Checkdam in Peravali (Anantapur) filled after October rains

Open well recharged after renovation of the checkdam

Chittoor

Renovatoin of Chinnakothaccheruvu percolation tank

The old irrigation tank, Chinnakothacheruvu located near C.Gollapalli and Nagari hamlets of Chittecherla village was renovated under NRM activity. The surplus weir was reconstructed with rocks, unwanted vegetation in the tank was removed and the bund of the tank was strengthened utilizing the silt removed from the tank. The capacity of the tank was 20400 m^3 before intervention and it was increased up to 27200 m^3 after renovation. The water storage capacity of the tank was enhanced from 20.4 lakh to 27.2 lakh liters after renovation. Farmers had taken up paddy crop on a larger area followed by tomato and fodder crops in the ayacut area of the percolation tank after it was completely filled with harvested water. Five bore wells were recharged in the vicinity of the percolation tank (Table 7).

Karanamvaricheruvu percolation tank

The old irrigation tank, Karanamvaricheruvu located near Gollapalli and Sirigalavaripalli hamlets of Chittecherla village was renovated under NRM activity. The feeder Channel was renovated and unwanted vegetation in the tank was removed with the help of JCB. The water storage capacity of the tank which was 17.4 lakh liters before renovation was increased to 21.45 lakh liters. Farmers had taken up tomato, groundnut and fodder crops in the ayacut area at present. Ten bore wells are likely to be recharged due to enhanced water storage in this percolation tank and 20 farmers are likely to benefited (Table 7).

Guttayanacheruvu percolation tank

The old irrigation tank, Guttayanacheruvu located near Chittecherla and Dasarigudem hamlets of Chittecherla village was renovated under NRM activity. The unwanted vegetation in the tank was removed with the help of JCB. The water storage capacity of the tank was 37.8 lakh liters earlier and the same was increased to 43.30 lakh liters after renovation. Farmers had taken up tomato, groundnut and fodder crops in the ayacut area at present. Six bore wells are expected to be recharged under this percolation tank and 15 farmers are likely to be benefited (Table 7).

Repair of bund and surplus weir of Chinnakothacheruvu (KVK, Chittoor)

Table 7: Details of tanks renovated under NICRA

Particulars	Tanks renovated till 2016-17					Tanks renovated during 2017-18		
	Nannapu-cheruvu	Gou-nicheruvu	Nayani cheruvu	Rayavar-apukunta	Err-akunta	Chinna-kothach-eruvu	Karanam-vari-cheruvu	Guttaaya-nacheruvu
Area of the tank	2.08 ha	1.84 ha	1.6 ha	1.0 ha	0.8 ha	1.28 ha	1.14ha	1.10ha
Water holding capacity before renovation	63.7 lakh liters	92.1 lakh liters	46.20 lakh liters	25.32 lakh liters	3.59 lakh liters	20.40 lakh liters	17.4 lakh liters	37.8 lakh liters
Water holding capacity after renovation	75.2 lakh liters	106.35 lakh liters	58.08 lakh liters	32.80 lakh liters	9.24 lakh liters	27.20 lakh liters	21.45 lakh liters	43.30 lakh liters
Area to be benefitted (ha)	6.48	10.45	14	4.45	7.2	8.04	6.0	6.0
Bore wells to be re-charged	8	13	15	6	5	5	10	6
Farmers benefited	23	31	30	13	12	20	20	15

Kurnool

Desilting of Burrakunta

The existing percolation tank (Burrakunta) in the NICRA village was deepened and the silt was applied on marginal soils in the vicinity to improve soil physical properties and fertility. Deepening of percolation tank created additional water storage capacity of 12.60 lakh liters and the number of defunct bore wells also decreased over years from 2013-14 to 2017-18. The recharge of defunct bore wells (81 out of 114) was 100 per cent during the monsoon period and water was available at a depth of 65 feet itself compared to 180 feet during summer months. Even during rain free months of November and December , 2017, 4-8 acres of crop land per bore well could be given supplemental irrigation because of the recharge of bore well resulting from desilting of the percolation tank (Table 8 & 9).

Table 8: Impact of de silting of Burrakunta on bore well recharge during the year 2017-18

Month	Water table in the bore well (ft.)	Availability of water in water storage structure (ft.)	Average area irrigated acre / Bore well	Rainfall (mm)
June-17	140	2.0	-	168.0 (8)
July-17	140-165	2.0	2.0	000.0
August-17	126	4.0	5.0	136.0 (6)
September-17	65	8.0	6.0	272.7 (7)
October17	90-95	6.0	6-8	221.8 (11)
November-17	100-110	5.0	6-8	000.0
December-17	110-120	3.5	4-6	000.0

***(Average of Six bore wells taken for data)-Total number of bore wells - 40**

Burrakunta before desilting

Water storage in Burrakunta during monsoon

Table 9: Year wise impact of Burrakunta on borewells recharge

Year	No. of borewells under Burrakunta	No. of defunct borewells during summer	No. of defunct borewells 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%)	64 (91 %)	158.4	71.4	594.3
2014-15	110	63(57%)	60 (95%)	150.2	74.6	668.6
2015-16	114	26(23%)	26(100%)	145.4	106.4	621.6
2016-17	114	72(63%)	56(78%)	156.6	96.4	655.5
2017-18	114	81 (71%)	81(100%)	180.4	64.0	798.0

Srikakulam

Renovation of Jagannadha Naidu Tank

Renovation of Jagannadha Naidu tank was initiated during the year 2011-12 to improve its storage capacity, repair the weakened sluices and bunds which would prevent water over flow and damage to the crops during heavy rains in tank fed areas. The water collected in the tank was utilized to overcome water scarcity at early and later stages of the crop during kharif. This resulted in higher productivity of paddy and enhanced net returns to the farmers over 80 ha of area. During 2017-18 yield loss due to flooding could be reduced to an extent of 22.5 per cent due to the repairs done to the tank. Area under *rabi* crops too went up to 40 ha during 2017-18 because of enhanced availability of water (Table 10).

Improvement of Jagannadhanaidu tank

Desilting of tank

Water level before renovation

Water level after renovation

Measuring of water level after renovation

Table 10: Economic impact of renovation of Jagannadhamnaidu Community tank on *kharif* paddy at Srikakulam

Particulars	Before NICRA	After NICRA				
		2013-14	2014-15	2015-16	2016-17	2017-18
Total area under paddy (ha)	120	130	130	130	130	130
Paddy under flood prone condition.	80	80	80	80	80	80
Yield (q/ha)	48	53.50	51.83	55.85	59.49	58.50
% Yield loss reduced	---	11.45	7.97	16.35	23.93	22.50
Cost of cultivation	28500	30910	38750	34438	38,400	37800
Gross Returns	48000	53,00	66410	78190	83286	81900
Net Returns	19500	22590	27660	43752	44886	43500
B:C Ratio	1.68	1.73	1.71	2.29	2.16	2.13
Total income from paddy under flood prone condition 80 (ha)	1560000	1807200	2212800	3500160	3590880	**3480000**

Table 11: Impact of renovation of Jagannadhanaidu tank on flood mitigation

Season	Impact parameter	2011-12 & 2012-13	2013-14 & 2014-15	2015-2016	2016-17	2017-18
Kharif (Jun-Oct)	Rain fall	1287.6 mm (57) & 1134.1 mm (78)	1613.4 mm (51) & 1337.5mm (77)	806.2mm (33)	1426.3mm (67)	989.4mm (61)
	Water storage	55531 m3	138575 m^3 (25 acres in 4.5 feet depth)	1,38,575 m^3 (25 acres in 4.5 feet depth)	182880 m^3 (25 acres in 6 feet depth)	152500 m^3 (25 acres in 5 feet depth)
	Area under paddy in *kharif* (ha)	120	130	130	130	130
	rabi Area (ha)	120	130	130	130	130

3.2 *In-situ* moisture conservation technologies

Andhra Pradesh

Anantapur

Sub-soiling with chisel plough

The NICRA village of the district faces the problem of low and uncertainly of productivity of crops because of recurrent and intermittent drought and also low and erratic rain fall. The soils are slopy (2-4%) and shallow in depth (10-15 cm) with low water holding capacity. Sub soiling was practiced in groundnut to conserve soil moisture and for improving the productivity. This is achieved due to breaking of hard pan that helps in percolation of rainwater into lower layers of soil from where it is not easily lost by evaporation and aids to deeper rooting. Subsequently , soil moisture and applied nutrients from the profile are better utilized by the plants and productivity of crops is enhanced .The practice of sub-soiling with a chisel plough resulted in 45.88% higher yield compared to farmers practice with additional net returns of Rs.18667/ha. This technology was taken up in an area of 3.2 ha covering 4 farmers (Table 12).

Chittoor

Trench cum bunding in mango

KVK has demonstrated trench cum bunding in mango orchards at 5 different locations of Chittecherla village under NRM interventions. These demonstrations in mango were taken up with an objective of conserving the soil moisture in the orchards itself as well as reducing soil erosion if any. There was an yield increase of 10.79% in demonstrations when compared to farmers practice. Addition net returns of Rs.29000/ha were obtained in the demonstrations with a favourable benefit cost ratio of 2.15 compared to 1.72 in the farmers practice where trench cum bunding was not adopted (Table 12).

Kurnool

Demonstration of conservation furrows in red gram between rows at 30-35 days after sowing was taken up with the objective of allowing rain water to be percolated during rains and more moisture to be retained in the soil to support crop growth during dry spells. These demonstrations taken up during kharif in an area of 12 ha covering15 farmers at NICRA village of Kurnool district (Yagantipalle) recorded 28.35% increase in yield over the farmers practice. With the additional cost of Rs. 14148 incurred per hectare a favourable benefit cost ratio of 2.8 was realized in the demonstrations compared to 2.31 in plots where conservation furrows were not formed (Table 12).



Conservation furrows in redgram for moisture conservation

Khammam

Demonstration of cotton on ridges and furrows was taken up in 4 ha area covering 10 farmers at Khammam district to allow percolation and retention of moisture for a longer time during crop period. Ridges and furrows in cotton recorded 21.60% increase in yield over the farmers practice and recorded a benefit cost ratio of 1.79 (Table 12).

Cotton on ridges – KVK, Khammam

Nalgonda

The in-situ moisture practice of dead /conservation furrows was demonstrated in cotton over 10.6 ha area involving 14 farmers for moisture conservation and stabilizing or enhancing productivity under rain fed conditions. The crop was under moisture stress during dry spell period of 18 days that occurred in the months of July and October. It was observed that moisture was retained at a depth of 20 cm in the fields where dead furrows were formed even during dry spells. The fields with conservation furrows recorded higher yield of 200 kg/ha over farmers' practice and gave additional net income of Rs. 8880/ha and a favourable benefit cost ratio of 2.20.

Conservation furrows in cotton and redgram- KVK, Gaddipalli

In-situ moisture conservation in pigeonpea through conservation furrows in an area of 6 ha covering 6 farmers was taken up in NICRA village of Nalgonda district. This practice resulted in higher net returns of Rs.10138/ha over farmers practice with a benefit cost ratio of 1.87 (Table 12).

Namakkal

Compartmental bunding in groundnut, blackgram and greengram was demonstrated in an area of 16 ha covering 40 farmers as an in situ moisture conservation measure in the NICRA village. Due to the moisture conserved through this practice, additional yields of 170, 180 and 155 kg /ha and benefit cost ratios of 1.98, 2.40 and 2.57 were realized in groundnut, blackgram and greengram respectively (Table 12).

Compartmental bunding for moisture conservation

3.3 Water harvesting and recycling through supplemental irrigation

Chittoor

In the NICRA village of Chittoor district farmers usually follow flooding method to irrigate groundnut crop because of which the efficiency of use of irrigation water is low. Low availability of water coupled with inefficient methods of irrigation result in low productivity. Hence KVK planned to conduct demonstrations on sprinkler method of

Supplemental irrigation to groundnut using sprinklers

Table 12: Effect of *in-situ* moisture conservation practices on productivity and profitability of different crops

KVK	Crop	Intervention	No. of demon-strations	Area (ha)	Yield (kg/ha)	Cost of cultivation (Rs./ha)	Gross returns (Rs./ha)	Net returns (Rs./ha)	B:C ratio
Anantapur	Groundnut	No sub soiling	4	3.2	1277	22500	51262	28762	2.30
		Sub soiling with chisel plough			1863	27650	75079	47429	2.70
Chittoor	Mango	No trench cum bunding	5	5.6	6950	45875	125000	79125	1.72
		Trench cum bunding			7700	48875	154000	105125	2.15
Kurnool	Red gram	Farmers practice	15	12	924	21540	49896	28356	2:31
		Conservation Furrow			1186	22860	64044	41184	2.80
Khammam	Cotton	Farmer Practice	10	4	1896	52129	79514	27385	1.52
		Ridge and furrow			2305	53918	96740	42822	1.79
Nalgonda	Cotton	Farmers practice	14	9.4	2001	48840	101185	52345	2.07
		conservation furrow			2201	50346	111571	61225	2.20
Nalgonda	Red gram	Farmers practice	6	6	760	22730	33440	10710	1.47
		conservation furrow			1025	24250	45098	20848	1.87
Namakkal	Groundnut	Farmers practice	10	4	825	32450	56250	23800	1.73
		Compartmental bunding			995	33,050	65750	32700	1.98
	Black gram	Farmers practice	10	4	615	18760	36900	18140	1.96
		Compartmental bunding			795	19850	47820	27970	2.40
	Green gram	Farmers practice	20	8	655	17400	39300	21900	2.25
		Compartmental bunding			810	18900	48600	29700	2.57

irrigation in groundnut to give supplemental irrigation at critical stages of crop growth and also to enhance efficiency of use of irrigation water. Supplemental irrigation in groundnut (K-6) using sprinklers resulted in higher productivity of 310 kg/ha compared to the farmer practice with higher net returns of Rs.11288/ ha (Table 13).

Khammam

Supplemental irrigation in cotton, paddy and fodder grass in an area of 4ha for each crop covering 47, 75 and 35 farmers respectively resulted in 451 kg/ha, 426.5 kg/ha and 3500 kg/ha increased yield with B:C ratio of 1.68, 1.80 and 1.97 respectively (Table 13).

Ramanathapuram

Water harvesting and recycling for supplemental irrigation through community ponds in Ramanathapuram of Tamil Nadu was demonstrated in paddy using two Varieties *viz*.,CO (R) 51 and NLR 34449 in an area of 20 ha and 25 ha covering 50 and 75 farmers and the varieties recorded higher yield of 596 Kg/ha and 345 Kg/ha than farmers practice with B:C ratio of 2.49 and 2.82 respectively (Table 13).

3.4 Soil Quality and fertility Management

Chittoor

Green manuring in mango with sunhemp in 16 ha area covering 40 farmers was demonstrated in the NICRA village in order to prevent erosion, improve water holding capacity of soil, enhance organic carbon and fertility status of soil. The seed of sunhemp was given as critical input which was sown in the month of July after kharif rains and the crop was trampled into soil at flowering stage during September. This practice fetched higher yields of mango (8 t /ha) in the demonstrations compared to 7.25 t /ha in the farmers practice of not following green manuring. There was an yield increase of 10.35% in demonstration with a benefit cost ratio of 2.92 when compared to farmers practice (Table 15).

Table 13: Enhanced performance of crops provided with supplemental irrigation using harvested water

KVK	Crop	Intervention	No. of demon-strations	Area (ha)	Yield (kg/ha)	Cost of cultivation (Rs./ha)	Gross returns (Rs./ha)	Net returns (Rs./ha)	B:C ratio
Chittoor	Ground nut (K-6)	Farmers Practice	2	0.4	2350	52688	94000	41312	1.78
		Supplemental irrigation			2660	53800	106400	52600	1.9
Khammam	Cotton (Sarpanch)	Farmers Practice	4	47	1845	51228	77416	26188	1.51
		Supplemental irrigation			2296	57116	96340	39224	1.68
	Paddy (Flooding)	Farmers Practice	4	75	5796	51730	89845	38115	1.73
		Supplemental irrigation			6223	53520	96456	42936	1.80
	Fodder grass	Farmers Practice	4	35	9500	31800	47500	15700	1.49
		Supplemental irrigation			13000	32950	65000	32050	1.97
Ramanatha-puram	Paddy CO (R) 51	Farmers Practice	20	50	3467				
		Supplemental irrigation			4063	22790	56889	34099	2.49
	Paddy NLR 34449	Farmers Practice	25	75	3467				
		Supplemental irrigation			3812	24245	68509	44264	2.82

Green manuring in mango with sunhemp

Field day on green manuring in mango

Nalgonda

Green manuring in paddy with *Dhaincha* was practiced for the reclamation of low fertile soils in an area of 2.8 ha covering 5 farmers. The practice resulted in higher yield of 6038 kg/ha in the demonstration compared to farmers practice (5786 kg / ha) with a BC ratio of 2.57 (Table 15).

Soil test based fertilizer recommendation was demonstrated in cotton in an area of 20 ha covering 26 farmers in the NICRA village of Nalgonda. This practice recorded a higher net results of Rs. 5783 in the demonstration plots and reduction in the cost of cultivation by Rs.2013/ha compared to farmers practice because of following balanced fertilization as decided based on the soil test data (Table 15).

Green manuring with *Dhaincha* in paddy fields

Namakkal

Soils in the NICRA village, Vadavattur have been diagnosed to have poor soil fertility status. Soils were mainly deficient in organic carbon (77.03%), available nitrogen (78.20%), zinc (56.69%) and boron (43.60%) (Table 14). In order to improve the fertility status, mixed pulse seeds were sown as green manure crop and incorporated in the same field. This was followed by cultivating small onion

(variety CO 4) with fertilizer application as per soil health card. This practice recorded higher yields (167 q/ha) and net returns (Rs 225544/ha) over the yields (140.12 q/ha) and net returns (Rs 179284/ha) recorded in the farmers practice (Table 15).

Table 14: Soil Analysis reports (2017-18) of Namakkal

S. No.	Parameters	Range	Average	Category
1	Soil reaction	6.29-8.15	7.52	Neutral
2	Electrical Conductivity (dS m^{-1})	0.017-0.165	0.078	Non saline
3	Lime status	-	Non calcareous & calcareous	Non calcareous & calcareous
4	Organic carbon (%)	0.33-0.50	0.49	Low
5	Available nitrogen (kg ha^{-1})	251-377	189	Low
6	Available phosphorus (kg ha^{-1})	14.2-72.1	15.9	Medium
7	Available potassium (kg kg^{-1})	89-390	219	Medium
8	Available sulphur (mg kg^{-1})	1.51-15.3	17.4	Medium
9	Available zinc (mg kg^{-1})	0.22-6.60	0.56	Deficient
10	Available boron (mg kg-1)	0.03-0.66	0.38	Deficient

Green manuring with mixed pulse crops before *rabi* small onion

Table 15: Soil quality and fertility management in different NICRA centers

KVK	Intervention	No. of demon-strations	Area (ha)	Yield (kg/ha)	Cost of culti-vation (Rs./ha)	Gross returns (Rs./ha)	Net returns (Rs./ha)	B:C ratio
Chittoor	No green manuring	40	16	7250	44875	166750	121875	2.72
	Green manuring in mango using Sunhemp			8000	46875	184000	137125	2.92
Nalgonda	No green manuring	5	4	5786	43555	110305	66750	2.53
	Green manuring in paddy with *Dhaincha*			6038	45155	116345	71190	2.57
	Farmers practice	26	20	2205	55395	111375	56970	2.00
	Soil test based nutrient manage-ment in cotton			2360	53382	116135	62753	2.17
Namakkal	No green manuring	100	20	14000	100956	280240	179284	2.78
	Green manuring with mixed pulse seed			16700	110256	335800	225544	3.05

4. Crop Production

4.1 Climate resilient crop cultivars

Flood tolerant varieties

Srikakulam

In the adopted village of Sirisuvada in Kothuru mandal, paddy crop is often prone to floods and submergence in the low lying areas of around 150 acres due to excess rainfall during monsoon or due to overflow of hill streams. In order to mitigate the effects of inundation on paddy crop in medium to high inundation areas, flood tolerant varieties have been assessed for their performance since 2012-13. The flood tolerant varieties under demonstration (MTU-1061, RGL-2537 and MTU-1075) and the check varieties (MTU-1001 and MTU-7029) were affected during early stages of crop growth due to flash flood in Vamsadhara river back waters of marripadugedda during July**,** 2017. The flood tolerant varieties under demonstration out performed two check varieties viz., MTU-1001 and MTU-7029 in terms of yield, net returns and benefit cost ratio. It was observed over years of demonstrations that the flood tolerant varieties do well when there is low to medium inundation in the NICRA village. High inundation during early stages of crop growth affected adversely all the varieties equally.

Upscaling of flood tolerant varieties (MTU- 1061, RGL-2537 & MTU-1064) through KVK during 2-17-18

In NICRA village		**Adjacent village**	
Extent (ha)	No. of farmers	Extent (ha)	No. of farmers
16	20	10	16

Through the efforts of KVK, the three flood tolerant varieties occupied an area of 16 ha in the NICRA village covering 20 farmers whereas they occupied 10 ha covering 16 farmers in the adjacent village. The efforts of department of agriculture and AP seeds corporation of Srikakulam district led to the spread of the three flood tolerant varieties viz., MTU-1061, RGL-2537 and MTU-1064 to 1394, 2666 and 717 ha compared to 22, 475 and 0 hectares respectively before the start of NICRA in 2012.

Upscaling of flood tolerant varieties in Srikakulam district through department of agriculture and AP Seeds Corporation.

S. No	Name of the variety	Area (ha) Before NICRA 2012-13	Seed in (q) produced during 2016-17	Extent of area occupied (ha) 2017-18	Increase in area (ha)
1	MTU-1061	22	418	1394	1372
2	RGL-2537	475	800	2666	2191
3	MTU-1064	0	215	717	717
Total		**497**	**1433**	**4777**	**4280**

West Godavari

Flood tolerant varieties MTU-1061 and MTU-1064 recorded higher yield of 6563 and 6288 kg/ ha respectively over the farmers variety MTU-7029 (5247 kg/ ha) with additional net returns of Rs. 26407 and Rs. 22649 /ha respectively (Table 16).

Upscaling of flood tolerant varieties: During 2011, MTU 7029 was the main variety occupying 95 per cent paddy area in the NICRA village. But with the consistent efforts from NICRA team, the area occupied by flood tolerant varieties increased to 90 % replacing MTU 7029 (10%). In the entire west Godavari district too, the area under MTU-7029 came down to 24.6% of total area under Paddy.

MTU-1061

MTU-1064

Thiruvarur

Flood tolerant long duration paddy variety at Tiruvarur district *viz.,* CR 1009 SUB 1 recorded higher yield (6005 Kg/ha) compared to the farmers variety CR 1009 (5427 Kg/ha) with a favourable B:C ratio of 2.77. Medium duration variety of Swarna Sub 1 (6026 Kg/ha) which is also flood tolerant reported higher yields than farmers variety BPT 5204 (5512 Kg/ha) with additional net income of Rs. 7230/ha) (Table 16).

Flood tolerant paddy variety (MTU-1061) at Srikakulam

Flood tolerant paddy variety (CR 1009 Sub1) at Thiruvarur

Biotic and abiotic stress tolerant varieties

Anantapur

Drought resistant variety of groundnut (Dharani) was demonstrated in the NICRA village of Anantapur. The improved variety recorded 84 Kg/ha higher yield compared to the traditional K-6 variety with a B:C ratio of 2.09 (Table 17).

Chittoor

Demonstrations were conducted with the drought resistant variety Dharani of groundnut under rainfed situation at NICRA village with an objective to improve productivity. About 19.56% increase in yield was observed in Dharani when compared to Kadiri-6, the local variety. An amount of Rs.9025 was realized as additional net returns by the farmers with this variety (Table 17).

Seedlings of the triple resistant variety of tomato , Arka samrat were supplied to the farmers for demonstration purpose. Both farmers variety and Arka Samrat were affected with bacterial leaf spot due to continuous rains and cloudy weather during Kharif season. Arka samrat variety showed 9.24% higher yield than farmers variety (US 448). Additional net returns of Rs. 60651 were realized with the improved variety compared to the check. The incidence of bud necrosis, a viral disease was to an extent of 4-6 % both in the improved and local varieties. The incidence of early blight and bacterial wilt were very less in Arka Samrat whereas the check variety US 448 was affected by early blight disease to an extent of 20-25% .

Drought resistant Dharani (Groundnut)

Triple resistant Arka Samrat (Tomato)

Kurnool

The drought tolerant variety of redgram PRG-176 which is suitable to medium to light soils and has 140-150 days duration was demonstrated against long duration (180 days) varieties that face moisture stress at flowering and pod development stage (terminal moisture stress) in the NICRA village of Kurnool where drought is the major climatic vulnerability.

Drought tolerant pigeon pea variety (PRG 176)

The results indicated that redgram variety PRG-176 with improved production technologies gave higher yield (926 kg/ha) which was 7.17 per cent higher than that of farmers practice (864 kg/ha) in medium black soils. The Economic viability of improved technology over farmers practice was calculated depending on prevailing prices of input and output costs. The improved technologies resulted in increased income with cost benefit ratio of 2.11. (Table 17).

NBeG-3 (Bengalgram)

NJ 2446 (Jowar)

Results of Bengalgram demonstrations indicated that NBeG-3 performed well in medium to light soils. The variety is fairly tolerant to drought with well developed root system and also exhibits tolerance to wilt diseases. The increased grain yield was mainly because of more no of pods/plant and higher 100 grain weight. Comparison of economics of demonstration and farmers practice (JG-11) indicated that the cultivation of NBeG-3 with improved technologies ensured additional yield of 230 kg/ha and net returns of Rs 10875/ha with a B:C ratio of 2.06 compared to 1.65 in the check variety.

Results of Jowar demonstrations indicated that two varieties NJ-2647 and NJ-2446 performed well in medium to light soils compared to local varieties. These varieties are fairly tolerant to drought with well developed root system .The increased grain yield was mainly because of short duration (105-110) than local varieties (120-125 days). Economics of demonstration and farmers practice indicated that the cultivation of NJ-2647 and NJ-2446 with improved technologies gave additional returns of Rs. 4564/ha and Rs. 23640/ha with benefit cost ratio of 1.5 and 3.1 respectively compared to 1.1 in the check variety (Table 17).

Table 16: Performance of flood tolerant varieties during 2017-18

KVK	Crop	Intervention	No. of demonstra-tions	Area (ha)	Yield (kg/ha)	Cost of cultivation (Rs./ha)	Gross returns (Rs./ha)	Net returns (Rs./ha)	B:C ratio
Srikakulam	Paddy	Farmers practice MTU- 1001	25	26	5356	37200	74984	37784	2.01
		MTU – 7029			4150	32000	58100	26100	1.81
		Improved varieties MTU-1061			5938	37400	83132	45732	2.22
		RGL- 2537			5762	36400	80668	44268	2.21
		MTU-1075			6050	38400	84700	46300	2.20
West Godavari	Paddy (Flood tolerant)	MTU-7029 (Check variety)	20	20	5247	45357	83750	38393	1.84
		MTU-1061 (Submergence & lodging tolerant variety)			6563	43950	108750	64800	2.40
		MTU1064 (Submergence& lodging tolerant variety)			6288	41458	105000	61042	2.50
Thiruvarur	Paddy (Flood tolerant)	CR 1009 SUB 1 (Flood tolerant Long duration)	230	108	6005	34706	96084	61377	2.77
		CR 1009 (check)			5427	37096	86835	49742	2.34
		Swarna Sub 1 (Flood tolerant Medium duration)			6026	38352	96416	58064	2.51
		BPT 5204 (check)			5512	37366	88200	50834	2.36

West Godavari

MTU-1121 (Paddy)

Short duration varieties of paddy *viz.,* MTU-1121 and MTU-1156 were demonstrated in 20 ha area covering 20 farmers with the purpose of adding a summer pulse after second crop of paddy thus intensifying cropping in the paddy-paddy-fallow system. The variety MTU-1121 gave high yield (7219 kg/ha) followed by MTU-1156 (7195 kg/ha) compared to the farmers variety i.e., MTU-1010 (7036 kg/ha). Higher net returns of Rs. 69747/ha were obtained with MTU-1121. (Table 17).

Khammam

Salinity tolerant paddy variety Siddi (WGL- 44) was demonstrated in an area of 20 ha covering 50 farmers in the NICRA village of Khammam. The improved variety recorded 488 kg/ha of additional yield compared to traditional variety with B:C ratio of 1.91.

Virus tolerant varieties were demonstrated in chillies (LCA- 625) and greengram (MGG -295) in an area of 2 ha and 31.5 ha covering 5 and 30 farmers respectively. The varieties LCA- 625 and MGG -295 recorded higher yields than farmers varieties with B:C ratio of 1.89 and 1.24 respectively (Table 17).

Salinity tolerant WGL-44 (Paddy)

Virus tolerant LCA-625 (Chillies)

Nalgonda

TBG-104, a YMV tolerant blackgram variety

Demonstrations were conducted on short duration redgram variety PRG-176 and YMV resistant blackgram variety TBG-104 in 6.0 and 2.4 ha covering 7 and 6 farmers respectively. Improved varieties recorded additional yields of 222 Kg and 81 Kg/ha than the farmers varieties with additional net returns of Rs. 9773/ha and Rs. 2920/ha respectively. Short duration varieties of red gram are preferred to long duration ones because of the reason that long duration varieties are prone to terminal moisture stress resulting in reduced productivity. The local varieties of blackgram cultivated in the NICRA village are YMV susceptible and hence need replacement with YMV resistant cultivars.

Namakkal

Short duration blackgram variety, VBN-8

Climate resilient varieties of groundnut (Drought resistant Dharani), blackgram (short duration VBN-8) and greengram (CO-8) were demonstrated in the NICRA village. Resilient variety Dharani of groundnut recorded 205 kg/ha higher yield compared to traditional variety. VBN-8 of blackgram gave higher net returns of Rs. 9300/ha over farmers variety. Short duration, synchronized maturing variety of greengram, CO-8 realized additional yield advantage of 155 kg/ha with an additional net income of Rs.7800/ha over farmers variety VBN-3 (Table 17).

Ramanathapuram

Short duration (CO (R) 51) and drought tolerant (Anna (R) 4) paddy varieties were demonstrated in an area of 8 ha covering 20 farmers for each variety at NICRA

village of Ramanathapuram. The results indicated that CO (R) 51 and Anna (R) 4 gave higher yields of 596 Kg/ha and 259 Kg/ha over farmer varieties with an additional net income of Rs. 8011/ha and Rs. 4156/ha respectively (Table 17).

Short duration rice variety CO (R) 51 (left) and check NLR 34449 (right)

Villupuram

Short duration varieties of greengram **(**CO8), mothbean (TMV1), blackgram (VBN-6) and drought tolerant variety of groundnut (TMV 13) were demonstrated in an area of 16.6 ha, 6 ha, 12.6 ha and 3 ha covering 133, 30, 63 and 30 farmers respectively. The results indicated that improved varieties gave additional yields of 156 Kg/ha, 180 Kg/ha, 117 Kg/ha and 323 Kg/ha with B:C ratio of 1.87, 2.21, 2.02 and 1.56 respectively (Table 17).

Co-8 (greengram)

VBN-6 (blackgram)

TMV-1 (mothbean)

TMV-13 (groundnut)

Table 17: Performance of crop cultivars for adaptation to climate variability

KVK	Intervention	Crop cultivars	No. of demon-strations	Area (ha)	Yield (kg/ha)	Cost of cultivation (Rs./ha)	Gross Returns (Rs./ha)	Net Returns (Rs./ha)	B:C ratio
Anantapur	Drought resistant variety of groundnut	Farmers variety (K-6)	5	5	1893	38850	80156	41306	2.06
		Dharani (TCGS-1043)			1977	37570	78670	41100	2.09
Chittoor	Drought resistant variety of groundnut	Farmers variety (K-6)	20	8	1610	48765	64400	15635	1.32
		Dharani			1925	52340	77000	24660	1.47
	Triple disease resistant variety in tomato	Farmers variety (US448)	10	4	59500	196344	594999	398655	2.03
		Arka Samrat			65000	190344	649650	459306	2.41
Kurnool	Drought tolerant pigeonpea	Farmers variety (Asha)	100	80	864	24530	46656	22126	1.90
		PRG-176			926	23655	50004	26349	2.10
	Drought tolerant Bengalgram	Farmers variety (JG-11)	25	20	810	24500	40500	16000	1.65
		NBeG-3			1040	25125	52000	26875	2.06
	Drought tolerant Jowar	Farmers variety Mahindra male	30	24	910	11680	12740	1060	1.10
		NJ-2647			1236	11680	17304	5624	1.50
West Godavari	Paddy (Short duration)	MTU 1010 (Farmers variety)	20	20	7036	48140	109740	61600	2.20
		MTU 1156 (Short duration)			7195	45870	112100	66230	2.40
		MTU 1121 (Short duration)			7219	43533	113280	69747	2.60
Khammam	Salinity tolerant Paddy	Farmers variety	50	20	5943	57560	94494	36934	1.64
		Siddi- WGL -44)			6431	53520	102260	48733	1.91
	Virus resistant chilli variety	Farmers variety	5	2	5565	260120	417375	157255	1.60
		LCA- 625			6435	234100	482625	228525	1.89

KVK	Intervention	Crop cultivars	No. of demon-strations	Area (ha)	Yield (kg/ha)	Cost of cultivation (Rs./ha)	Gross Returns (Rs./ha)	Net Returns (Rs./ha)	B:C ratio
Nalgonda	Early duration redgram variety	Farmers variety (LRG-41)	7	6	770	22970	33110	10140	1.44
		PRG-176			992	23204	43117	19913	1.85
	YMV tolerant blackgram variety	Farmers variety (LBG-752)	6	2.4	579	14788	22773	7985	1.53
		TBG-104			660	15080	25985	10905	1.72
Namakkal	Drought resistant groundnut variety	Farmers variety	10	2	815	33550	55750	22200	1.66
		Dharani			1020	33400	66000	32600	1.97
	Short duration blackgram	Farmers variety	10	4	610	16300	36600	20300	2.25
		VBN-8			790	17800	47400	29600	2.66
	Improved variety in greengram	Farmers variety (VBN-3)	20	4	650	13400	39000	25600	2.91
		CO-8			805	14900	48300	33400	3.24
Ramanatha puram	Short duration paddy variety	Farmers variety	20	8	3467	22450	48538	26088	2.16
		CO (R) 51			4063	22790	56889	34099	2.49
	Drought tolerant paddy variety	Farmers variety	20	8	3467	22450	48538	26088	2.16
		Anna (R) 4			3726	21920	52164	30244	2.38
Villupuram	Short duration variety of greengram	Farmers variety	133	16.6	436	17612	26212	8600	1.49
		CO8			592	19060	35571	16510	1.87
	Short duration variety of moth bean	Farmers variety	30	6	542	15812	27097	11284	1.71
		TMV 1			722	16353	36130	19777	2.21
	Short duration variety of blackgram	Farmers variety	63	12.6	492	17744	30789	13046	1.72
		VBN 6			609	18976	38153	19177	2.02
	Drought tolerant groundnut variety	Farmers variety	30	3	1680	36088	51128	15953	1.42
		TMV 13			2003	39238	61081	21844	1.56

4.2 Climate resilient intercropping systems

Intercropping was demonstrated as a climate resilient crop production practice in NICRA villages of the zone with an objective of effectively utilizing soil moisture and nutrients from different depths of soil and to mitigate the risk of total crop failure during periods of extreme weather events.

Chittoor

To get assured income from diversified crops under drought conditions, demonstration was conducted on intercropping of mango with field bean. The field bean was sown when mango was at bud initiation stage. The seed of field bean (Variety: TFB-1) was distributed to 6 farmers. An additional income of Rs.82300/ha was obtained due to the intercropping system when compared to the sole crop of mango (Table 18).

Intercropping of field bean in mango

In order to ensure some income and to overcome the problem of low prices of tomato during glut, KVK has supplied Marigold seedlings to 20 beneficiaries for intercropping marigold in tomato in the ratio of 6:1. Additional net returns of Rs. 32405 were obtained from the intercropping system when compared to the sole crop of tomato (Table 18).

Intercropping of marigold in tomato

Kurnool

Intercropping of pigeionpea +foxtail millet (1:5)

Delayed onset of monsoon and prolonged dry spells during the crop season in the rain fed NICRA village of Kurnool district often result in total or partial crop failures. In order to utilize the bi-model distribution of rainfall and also to insure against crop failure due to drought, millet based inter cropping systems were demonstrated as a climate resilient option as against sole crops in the NICRA village.

Pigeonpea + foxtail millet (1:5) inter cropping system was demonstrated in comparision with sole crop of redgram and foxtail millet in order to increase the cropping intensity and net returns of the farmers. Results of intercropping of pigeonpea + foxtail millet in the demonstration plots indicated that net income of the intercropping system was higher (Rs.17498/ha) than sole foxtail millet (Rs.8700/ha). Besides ensuring higher net returns, the intercropping system with red gram will help sustain fertility and microbial activity of the soil through addition of biomass of pigeonpea (Table 18).

Khammam

Intercrop of cotton + pigeonpea (6:1) at Khammam

The NICRA village received heavy rainfall during the months of September and October when the cotton crop was at flowering and boll bursting stage and as a result cotton crop was damaged heavily. Cotton and pigeonpea intercropping system in 6:1 ratio was taken up in NICRA village of khammam for obtaining additional benefit compared to sole cotton. An enhanced net income of Rs.6026/ha was obtained in intercropping system compared to sole crop (Table 18).

Nalgonda

Cotton + pigeonpea at Nalgonda

To minimize the risk of low productivity or crop failures and loss of income from crops due to erratic rainfall, cotton + redgram (6:1) intercropping was demonstrated in 6 ha area covering 10 farmers in NICRA village of Nalgonda district. The results indicated that, an additional net income of Rs.11419/ha was realized from intercropping system when compared to sole crop of cotton with a BC ratio of 2.24 (Table 18).

4.3 Farm mechanization for resource conservation

Chittoor

Power weeder in tomato- Chittoor

Weeding with manual labor involves high cost, less coverage and less precision. Demonstrations were conducted to control weeds in tomato using power weeder which was supplied to farmers through CHC. The demonstrations were taken up in an area of 4 ha covering 10 farmers. The results indicated decrease in cost of cultivation by Rs. 22000/ha and an additional income of Rs. 35870/ha.

Kurnool

Traditional method of sowing Bengalgram with bullocks involves higher cost, less coverage and less precision. To circumvent these demerits associated with this method of sowing, farm mechanization was opted as an alternative which would reduce the cost of sowing, increase the precision and cover more area in unit time especially during periods of labour shortage. Ten demonstrations were conducted on sowing Bengalgram with improved seed drill in 10 ha of area. The demonstrations gave higher net income of Rs.7610 / ha and reduced cost of

cultivation by Rs.1410/ha compared to farmer practice. Similarly sowing with seed drill in sorghum resulted in additional net income of Rs.1912/ha and reduced cost of cultivation by Rs.680 / ha (Table 19).

Sowing with seed drill in Bengalgram

Sowing with seed drill in Jowar

West Godavari

Field visit to machine transplanted paddy

Traditional method of manual transplanting of paddy involves high cost, less coverage and less precision and also has the problem of non-availability labour during peak planting time. Mechanical transplanting of paddy which helps overcome these problems was demonstrated at three locations and gave higher yield advantage of 500 kg/ ha over manual transplanting. The cost of cultivation was reduced by Rs 2266/ha with higher net income of Rs. 9301/ha (Table 19).

4.4 Resource/ Water saving technologies

Anantapur

Zero tillage in maize was followed to utilize residual soil moisture available in rice fallows. This would not only reduce cost of cultivation but also reduce crop duration and add organic matter to the soil in the form decomposing paddy stubbles. This technology was demonstrated in an area of 2 ha covering 5 farmers.

The demonstrations gave 640 kg/ha increased yield compared to farmers practice with an additional net income of Rs. 15780/ha. The cost of cultivation was also brought down by Rs.3750/ha. (Table 20).

Chittoor

Direct seeding in paddy using drum seeder conserves seed, water, labour and allows the crop to produce more tillers. The improved practice resulted in higher yield advantage (13.85%) over conventional method of planting and ensured higher net returns of Rs.16172/ha. Crop duration was also reduced by 10 days in direct seeding method (Table 20).

Srikakulam

Zero tillage in maize was followed to utilize residual soil moisture available in rice fallow. The results showed an additional yield advantage of 594 kg/ha compared to farmers practice and an additional net income of Rs.9228/ha. Cost of cultivation was also reduced by Rs.2100/ha compared to normal method of cultivating maize (Table 20).

Zero tillage maize in rice fallows

West Godavari

Direct sowing with drum seeder in paddy is useful to reduce the cost of cultivation and to improve the water use efficiency. This improved technology reduced the cost of cultivation to Rs.5989/ha with additional yield advantage of 363 kg/ha compared to traditional practice in the demonstrations conducted at 20 locations on 20 ha of area. The improved method brought down cost of cultivation by Rs.5989 (Table 20).

Khammam

Conservation and effective utilization of residual soil moisture through cultivation of Sunhemp for seed in rice fallows was demonstrated in an area of 30 ha

covering 40 farmers in the NICRA village of Khammam. This technology gave a net income of Rs. 39500/ha from the fields which were totally left fallow and underutilized after rice (Table 20).

ZMC visit to sunhemp seed production plots in rice fallows

Thiruvarur

System of rice Intensification (SRI) was demonstrated at 110 locations covering 50 farmers in the NICRA village to reduce the cost of cultivation and to improve water use efficiency. The SRI method resulted in 469 Kg/ha increase in yield with an additional net income of Rs. 10075/ha compared to traditional method of cultivation (Table 20).

Villupuram

Paddy requires more number of supplemental irrigation due to larger dry spells during *kharif*. Moreover it has been observed many times that transplanting delayed due to late on set of monsoon resulted in poor yield. Hence, the farmers are motivated to adopt alternate wetting and drying method (Pani- pipe) to conserve the water by reducing the number of irrigations and increase the ground water level. The benefits of alternate wetting and drying method have been demonstrated in Agoor village of Mailam block through off campus trainings. The pani-pipes have been distributed to the farmers for adopting this technology. The results revealed that number of irrigations in rice field was reduced by 12 to15 and there was increase in th e number of tillers. The average yield was 4880 kg/ha which was 5.62% higher when compared to the control plot (4620 kg/ha) (Table 20).

Pani pipe technology in paddy field

Table 18: Performance of climate resilient cropping systems

KVK	Intervention	No. of demonstrations	Area (ha)	Yield (kg/ha)	Cost of cultivation (Rs./ha)	Gross returns (Rs./ha)	Net returns (Rs./ha)	B:C ratio
Chittoor	Mango sole crop	6	2.5	4375	43375	100625	57250	2.32
	Mango + Fieldbean			10625	117325	256875	139550	2.19
	Tomato sole crop	20	8	65625	188880	262500	73620	1.39
	Tomato + Marigold			58500	186475	292500	106025	1.57
Kurnool	Foxtail millet sole crop	72	57.6	1200	12000	20700	8700	1.72
	Foxtail millet + Redgram (5:1)			784(F)+ 386 (R)	16890	34388	17498	2.03
Khammam	Cotton sole crop	5	2	2025	2015	89100	27,258	1.44
	Cotton(Sarpanch) + redgram (WRG- 65)			1965 (C) + 268 (R)	63896	97180	33284	1.52
Nalgonda	Cotton sole crop	10	6	2380	53950	116620	62670	2.16
	Cotton (Bt) + pigeon pea (PRG-176) (6:1)			2286 (C)+ 492(R)	59521	133610	74089	2.24

Table 19: Influence of farm implements on yield and economics of crops in NICRA villages

KVK	Crop	Intervention	No. of demon-strations	Area (ha)	Yield (kg/ha)	Cost of cultivation (Rs./ha)	Gross returns (Rs./ha)	Net returns (Rs./ha)	B:C ratio
Chittoor	Tomato	Manual weeding	10	4	54100	189000	541000	48600	2.86
		Power weeder in tomato			59500	167000	595000	84470	3.56
Kurnool	Bengal gram	Farmers method of seeding	10	10	1040	27950	52000	24050	1.90
		Improved seed drill			1164	26540	58200	31660	2.20
	Jowar	Farmers method of seeding	10	10	1236	11680	17304	5624	1.50
		Improved seed drill			1324	11000	18536	7536	1.70
West Godavari	Paddy	Manual transplanting	3	3	6700	54766	93765	38999	1.71
		Mechanical Trans- planting in Paddy			7200	52500	100800	48300	1.92

Table 20: Effect of water saving technologies on productivity and profitability of different crops

KVK	Intervention	No. of demonstrations	Area (ha)	Yield (kg/ha)	Cost of cultivation (Rs/ha)	Gross returns (Rs/ha)	Net returns (Rs/ha)	BC ratio
Anantapur	Farmers practice	5	2	4930	50625	80716	30091	1.59
	Zero tillage maize			5570	46875	92746	45871	1.98
Chittoor	Farmers practice	18	7.2	5506	51506	84425	32919	1.64
	Direct sowing with drum seeder			6269	51221	100312	49091	1.96
Srikakulam	Farmers practice	41	40	7052	38500	84624	46124	2.10
	Zero tillage maize			7646	36400	91752	55352	2.50
West Godavari	Farmers practice	20	20	6323	47871	99120	51249	2.01
	Direct sowing with drum seeder			6686	41882	105020	63138	2.50
Khammam	Farmers practice	40	30	**Fallow**				
	Conservation tillage Sun hemp (Local variety)			985	9750	49250	39500	4.05
Thiruvarur	Farmers practice	110	50	5650	37142	90403	53261	2.43
	SRI method			6119	34569	97904	63336	2.84
Villupuram	Farmers practice	25	10	4.62	43138	73945	30806	1.71
	Pani pipe			4.88	43463	78144	34680	1.80

4.5 Crop diversification

Diversification with climate resilient crop options has been demonstrated in various NICRA centers as an adaptive strategy to mitigate the adverse effects of climatic vulnerability.

Anantapur

Groundnut (K-6) cultivation realized very low net returns due to delayed sowing because of delayed on set of monsoon. Crop diversification with the drought tolerant and short duration variety of foxtail millet SIA-3085 resulted in higher net returns (Rs.33456/ha) and B:C ratio (3.66) compared to groundnut (Table 21).

Foxtail millet (SIA-3085) at Anantapur

Kurnool

Foxtail millet (SIA-3085)

Desi cotton is the traditional crop grown in NICRA village of Kurnool district and highly prone to the vagaries of weather resulting in poor productivity. Crop diversification with foxtail millet was demonstrated as a drought mitigation strategy in an area of 55.2 ha covering 92 farmers. The adoption of foxtail millet by the farmers was due to its suitability to delayed monsoon, short duration and additional benefit of fodder. The market price of foxtail millet is also on a rise due to growing awareness among consumers on the benefits of including millets in the diet. Comparison of economics of demonstration and farmers practice indicated that the cultivation of alternative crop of foxtail millet with improved technologies ensured additional net returns of Rs.2190/ha with B:C ratio of 1.60. In view of drought tolerance and minimum requirement of water, foxtail millet is preferred to *desi* cotton by farmers. Because of sustainable yield and income obtained even under harsh weather conditions,

the cropped area under foxtail millet increased from 05 to 250 acres in the NICRA village during *kharif* 2017 (Table 21).

Khammam

Cultivation of cotton has been a traditional practice in the NICRA village of Khammam. Frequent and intermittent droughts have been adversely affecting the productivity of the crop in the village. Redgram (WRG- 65) was demonstrated as an alternative to cotton which resulted in an additional net income of Rs.7290/ha compared to farmers practice with a benefit cost ratio of 1.42 (Table 21).

Nalgonda

Demonstrations on PSV-2, Jowar variety during late *rabi* season were taken up in 7.0 ha with 35 farmers instead of leaving the field fallow for effective utilization of irrigation water. The results indicated that, farmers got an extra net income of Rs 29362/ha with B:C ratio of 2.93 by growing jowar in *rabi* (Table 21).

Jowar (PSV-2)

Table 21: Crop diversification for sustainability in different NICRA centers

KVK	Intervention	No. of demon strations	Area (ha)	Yield (kg/ha)	Cost of cultivation (Rs/ha)	Gross returns (Rs/ha)	Net returns (Rs/ha)	BC ratio
Anantapur	Groundnut (K-6)	58	70	1254	22850	53060	30210	2.32
	Diversification with Foxtail millet (SIA-3085)			2378	12570	46026	33456	3.66
Kurnool	Desi cotton	92	55.2	345	12930	17940	5010	1.40
	Diversification with Foxtail millet (SIA 3085)			1200	12000	19200	7200	1.60
Khammam	Cotton	5	2	1830	65115	73200	8085	1.12
	Diversification with Red gram (WRG- 65)			1295	36425	51800	15375	1.42
Nalgonda	Fallow fields	35	7	--	--	--	--	--
	PSV-2 Jowar variety			1074	15201	44563	29362	2.93

4.6 Nutrient Management

Chittoor

Micro-nutrient management in mango using IIHR mango special was demonstrated covering 25 farmers over 10 ha area. In the demonstrations, fruit yield was increased by 23.07% when compared to farmers practice. Moreover, fruit quality was superior and fetched Rs.1000 additional price per tonne with this improved technology as against normal method. Additional net returns of Rs.49250 was obtained in the demonstration with a benefit cost ratio of 3.76 (Table 22).

Demonstrations were conducted on fertigation in tomato with water soluble fertilizers like 19-19-19, 13-0-45 and calcium nitrate covering 10 farmers. Fertigation schedule was followed as per IIHR recommendation. The demonstrations gave 40.45% higher yield than farmers practice. Additional net returns of Rs.105616/ha was obtained with this improved technology while recording a decreased cost of cultivation of Rs.11775/ha (Table 22).

West Godavari

Indiscriminate use of chemical fertilizers is leading to high cost of cultivation and lower yield in paddy. Use of liquid bio-fertilizers (1250 ml of *Azospirillum* + 1250ml of PSB + 75 % RDF (100 kg Urea+ 100 Kg DAP + 100 Kg MOP/ ha) enhanced paddy yields by 225 kg/ha over farmers practice with B:C ratio of 2.46 (Table 22).

Use of liquid bio-fertilizers in paddy

Nalgonda

Demonstration of foliar nutrient application in cotton covering 44 farmers in 32 ha area recorded additional yield of 140 kg/ha and an additional net income of Rs.7326/ha over farmers practice with B:C ratio of 2.11 (Table 22).

Foliar nutrient application in cotton

Soil test based fertilizer application in cotton at NICRA village of Nalgonda decreasd the cost of cultivation by Rs. 2013/ha with an additional net income of Rs. 5783/ha compared to farmer practice (Table 22).

Soil sample collection

Table 22: Effect of nutrient management practices on productivity and profitability of different crops

KVK	Crop	Intervention	No. of demonstrations	Area (ha)	Yield (kg/ha)	Cost of cultivation (Rs./ha)	Gross returns (Rs./ha)	Net returns (Rs./ha)	B:C ratio
Chittoor	Mango	No micronutrient spraying	25	10	8125	46275	178750	132475	3.04
		Spraying of Micronutrient mixture			10000	48275	230000	181725	3.76
	Tomato	Indiscriminate use of fertilizers	10	4	55678	155975	231992	76017	1.53
		Fertigation Schedule			78200	144200	325833	181633	2.34
West Godavari	Paddy	Without liquid bio-fertilizers	5	5	6375	45167	100300	55133	2.22
		Use of Liquid bio-fertilizers			6600	42167	103840	61673	2.46
Nalgonda	Cotton	Farmers practice	26	18.4	2205	55395	111375	56970	2.0
		Soil test based fertilizer application			2360	53382	116135	62753	2.17
		Without nutrient application	44	32	2150	53120	105350	52230	1.98
		Foliar nutrient application			2290	53421	112977	59556	2.11

4.7 Crop Protection

Chittoor

Leaf miner is a serious pest of tomato. Farmers use pesticides indiscriminately to control the pest leading to higher cost of cultivation. KVK supplied WOTA traps, Tuta lures and 1500ppm neem oil to 20 tomato growers for conducting demonstrations on IPM of leaf miner in tomato. An yield increase of 35.18 % was recorded in demonstrations where IPM of leaf miner was followed compared to farmers method. The crop received only two pesticidal sprays in the demonstrations whereas four pesticide sprays were given in farmers practice. Besides providing better efficacy in managing the pest thereby increasing the yield, there was a reduction in the cost of plant protection by Rs.6500 / ha in the demonstration as against farmers practice (Table 23).

Srikakulam

Biotic stress management in flood prone area for the management of paddy sheath blight, blast and brown plant hopper was demonstrated to reduce the yield loss because of disease incidence during floods. The improved practice involves seed treatment, formation of alleyways, need based chemical spray for blast, sheath blight and brown plant hopper which resulted in additional yield advantage of paddy over no plant protection measures with very low incidence of pests and diseases. This improved technology gave an additional net income of Rs. 2000/ha with B:C ratio of 2.10 compared to farmers practice (Table 23).

Particulars	Demo	Farmers practice
Blast Incidence	11.6	16.8
Sheath blight incidence	15.2	22.4
BPH incidence	5.8	10.3
Productive tillers per square meter	285	262
Grains per panicle	153	146
Yield (q/ha)	56.5	54.5
B:C ratio	2.10	2.07

West Godavari

Field visit to IPM plot of Paddy

IPM technology (Seed treatment with Carbendazim, clipping of leaf tips, erection of pheramone traps, formation of alley ways, release of *Trichogramma* and a need based application of chemical pesticides) was demonstrated in paddy and results indicated that, an additional net income of Rs. 10161/ha with B:C ratio of 2.74 compared to farmers practice (Table 23).

Namakkal

IDPM in small onion

Onion is mainly affected by basal rot and thrips resulting in a yield loss of 20 – 30%. To avoid the yield loss IPDM technology was demonstrated in NICRA village in an area of 40 ha covering 100 farmers resulting in an increase in yield of 1900 Kg/ha with additional net returns of 44733/ha compared to farmers practice (Table 23).

Table 23: Effect of Crop protection measures on productivity and profitability of different crops

KVK	Intervention	No. of demon-strations	Area (ha)	Yield (kg/ha)	Cost of cultivation (Rs./ha)	Gross returns (Rs./ha)	Net returns (Rs./ha)	B:C ratio
Chittoor	Indiscriminate use of pesticides	20	8	5400	162895	163200	305	1.00
	IPM technology in tomato			7300	156395	220500	48600	1.41
Srikakulam	Farmers Practice	36	20	5450	36700	76300	39600	2.07
	IPM technology in Paddy			5650	37500	79100	41600	2.10
West Godavari	Indiscriminate use of pesticides	20	20	6752	48022	112500	64479	1.74
	IPM in paddy			7064	42860	117500	74640	2.74
Namakkal	Farmers Practice	100	40	11200	102475	168000	65525	1.63
	IPDM in small onion var. Co-4			13100	86242	196500	110258	2.27

5. Livestock and Fisheries

5.1 Performance of improved fodder varieties

Chittoor

NitiAyog team visiting fodder demonstrations (CoFS-31)

One of the major livestock enterprises in the NICRA village is dairy. Some of the farmers are growing APBN-1 fodder variety for rearing of cattle. Late onset of monsoon and recurring drought situation creates scarcity of green fodder before *kharif* season. Farmers rely on paddy straw procured from nearby paddy growing mandals for feeding animals during such situations. Keeping in view the problem of shortage of green fodder, KVK conducted demonstrations of improved and drought resistant Hybrid Napier Co-4 fodder variety at ten locations by supplying slips to dairy farmers. Hybrid Napier Co-4 gave higher fodder yield (54.2 t/ha) compared to farmers variety (42.4 t/ha).

Improved fodder variety CoFS-31 (multi cut) was also demonstrated in 40 farmers fields covering an area of 16 ha and the variety gave an additional yield of 31.5 t/ha with a benefit cost ratio of 1.49 over the farmers practice (Table 24).

Khammam

Demonstrations were conducted on CO –4 fodder variety in an area of 10 ha covering 20 farmers. The improved fodder variety gave increased fodder yield of 3.9 t/ha with an additional net income of Rs. 13700/ha compared to farmers practice (Table 24).

Supply of fodder seed to farmers

Fodder grass (CO – 4)

Nalgonda

Improved fodder variety APBN-1 was demonstrated in 29 farmers fields covering an area of 5.3 ha against farmers variety MP chari. APBN-1 gave a higher yield of 170 t/ha with a benefit cost ratio of 7.44 over the farmers practice (Table 24).

Fodder grass (APBN-1)

Ramanathapuram

Demonstrations were conducted on Velimasal (*Desmanthus*), a fodder variety in an area of 20 ha covering 40 farmers. The fodder variety showed recorded higher yield of 68t/ha with B:C ratio of 6 (Table 24).

Villupuram

Demonstrations were conducted on African Tall maize, CoFS-29 (Multicut fodder sorghum), COBN-5 (Cumbu Napier Grass) and GG-3 (Guinea Grass) in an area of 1.2 ha, 2.4 ha, 0.4 and 0.2 ha covering 30, 30, 10 and 5 farmers and the fodder varieties showed an yield advantage of 28.26 t/ha, 38t/ha, 245t/ha and 182t/ha with B:C ratio of 1.81, 3.04, 5.21 and 5.08 respectively compared to farmers practice (Table 24).

African Tall Maize

CoFS-29 (Multicut fodder sorghum)

CO (BN)-5 (Cumbu Napier Grass)

GG-3 (Guinea Grass)

Table 24: Performance of improved fodder varieties at different NICRA centers

KVK	Intervention	No. of demon-strations	Area (ha)	Yield (t/ha)	Cost of cultivation (Rs./ha)	Gross returns (Rs./ha)	Net returns (Rs/ha)	B:C ratio
Chittoor	Local variety (APBN-1)	20	10	42.4	63685	84800	21115	1.33
	Hybrid Napier Co-4			54.2	65250	108400	43150	1.66
	Local variety (Private variety)	40	16	105.0	58250	70000	11750	1.2
	CoFS-31 (multi cut)			136.5	61250	91000	29750	1.49
Khammam	Local variety	20	10	8.9	26100	44500	18400	1.70
	CO – 4			12.8	31900	64000	32100	2.0
Nalgonda	Local variety (MP-Chari)	29	5.3	60.0	40100	192000	151900	4.78
	APBN-1			170.0	68500	510000	441500	7.44
Ramanathapuram	Open grazing	40	20	–	–	–	–	–
	Velimasal (Desmanthus)			68.0	20000	120000	100000	6
Villupuram	Farmer practice (Open grazing + CO-4)	30	1.2	14.0	12500	14000	1500	1.12
	African Tall maize			28.2	31250	56550	25300	1.81
	Farmer practice (Open grazing)	30	2.4					
	COFS-29 (Multicut fodder sorghum)			38.0	12500	38000	25500	3.04
	Farmer practice (Open grazing + CO-4)	10	0.4	218.0	22500	109000	86500	4.84
	COBN-5 (Cumbu Napier Grass)			245.0	23500	122500	99000	5.21
	Farmer practice (open grazing)	5	0.2	–	–	–	–	
	GG-3 (Guinea Grass)			182.0	17900	91000	73100	5.08

Namakkal

Demonstrations conducted on feeding of livestock with mixed green fodders (multicut sorghum and subabul) resulted in an increase in milk yield (60%), fat content(14%) and net returns /peak lactation (182 %) compared to farmers practice (dry fodder, low nutritive feed stuffs and grazing (Table 25).

Table 25: Effect of improved fodder varieties on economic parameters of livestock at Namakkal

Parameter with unit	Demo (multicut sorghum and subabul)	Check (dry fodder, low nutritive feed stuffs and grazing)
Milk yield (l/day)	8.0	5.0
SNF content (%)	7.8	7.8
Fat content (%)	4.0	3.5
Gross cost (Rs.)/6 months	14400	11880
Gross return (Rs.)/ peak lactation 100days	31680	18000
Net return (Rs.)/ peak lactation 100days	17280	6120
BCR	2.20	1.50

5.2 Green fodder preservation through silage making

Silage making is a process of chopping available green fodder (sorghum, maize, hybrid napier, sugar cane tops etc.) with a chaff cutter and storing it in air tight plastic bags after some treatment. Silage thus prepared can be stored for 8-10 months and can be used during times of scarcity of green fodder. This method circumvents the problem of purchasing green fodder during summer months at high cost leading to increased cost of milk production. Silage making saves cost of labour required for fodder cutting and transporting. Farmers of NICRA villages prepared silage whenever green fodder / plant material is available to them in plenty to meet the requirement of fodder during lean months.

Namakkal

Silage making was taken up at NICRA village of Namakkal, Tamil Nadu to make available green nutritious fodder during scarcity period. The practice of silage making reduced the cost of fodder by Rs.3000/100 days and increased milk

production (8.33%) with a BC ratio of 2.10 compared to check. Net returns per peak lactation of 100 days are also higher by Rs. 5000 when the cows are fed with silage (Table 26).

Table 26: Effect of feeding silage on economic parameters of livestock at Namakkal

Parameter with unit	Demo	Check
Milk yield (l/day)	6.5	6.0
SNF content (%)	7.8	7.8
Fat content (%)	3.4	3.4
Gross cost (Rs.)/peak lactation 100days	12600	15600
Gross return (Rs.)/ peak lactation 100days	26000	24000
Net return (Rs.)/ peak lactation 100days	13400	8400
BCR	2.10	1.50

Silage making with crop residues of small onion at Namakkal

Villupuram

Silage feeding in Villupuram district was demonstrated covering 10 beneficiaries and the improved practice enhanced milk yield by 5.13% compared to traditional practice. Net returns were also high by Rs.1032 in the improved method (Table 27).

Silage making-KVK, Villupuram

Table 27: Potentials of fodder varieties under irrigated or rain fed environment

Treatments	Fodder Yield (t/ha)	Cost of cultivation (Rs/ha)	Gross income (Rs/ha)	Net income (Rs/ha)	BC ratio
Local Method	7.8	4212	5148	936	1.22
Silage feeding	8.2	4182	6150	1968	1.47

5.3 Feed enrichment techniques

Supplementation of mineral mixture/ mineral blocks to milch animals

Kurnool

Feeding livestock with Regional Specific Mineral Mixture (RSMM) along with farmers practice of feeding resulted in higher milk production (237.6 l/60 days) with higher net income of Rs.2734 compared to the farmers practice in NICRA village of Kurnool (Table 28).

Feeding livestock with RSMM-Kurnool

Khammam

Promotion of mineral mixture to dairy farmer-Khammam

Feed enrichment with mineral mixture was demonstrated in NICRA village of Khammam, Telangana. Supplementation of minerals through mineral mixture resulted in higher milk production 534 l/ 60 days with an additional net income of Rs.14800/animal compared to farmer practice (Table 28).

Villupuram

Feed enrichment with urea treated paddy straw resulted in increased milk yield of 9 l/60 days with an additional net income of Rs. 706/animal (Table 28).

Feeding with TANUVAS mineral mixture in livestock resulted in exhibition of estrus signs at 18 months where as in farmers practice the signs were recorded at 24 months. The improved practice also recorded higher net returns of Rs. 2425/ animal compared to farmers practice (Table 29).

Feed enrichment with urea treated paddy straw

Feeding livestock with TANUVAS mineral mixture

Table 28: Influence of feed enrichment techniques on productivity of live stock

KVK	Treatments	Average milk yield/ animal (l/Day)	Total milk yield /animal (l/60days)	Cost of feeding (Rs./ animal)	Gross returns (Rs./ animal)	Net returns (Rs./ animal)	BC ratio
Kurnool	Farmers practice (FP)	3.3	196.8	1286	6691	5405	5.20
	FP+ RSMM	3.9	237.6	1840	9979	8139	5.42
Khammam	Farmers practice	5.8	348.0	8340	17400	9060	2.08
	FP+Mineral mixture	8.9	534.0	8840	26700	23860	3.02
Villupuram	Farmers practice	7.5	450.0	4050	4950	900	1.22
	Urea treatment of paddy straw	7.7	459.0	4131	5737	1606	1.39

Table 29: Influence of mineral mixture on productivity of live stock at villupuram

Treatments	Exhibition of estrus signs	Cost of feeding (Rs./animal)	Gross returns (Rs./animal)	Net returns (Rs./animal)	B:C ratio
Farmers practice	24 months	8250	20000	11750	2.42
TANUVAS mineral mixture	18 months	5825	20000	14175	3.43

Ramanathapuram

Feeding livestock with mineral salts resulted in an additional weight gain i.e., 6kg/ goat with B:C ratio of 2.03 compared to farmers practice (Table 30)

Feeding with TANUVAS mineral mixture in livestock also showed an increased milk yield of 150l/ year with B:C ratio of 1.41 compared to farmers practice (Table 31)

Table 30: Influence of mineral salt on productivity of live stock at Ramanathapuram

Treatments	Wt/goat (Kg)	Gross cost (Rs./ goat)	Gross Returns (Rs./goat)	Net Returns (Rs./goat)	BC ratio
Farmers practice	15	3410	5250	1840	1.53
Mineral salt	21	3610	7350	3740	2.03

Table 31: Influence of mineral mixture on productivity of live stock at Ramanathapuram

Treatments	Milk yield (l/yr.)	Cost of feeding (Rs./ animal)	Gross returns (Rs./ animal)	Net returns (Rs./ animal)	BC Ratio
Farmers practice	2400	44250	60000	15750	1.35
TANUVAS mineral mixture	2550	45000	63750	18750	1.41

Azolla Production

Demonstration of azolla production as alternative feed to milch animals was conducted at NICRA village of Chittoor district covering 10 farmers with 10 units of Azolla for providing balanced nutrition and enhancing the milk productivity in milch animals. Farmers in the village usually feed dairy animals with green fodder, dry fodder and rice bran. Feeding of azolla along with farmer practice resulted in 50% increase in milk yield (Table 32).

Table 32: Demonstration of Azolla as alternate feed to milch animals at Chittoor

Intervention	No. of farmers	Milk yield (l/ animal)
Farmers practice	10	1.0
Azolla as alternative feed		1.5

Azolla as feed to milch animals- Chittoor

5.4 Backyard Poultry for nutritional needs and income generation

Agriculture being dependent on weather is prone to uncertainty and hence alone is unable to provide livelihood security to small and marginal farmers in rain fed regions. There is a need to supplement the income of the farmers from agriculture though income generating activities like backyard poultry for sustaining livelihood and to have assured income from at least one source.

Chittoor

Demonstrations on improved poultry breed Rajasri were conducted to supplement income of small and marginal farmers. Rajasri breed was found superior to local breed with higher growth rate and additional net income of Rs. 452/year/bird. The improved breed weighed 0.6 kg higher per bird after one year and laid 88 more eggs /bird /year (Table 33) .

West Godavari

Local poultry breeds have less growth rate, egg laying capacity and high susceptibility to diseases. So demonstrations on improved breed (vanaraja) were

conducted in NICRA village of West Godavari district. Improved breed performed better than local breed in terms of higher net returns (Rs. 600/bird), more body weight (0.5kg) and more number of eggs (68/year) laid per year (Table 33).

Nalgonda

In Nalgonda too the improved breed (Rajasri) gave higher net income Rs. 700/bird by giving 100 eggs more per bird and putting on 0.8 kg higher body weight after one year compared to local breed (Table 33).

Rajasri (Improved breed) at Nalgonda

Table 33: Performance of poultry birds in augmenting farm income in NICRA Villages

KVK	Particulars	Initial wt.(g)	Weight of bird (Kg) after one year	No. of eggs/ year	Total expendi-ture (Rs.)	Income from eggs (Rs.)	Income from meat (Rs.)	Total income (Rs.)
Chittoor	Local Breed	50	1.9	90	634	360	350	710
	Rajasri	65	2.5	178	813	712	450	1162
West Godavari	Local Breed	450	1.5	52	660	260	500	760
	Vanaraja	450	2.0	110	975	660	700	1360
Nalgonda	Local Breed	300	2.2	60	450	300	550	850
	Rajasri	450	3.0	160	620	800	750	1550

Khammam

The improved breed of Rajasri produced 180 eggs/bird compared to local breed (55) and gave higher net returns of Rs. 701 compared to local breed with B:C ratio of 1.84 (Table 34).

Table 34: Performance of poultry birds in augmenting farm income at Khammam

Treatment	Egg Production	Gross Cost (Rs./Bird)	Gross returns (Rs./Bird)	Net Returns (Rs./year /Bird)	B:C ratio
Local breed	55	305	369	64	1.2
Rajasri	180	579	1070	491	1.84

Villupuram

In the demonstrations at Villupuram, Tamil Nadu, the improved poultry breed, Nandanam-2 recorded higher body weight (0.26 kg) with an additional net income of Rs. 1238/bird compared to local breed (Table 35).

Nandanam-2 (Improved breed)

Table 35: Performance of poultry birds in augmenting farm income at Villupuram

Particulars	Weight of bird (Kg) 8th week	Total expenditure	Gross returns (Rs.)	Net returns (Rs.)	B:C ratio
Local breed	0.98	1800	4665	2865	2.59
Nandanam-2	1.24	1800	5902	4102	3.28

5.5 Conservation of cattle

Calf Registration and healthy calf programme at Kurnool

Deworming of calves at kurnool

Dairy farming is the most sustainable livelihood to the farmers. Continuous growth in dairy sector in Kurnool district indicates the interest of the farmers towards this sector. Scientific rearing of dairy animals will keep the animals healthy as well as productive. Especially, calves are usually neglected and are not provided proper medication and feeding. This results in poor growth rate and delayed maturity (4-5years). To educate the farmers towards scientific practices in calf rearing "Calf registration and healthy calf programme" was initiated during 2011-12 under NICRA project in Yagantipalle village with an objective to reduce the calf mortality and to improve growth rate in calves. During 2017-18, 50 buffalo calves were registered under the programme in NICRA village. The registered calves were administered monthly de-worming and supplemented with vitamin A and B-complex and fed with calf starter for 5 months @ 500g/day.

Health camps were organized every month along with medication. The registered calves showed 22% increase in body weight gain with reduced mortality rate (3%) over un- registered calves (11%) (Table 36).

Table 36: Performance of calves registered under calf registration programme

Particulars	Farmers practice	Demonstration	Remarks
Initial body weight (kg)	26.9	25.4	The increased growth rate helps calves come to heat early.
Final body weight (Kg)	72.7	81.2	
Body weight gain (kg)	45.8	55.8	
% gain in body weight	22		
Mortality (%)	11	3	

Namakkal

In order to enhance the availability of veterinary health care at the doorstep of farmers at Namakkal, community health care services were provided to 1460 desi birds and 1920 sheep and goat covering 124 farmers during 2017-18.Deworming and regular vaccination of livestock (small ruminants) showed an increased body weight (16 Kg/6months) over the control (12 Kg) with an additional net returns of Rs. 850/animal (Table 37).

Table 37: Performance of regular vaccination in small ruminants

Particulars	Farmers practice (Irregular vaccination)	Treated (vaccinated livestock)
Initial body weight (kg)	1.5 to 1.75	1.75 to 2.00
Final body weight (kg)/ 6 month	12	16
Gross returns (Rs.)	3000	4000
Total cost (Rs.)	100	250
Net returns (Rs.)	2900	3750

Vaccination of livestock at Namakkal

5.6 Shelter management for stress tolerance

Namakkal

In NICRA adopted village most of the farmers are small holders and they do not have proper housing for their animals and the animals are tied in open space under tree shades/other shades. In these conditions the animals are subject to heat stress, prone to vector borne diseases and the production performance of the animals remains low. Low cost thatched roof shed for sheep, slotted floor goat shed, and night shelter for poultry birds were demonstrated as improved shelters for sheep, goat and poultry respectively to cope with heat stress and to maintain hygiene. The livestock under improved house showed better performance over the control. Kidding/Lambing interval was reduced from 10 month to 8 month with average birth weight of kid being improved from 1.5 to 1.75 kg and kid mortality was reduced from 10% to 3%. In poultry, the marketable weight of 1.5 kgs was obtained in 4 months as against 6 months in farmers practice. Clutch size increased from 12 to 15 and chick mortality was reduced to 2 to 3% from 10 to 20% (Table 38).

Table 38: Performance of various livestock (small ruminants and poultry) in improved house

Particulars	Farmer Practice (shed constructed with locally available materials)	Improved practive (Low cost thatched roof shed for sheep, Slotted floor goat shed, and Night shelter for poultry birds)
Small ruminants		
Lambing interval (months)	10	8
Average birth wt (kg)	1.5	1.75
Kid mortality (%)	10	3
Poultry		
Marketable weight (Kg)	1.5 (6^{th} month)	1.5 (4^{th} month)
Clutch size	12	15
Chick mortality (%)	10-20	2-3

Poultry Night shelter

Housing for goat and sheep

Chittoor

KVK has supplied 0.5 hp motors and foggers to five members to conduct demonstrations on heat stress management in dairy cattle during summer. By installation of foggers and spraying water as a fine mist, the heat in the shelter was brought down during summer and the improved conditions enhanced milk yield to 6 litres per day per animal as against 4.5 litres obtained in farmers practice (without foggers) (Table 39).

Table 39: Effect of protection measures during extreme weather

Intervention	Milk yield (litre/day/ animal)	Milk production (litres/ 3 months)	Total Milk yield /5 animals	Expenditure (Rs.)	Total Income (Rs.)	B:C ratio
Without foggers	4.5	405	2025	36000	80100	2.23
Installation of foggers	6.0	540	2700	47800	108000	2.26

Heat stress management in dairy animals using foggers

5.7 Promotion of fisheries

Srikakulam

Captive rearing of fish seed

Captive rearing of fish seed at Srikakulam

Captive rearing of fish seed *i.e.,* rearing of fish fry up to fingerling stage in nursery pond was demonstrated 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. Rearing fish seed in pen culture (Hapa nets) at grow out culture ponds from spawn stage to advance fry stage showed 32.5 % of survival rate and B:C ratio 1.64 compared to farmers practice. Farmers could save upto Rs.9575 for the same number of fish seedlings through captive rearing (Table 40).

Table 40: Captive rearing of fish at NICRA village of Srikakulam

Treatments	Fish seed Survival (no/unit)	Cost of cultivation (Rs./per unit)	Gross income (Rs.)	Net income (Rs.)	B:C ratio
Captive rearing of fish seed upto fingerling size in nursery ponds	48750 nos advance fry realized with 32.5% survival rate	14800 (@ Rs.0.30 for fingerling	24375	9575	1.64
Purchase from out side market	-	24375 (@Rs.0.50 for fingerling	-	-	-

Namakkal

Introduction of improved species of fish with commercial fish feed showed better performance than traditional species with locally available feeds (GNOC & rice bran) at NICRA village of Namakkal. The improved species showed a higher survival rate of 77.60% than traditional species due to complete availability of their nutrients from the commercial feed than local feed.

6. Institutional Interventions

6.1 Custom hiring center

Increasing scarcity of human labour and difficulties associated with upkeep of animals has necessitated a shift in Indian agriculture from dependence on human and animal power to mechanical power. Mechanical power enables timeliness of farm operations besides reducing drudgery and thus contributes to increased productivity directly. Because of the capital involved in acquiring machines/tools used in agriculture, the use of them is largely confined to 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 small/marginal farmers, by virtue of their economic condition are unable to own farm machinery on their own or through institutional credit. With the objective of making farm machinery available to small and marginal farmers ,Custom Hiring Centers (CHC) with collective ownership have been included as one of the institutional interventions under NICRA.

Custom Hiring Center (CHC) houses a combination of farm machinery, implements and equipment that can be hired on cost basis by farmers of the NICRA village. 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. It was ensured that the CHC has farm machinery that are commonly used for tillage operations for all crops, multi crop equipment and a minimum of crop specific machinery. The center is maintained by the Village Climate Risk Management Committee (VCRMC). A separate bank account is maintained to deposit the hiring charges collected, a part of which is used for the repairs of the tools and implements.

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.

Progress of CHCs in NICRA centers

Andhra Pradesh

Anantapur

Groundnut is an important oilseed crop grown in NICRA village of Anantapur district under rainfed conditions. Timeliness, precision in sowing and other crop production operations largely decide the productivity of this crop. Farmers are forced to sow the crop even up to the end of August due to non availability of labour and draft power. Custom Hiring Center was established in the NICRA village during 2011 for providing timely services for various agricultural operations to the farmers.Timely sowing of groundnut, greengram, korra and jowar with automatic seed drill, threshing of groundnut with thresher and sub-soiling for insitu moisture conservation were the farm operations that could be undertaken by farmers in the NICRA village during 2017-18 through hiring of farm implements of the CHC. The center provided hiring services to 95 farmers covering 200 ha and earned net income of Rs. 37400 (Table 41).

Chittoor

Custom hiring centre was established during 2015-16.The equipment available in the center are sub-soiler, disc plough, tarpaulins, drum seeders, power weeder, taiwan sprayers, power sprayers, knapsack sprayers, brush cutter, pole pruner, tractor mounted sprayer, star weeders, sprinkler system, mini rice mill, secateurs, loppers and pruning saws. The custom hiring services were mainly utilized in the crops viz., paddy, tomato, groundnut and mango on an area of 107 hectares benefitting 58 farmers (Table 41).

Kurnool

Custom hiring center was established in the NICRA village in 2011 with an investment of Rs.6.25 lakh as a group activity. During 2017-18, the custom hiring center provided hiring services for various operations in crops like pigeonpea, jowar, chickpea and foxtail millet in an area of 46ha covering 21 farmers and realized an income of Rs. 5100 (Table 41).

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 an investment of 6.25 lakhs. The committee assessed the needs of mechanization for different crops before finalizing action plan in each year.

In 2017-18, the center provided hiring services to the crops of paddy (10ha), cotton (2.5 ha) and vegetables (2 ha) in an area of 14.5 ha covering 43 farmers with a net income of Rs. 3250 (Table 41).

West Godavari

The custom hiring centre was established in NICRA village of Undi in West Godavari district in the year 2011 with an investment of Rs.482077. In 2017-18 the center provided hiring services for an area of 4ha covering 3 farmers and collected rental charges of Rs.1500 (Table 41).

Telangana

Khammam

The CHC was established in Nacharam village (NICRA village) of Khammam district during 2010-11 with an investment of Rs.55047 for providing hiring services for different agricultural operations to the farmers. About 9 persons of VCRMC are engaged in running the centre. In the process of operation, different commodity groups are formed to identify and assess the demand of tools for various crops and various operations and to prepare the schedule to be implemented

during the year. The centre procured Taiwan Sprayer (1), seed cum- fertilizer drill (1), paddy reaper (1), multi-crop thresher (1) and 2-M.B. plough (1). During 2017-18, the center provided hiring services an area of 55.4ha covering 79 farmers and collected rental charges of Rs.32181 (Table 41).

Nalgonda

The centre was established in Nandyalagudem 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 of VCRMC are engaged to run this centre and 155 farmers are the members. During 2017-18, the center provided hiring services to the crops of cotton (10 ha), paddy (6.8 ha), mulberry (4.0 ha) and groundnut (1.2 ha) in kharif season and cotton (1.6 ha), paddy (5.2 ha) and mulberry (2.5 ha) in rabi season covering a total of 32 farmers with an net income of Rs. 8100 (Table 41).

Tamil Nadu

Namakkal

During 2017-18, the center provided hiring services to the crops of groundnut (26 ha), sorghum (14.5 ha) and blackgram (5ha) in kharif season and small onion (21 ha) in rabi season covering a total of 63 farmers with a net income of Rs. 38630 (Table 41).

Ramanathapuram

During 2017-18, the center provided hiring services in an area of 3 ha covering 3 farmers and collected an amount of Rs.3900/year as service charges (Table 41).

Thiruvarur

The CHC in the NICRA village of Thiruvarur provided hiring services on an area of 123 ha covering 154 farmers and earned net profit of Rs. 75500 during 2017-18 (Table 41).

Details of Implements purchased at Thiruvarur

Sl. No.	Implements purchased	Total cost (Rs.)
1.	Power Tiller	161175
2.	Levelling Board	9700
3.	Oil Engines (3)	64500
4.	Power Sprayers (2)	7500
5.	Battery Sprayers (3)	17500
6.	Knapsack Sprayers (2)	4000
7.	ConoWeeder (20)	25000
	Total	**289375**

Villupuram

During 2017-18, the center provided hiring services to the crops of Crossandra (0.2 ha) in *kharif* season and groundnut (7.8 ha) in *rabi* season covering 14 farmers and collected an amount of Rs.3000/year as service charges (Table 41).

Table 41: Performance of custom hiring center at different NICRA centers during 2017-18

KVK	Farmers covered	Area covered (ha)	Revenue generated through CHCs (Rs.)
Anantapur	95	200.0	37400
Chittoor	58	29.5	4650
Kurnool	21	46.0	5100
Srikakulam	43	14.5	3250
West Godavari	3	4.0	1500
Khammam	79	55.4	32181
Nalgonda	32	31.3	8100
Namakkal	63	66.5	38630
Ramanathapuram	3	3.0	3900
Thiruvarur	154	123.0	75500
Villupuram	14	8.0	3000
Total	**562**	**578.2**	**209311**

Custom hiring center (Chittoor)

Custom hiring center (Khammam)

Custom hiring center (Namakkal)

Custom hiring center (Villupuram)

6.2 Seed bank

Productivity of any crop mainly depends on the quality of seed used by farmers. It is imperative to make available quality seed at right time and affordable prices to sustain the productivity of crops and in turn livelihood security of small and marginal farmers. The baseline studies in the project areas of NICRA 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.

To address this problem alternative seed systems, which ensure availability of quality seed of improved varieties at local level have been developed under NICRA. 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 ensured higher incomes to the farmers who took up seed production as a local enterprise.

Andhra Pradesh

Seed production of groundnut var. K-6(120 kg), groundnut var. Dharani(120 kg), foxtail millet var.SiA 3085 (20 kg) and Paddy var. NLR-34449 (90 kg) was taken up for seed bank in NICRA village of Anantapur district covering 22 farmers in 9 ha area. Seed production in redgram var.Asha (1 tonne), redgram var. PRG-176 (2.5 tonne), foxtail millet var. SIA-3088 (1.5 tonne), foxtail millet var.SIA-3221 (01 tonne) and Bengalgram var NBeG-3 (1.5 tonne) was taken up for seed bank in the NICRA village of Kurnool district covering 25 farmers in 15 ha area (Table 42).

Telangana

Seed production of Paddy var. Siddi (19 tonnes) which is a salinity tolerant variety, was taken up for seed bank in NICRA village of Khammam district covering 50 farmers in 20 ha area. Sunhemp seed production was also taken in an area of 35 ha covering 40 farmers (Table 42).

Tamil Nadu

Villupuram

Seed production of ground nut var.CO 7(1140 kg) was taken up for seed bank in NICRA village of Villupuram district in an area of 0.8 ha covering 2 farmers (Table 42).

Seed Bank (Villupuram)

Table 42: Performance of Seed Banks at different NICRA centers during 2017-18

KVK	Name of crops	Quantity (q)	No. of farmers	Area (ha)
Anantapur	Groundnut (K-6)	1.2	5	1.5
	Groundnut (Dharani)	1.2	10	4
	Foxtail millet (SiA 3085)	0.2	2	1.5
	Paddy (NLR 34449)	0.9	5	2
	Sub total	**3.5**	**22**	**9**
Kurnool	Redgram(Asha)	10	5	2
	Redgram(PRG-176)	25	5	3
	Foxtail millet (SIA-3088)	15	5	2
	Foxtail millet(SIA-3221)	10	5	5
	Bengalgram(NBeG-3)	15	5	3
	Sub total	**65**	**25**	**15**
Khammam	Paddy (Siddi- WGL- 44)	190	50	20
	Sunhemp seed	300	40	35
	Sub **total**	**490**	**90**	**55**
Villupuram	Groundnut (CO 7)	11.4	2	0.8
	Sub total	**11.4**	**2**	**0.8**
	Zone toal	**569.9**	**139**	**79.8**

6.3 Fodder bank

Andhra Pradesh

Fodder cultivars *Viz.,*Fodder jowar and Multicut fodder sorghum CoFS – 29were cultivated in 5and 4 ha of area covering 10 and 4 farmers respectively in NICRA village of Anantapur district. 300 kg of fodder jowar and 200 Slips of CoFS – 29 were produced during 2017-18. CO-4 was cultivated in 1 ha area covering 10 farmers in NICRA village of Kurnool (Table 43).

Telangana

13.0 tonnes of Sugar graze (CO-4) slips were produced in an area of 32 ha covering 40 farmers at Khammam district in a fodder bank during 2017-18 (Table 43).

Tamil Nadu

Velimasal (*Desmanthus*) and CO (FS) 29 were cultivated in 1 and 4.6 ha of area covering 5 and 23 farmers respectively in NICRA village of Ramanathapuram district. 47 tonnes/ ha/ year of Velimasal and 90 tonnes/ha /year of CoFS – 29 were produced during 2017-18 (Table 43).

9000 rooted slips of Guinea grass (GG-3) were produced in an area of 0.2 ha covering 1 farmer at Villupuram district during 2017-18 (Table 43).

Table 43: Performance of fodder banks at different NICRA centers during 2017-18

KVK	Name of crops/ Commodity/ groups/ Implements	Quantity/ Number / Rent / Charges	No. of farmers	Area (ha)
Anantapur	Fodder jowar	300 kg	10	5
	Multicut fodder sorghum CoFS – 29	200 Slips	4	4
Kurnool	CO-4	-	10	1
Khammam	Sugar graze – (CO-4 Slips)	13tonnes grass/ha	40	32
Ramanathapuram	Velimasal (*Desmanthus*)	47tonnes/ha/year (7 harvests)	5	1
Villupuram	CO (FS) 29	90 tonnes/ha/year (6-7 cuts)	23	4.6
	Guinea grass (GG-3)	9000 nos of rooted slips	1	0.2

Fodder bank at Kurnool

7. Capacity building of farmers and youth on climate resilient practices/ technologies

Capacity building of farmers in NICRA villages was taken up by KVKs through a series of knowledge and skill development training programmes conducted on varied thematic areas related to resilient technologies. This kind of training will enable the farmers to extend their support 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 Tamil Nadu. The NICRA centers working in the state of Andhra Pradesh organized 90 skill oriented training programmers with the active participation of 2212 participants, while the NICRA centers in the state of Telangana organized 13 need based training programmes on improving the productivity of agricultural and horticultural crops, livestock, and custom hiring centers with active involvement of 550 participants. In Tamil Nadu, the NICRA centers organized 32 training programmes with the participation of 826 farmers. Thus the Principal investigators of NICRA in the states of Andhra Pradesh, Telangana and Tamil Nadu organized 135 training programmes with the participation of 2838 farmers and 750 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 44 & 45).

Table 44: State-wise summary of capacity building activities

State	No. of courses	No. of participants		
		Male	Female	Total
Andhra Pradesh	90	1904	308	2212
Telangana	13	261	289	550
Tamil Nadu	32	673	153	826
Grand Total	135	2838	750	3588

Table 45: Capacity building activities during 2017-18

KVK	Title of the Training Programme	No. of Courses	No. of participants		
			Male	Female	Total
Ananthapur	Natural resource management	4	120	30	150
	Resource conservation technologies	4	90	18	108
	Crop management	4	60	15	75
	Nutrient management	2	70	20	90
	Pest and disease management	3	60	20	80
	Live stock management	2	40	20	60
	Fodder and feed management	1	30	10	40
	Farm implements and machineries	4	150	20	170
Chittoor	Soil and moisture conservation techniques in mango with green manuring	1	41	2	43
	Production technology of groundnut	1	35	5	40
	Importance of pruning in mango	1	22	3	25
	Production technology of tomato	1	23	2	25
	Pest and disease management in tomato	1	22	3	25
	Pest and disease management in ground nut	1	16	4	20
	Pest and disease management in tomato	1	23	2	25
	Drum seeder technology in paddy	1	23	2	25
	Integrated pest management in tomato	1	21	4	25
	Integrated nutrient management in mango	1	22	3	25
	Production technology of fodder crops	1	17	3	20
	Intercropping of vegetables	1	20	5	25
	Fertigation in tomato	1	22	3	25
	Integrated farming system	1	18	4	22
	Production technology of summer tomato	1	23	2	25
	Heat stress management in dairy animals	1	23	2	25
Kurnool	Natural resource management	2	76	9	85
	Crop diversification	1	42	2	44
	Crop management	3	96	15	111
	Live stock management	3	62	20	82
	Fodder and feed management	2	48	12	60
	Crop pest and disease management in redgram andBengalgram	3	105	13	118
	Training on Fodder Varieties	1	26	12	38
	Post harvesting technologies in different crops	1	28	4	32
	Farm implements &machineries	1	28	4	32

KVK	Title of the Training Programme	No. of Courses	No. of participants		
			Male	Female	Total
Srikakulam	Integrated nutrient management in paddy	1	22	3	25
	Kharif pest and disease management	1	20	--	20
	Resource conservation technology on zero tillage maize	1	11	--	11
	Water management in zero tillage maize	1	22	12	34
	Water management in zero tillage maize	1	22	12	34
West Godavari	Paddy nursery management	2	26	--	26
	Bio-fertilizers application in paddy	2	22	--	22
	Water quality managementin fish ponds	2	26	--	26
	Disease diagnosis in prawn ponds	2	20	--	20
	Pest and disease management in paddy	2	36	--	36
	Black headed caterpillar in coconut	2	27	--	27
	BPH and disease management in paddy	2	26	--	26
	Training programme on mechanical trans-planted paddy	2	22	--	22
	Training programme on direct sowing and machine transplanting in rabi paddy	2	20	---	20
	Training Programme on weed and irrigation management in paddy	2	17	--	17
	Machine transplanting in paddy	2	19	--	19
	Direct sowing with drum seeder in paddy	2	26	--	26
	Nursery management in mechanical trans planting	2	30	--	30
	Training programme on pulse production technology	2	16	--	16
Khammam	Farm mechanization and importance of custom hiring centre	1	6	54	60
	Drought mitigation practices in kharif and rabi crops.	1	20	46	66
	Climate change problems and their control in live stock	1	39	43	82
	Pest and disease management in rabi crops	1	24	51	75
	Insitu moistureconservation practices in rain fed crops	1	4	52	56

KVK	Title of the Training Programme	No. of Courses	No. of participants		
			Male	Female	Total
Nalgonda	Natural resource management	1	21	7	28
	Resource conservation technologies	1	28	3	31
	Crop management	1	26	2	28
	Crop diversification	1	25	11	36
	Nursery raising	1	14	4	18
	Nutrient management	1	25	4	29
	Fodder and feed management	1	17	7	24
	Vermicompost preparation	1	12	5	17
Namakkal	VCRMC meeting	1	7	2	9
	Role of green manure for soil fertility improvement	1	62	29	91
	Nursery raising in small onion	1	23	2	25
	Balanced fertilization in oil seed crops	1	30	5	35
	Crop management in kharif season crops	1	6	22	28
	Training programme for community flock men	2	4	--	4
	Importance of soil health card and its uses for soil fertility	1	8	13	21
	Low cost feed preparation	2	20	8	28
Ramanatha puram	Soil sampling techniques	1	17	9	26
	Seed drill sowing and its advantages in semi dry rice cultivation	1	27	2	29
	Azolla production technology	1	18	7	25
	Weed management in semi dry rice	1	21	6	27
	IPDM Practices in paddy	1	26	--	26
	Foliar application of PPFM for drought mitigation	1	22	7	29
	Dry land technologies in agriculture	1	29	3	32
	Production technology of chillies	1	23	2	25
	Animal health camp	1	13	10	23
Thiruvarur	Nursery raising	1	24	--	24
	Nutrient management	1	24	--	24
	Pest and disease management	2	28	8	36

KVK	Title of the Training Programme	No. of Courses	No. of participants		
			Male	Female	Total
Villupuram	Integrated pest and disease management practice in flower crops	1	29	--	29
	Application of crop boosters to enhance the production	1	30	--	30
	Alternate wetting and drying (Pani pipe technology)	1	26	--	26
	Integrated crop management in oilseeds	1	25	5	30
	Soil moisture conservation techniques	1	27	3	30
	Improved crop management techniques in pulses	1	28	--	28
	Group dynamics for effective functioning of SHG	1	20	--	20
	Disease management in small ruminants	1	28	8	36
	Hatchery management	1	28	2	30

Training programme (Ananthapur)

Training programme on bee keeping (Chittoor)

Training programme (Kurnool)

Group discussion (West Godavari)

VCRMC Meeting by ZMC (Khammam)

Training programme (Nalgonda)

VCRMC meeting (Ramanathapuram)

Group meeting (Villupuram)

8. Extension activities for popularization of climate smart agricultural practices

Various extension activities were taken up by KVKs in NICRA villages in order to bring awareness among farmers on climate resilient agricultural technologies and to motivate them for wider adoption of the same. The extension activities organized by different KVKs in NICRA centers during 2017-18 include awareness programmes on climate resilient agriculture, field days, kisanmelas, method demonstrations, health camps, diagnostic visits, agro-advisory services, exposure visits etc., During 2017-18, 338extension activities were taken up with the participation of 8175farmers. Among these, 174 activities were organized with 5029 farm men and 804 farm women in the state of Andhra Pradesh: while in Telangana state, 66 extension activities were organized with the participation of 1132 farm men and women. About 1210 farm women and men participated in 98 extension activities in the state of Tamil Nadu during 2017-18. The details are presented below (Table 46 &47).

Table 46: State wise Summary of extension activities

State	No. of Programmes	No. of participants		
		Male	Female	Total
Andhra Pradesh	174	5029	804	5833
Telangana	66	865	267	1132
Tamil Nadu	98	868	342	1210
Grand Total	338	6762	1413	8175

Method demonstration (Anantapur)

Field day (Chittoor)

Table 47: Extension activities conducted at different NICRA centers

KVK	Title of the activity	No. of activities	No. of participants		
			Male	Female	Total
Ananthapur	Method demonstrations	7	142	49	191
	Agro advisory services	18	186	43	229
	Group discussion	2	29	6	35
	Field Days	3	54	38	92
	Diagnostic visits	2	35	5	40
Chittoor	Awareness Programme	1	42	9	51
	Field visits	12	128	35	163
	Group discussions	3	121	24	145
	Method demonstrations	3	64	11	75
	Agro advisory mobile services	16	72	---	72
	Field day in mango	1	21	7	28
	World Honey bee day	1	55	10	65
	Awareness Programme	1	20	2	22
	VCRMC meeting	1	22	3	25
	Field day in groundnut	1	21	4	25
	Interaction meeting on NICRA activities	1	65	15	80
	World soil day	1	20	-	20
	Field day in tomato	1	24	1	25
	Exposure visit	1	10	5	15
	Animal health management	2	40	25	65
	Livelihood development through integrated farming system	1	1	5	30
	Protection of plant varieties and farmers right act	1	20	-	20
	Field day on intercopping with marigold	1	23	7	30
Kurnool	Method demonstrations on Seed treatment ofjowar&Bengalgram	2	22	-	22
	Agro advisory services	51	3315	408	3723
	Awareness on Production technologies in rain fed crops	1	38	6	44
	Diagnostic visits	4	127	16	143
	Group discussions	4	134	18	152

KVK	Title of the activity	No. of activities	No. of participants		
			Male	Female	Total
Srikakulam	Method demonstrations	5	42	21	63
	Agro advisory services	13	32	11	43
	Diagnostic visits	6	25	10	35
	Group Discussions	2	12	3	15
West Godavari	Method demonstration on testing of dissolved oxygen in ponds	1	18	-	18
	Method demonstration on seed treatment in paddy	1	15	-	15
	Method demonstration on application of bio-fertilizers in paddy	1	22	-	22
	Group discussion on water quality management in fish ponds	1	26	-	26
	Method demonstration on disease diagnosis in prawn ponds	1	20	-	20
	Method demonstration on recording water quality parameters in fish ponds	1	16	-	16
	Method demonstration on identification of stem rot in paddy	1	22	-	22
	Group discussion on bacterial Leaf blight in paddy	1	29	-	29
	Group discussion on stem rot and BPH management in paddy	1	26	-	26
	Method demonstration on tray nursery preparation for mechanical transplanting in paddy	1	30	-	30
Khammam	Integrated farming system	8	98	18	116
	Field days	2	110	38	148
	Method demonstrations	9	125	53	178
	Awarenessprogrammes	10	0	79	79
	Agro advisory services	12	326	46	372

KVK	Title of the activity	No. of activities	No. of participants		
			Male	Female	Total
Nalgonda	Method demonstrations	3	28	7	35
	Agro advisory services	5	43	7	50
	Awareness programmes	3	19	4	23
	Exposure visits	1	18	4	22
	Field days	1	26	3	29
	Group discussions	5	44	8	52
	Diagnostic field visits	7	28	-	28
Namakkal	Agro advisory services	4	30	26	56
	Exposure visit	1	17	19	36
	Method Demonstration (Collection of soil sample)	1	6	23	29
	Method Demonstration (Raised bed nursery raising of small onion var. Co(On) 5	1	23	2	25
	Group discussion	1	6	23	29
	VCRMC Meeting	1	7	2	9
	Method Demonstration (Preparation of silage making)	1	6	4	10
	Method demonstration(Seed bulb treatment in small onion with bio agents)	2	5	12	17
	Farmers day Exposure visit @ TNAU	1	31	19	50
Ramanatha puram	Field days on paddy	2	61	9	70
	Exposure visit of farmers	1	11	37	48
	Method demonstrations on soil sample collection	1	17	9	26
	Method demonstrations on *Azolla* production technology	1	18	7	25
	Animal health camp	1	13	10	23
Thiruvarur	Method demonstrations	2	44	-	44
	Agro advisory services	55	55		55
	Awarenessprogrammes	2	45		45
	Exposure visits	-			
	Field Day	1	40		40
	Group discussions	2	45		45
	Diagnostic visits	4	42	-	42

KVK	Title of the activity	No. of activities	No. of participants		
			Male	Female	Total
Villupuram	Exposure visit-New crop varieties and technologies at Farmers day, TNAU, Coimbatore	1	45	5	50
	Exposure visit- Organic farming and dairy farming	1	35	10	45
	Backyard poultry	1	28	7	35
	Black gram	1	32	4	36
	Groundnut	1	25	4	29
	Silage making	1	35	7	42
	Farm Machinery	1	26	-	26
	Method demonstrations-Hydroponic fodder production	1	1	32	33
	Method demonstrations – Pulse wonder spray	1	28	2	30
	Seed treatment in pulses	1	28	1	29
	Eradication of congress weed	3	63	68	131

Method demonstration (Srikakulam)

Field Visit (West Godavari)

Field Visit (Khammam)

Exposure visit (Ramanathapuram)

Exposure visit (Villupuram)

Awareness Programme (Villupuram)

List of Contributors

S. No.	KVK	PI	Co PI	Address
Andhra Pradesh				
1	Anantapur	Dr. P. Lakshmi Reddy	Dr. V. Siva Jyothi	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	Krishi Vigyan Kendra, PO:Yagantipalli, Via: Banaganapalli, Distt. Kurnool – 518124, Tel: 08515 200340. Email: pendekantikvk@rediffmail.com
4	Srikakulam	Dr. D. Chinnam Naidu	Dr. P. Amara Jyothi	Krishi Vigyan Kendra, Agril. Research Station, Amdalavalsa, Distt. Srikakulam-532185, Tel: 08942286210. E-mail: kvk_adv2006@yahoo.co.in
5	West Godavari	Dr Mallikharjuna Rao	Dr. M. V. Krishnanji	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. K. Ravi 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
Tamil Nadu				
8	Namakkal	Dr. N. Akila	Dr. C. Sharmila Bharathi	Krishi Vigan Kendra, VC & RI Campus, Namakkal District - 637 002, Tel No: 04286 - 266345, 266650. Email: kvk.Namakkal@icar.gov.in
9	Ramanatha puram	Dr. S. Kavitha	Dr. J. Ramkumar	Krishi Vigyan Kendra, Ramanathapuram - 623 503, Tel No **04567 230250,** Email: ramnadkvk@tnau.ac.in
10	Thiruvarur	Dr. R.Baskaran	Dr. R. Ramesh	Krishi Vigyan Kendra, Needamangalam-614404, Thiruvarur, Tamil Nadu. Phone:04367-261444/260666, Email: kvkndm@tnau.ac.in
11	Villupuram	Dr.K. Parameswari	Dr. V. K. Satya	Krishi Vigyan Kendra, Tamil Nadu Agricultural University, Tindivanam – 604 002, Villupuram District, Tamil Nadu. Tel No. 04147-250001, 04147-250002, Email: kvktvm@tnau.ac.in