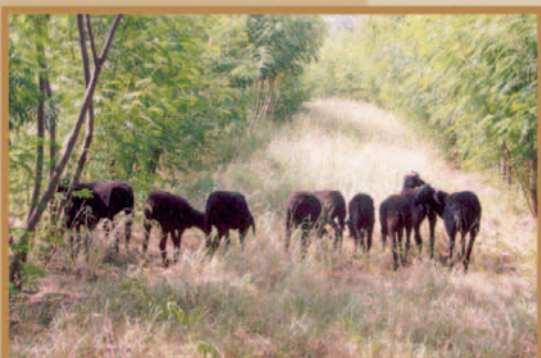




वार्षिक प्रतिवेदन

Annual Report

2003-2004



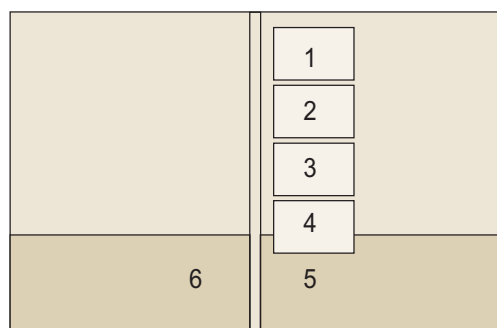
CRIDA



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Cover page



- | | |
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| 1 Percolation pond | 4 Training farmwomen |
| 2 Orchard sprayer | 5 Farm pond |
| 3 Silviculture | 6 Conservation furrow |

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केंद्रीय बारानी कृषि अनुसंधान संस्थान

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Preface

Augmenting the production and productivity of the rainfed regions is the key for assuring livelihood security for millions of poor inhabiting these areas. Sustainability of the gains achieved assumes greater importance in view of the recurrent droughts in these regions. Thus, strategies to overcome the adverse impact of aberrant weather are of utmost relevance. However, augmentation of production in good rainfall years will enable encashing of favourable conditions to regain the lost momentum in the economy due to droughts. An ample testimony to this is the agricultural growth in the year under report (2003-04). The year witnessed a favourable monsoon and registered 9.1% growth compared to the previous year's decline by 5.2% (2002-03). CRIDA has been playing a major role in developing and disseminating technologies to meet the twin objectives of sustaining and augmenting productivity of rainfed regions. The pages that follow in this Report provide insights into our efforts in achieving these objectives.

Research focus for achieving productivity increase and ensuring profitability from the rainfed areas has been on rainwater management - its conservation and utilization on watershed basis; matching crops with land capability; diversification to increase rural incomes; selective mechanization for timeliness and efficiency of agricultural operations; integrated nutrient and pest management; participatory research and evaluation of dryland technologies, and training and technology transfer.

Climatic variability has a profound effect on land use pattern. Models developed at CRIDA predict a substantial increase in the area under groundnut and pigeonpea in four districts of Andhra Pradesh. Agro-climatic studies indicated the probabilities for agricultural drought in major crop growing districts for sorghum and groundnut. Models integrating climate, soil and crop growth have been devised to predict regional level yield of cotton. Simple climatic model using rainfall regime of specific meteorological subdivisions influencing agricultural productivity along with the southern oscillation index has been developed and tested to reasonably predict the national food grain production well in advance.

Analysis of hydrological data revealed the effectiveness of resource conservation technologies at Nalgonda and Prakasam districts. Impact analysis of watershed management practices in 31 watersheds across the country clearly brought out critical indicators for success/failure of watersheds.

Best bio-intensive IPM modules that are economical and eco-friendly have been identified through large-scale on-farm trials in castor. Simple techniques when demonstrated to farmers in castor and pigeonpea could reduce one or more chemical sprays. Best crop combinations in castor and pigeonpea were identified for reduction of pest damage and increased income. A thorough analysis of research on intercropping systems in the rainfed areas in the country has been documented.



Integrated study on biomass production from subabul and gliricidia linked to their nutritive potential and feeding strategy for small ruminants was undertaken. A rural bio-centre was established in Nalgonda for low cost multiplication of teak plants. Research on dryland horticulture and value addition led to study of best management practices for mango cultivation in rainfed tracts, *in situ* grafting and processing of custard apple, deseeding technique in *amla*, colouring and organoleptic properties of roselle, and refinement of essence extraction from curry leaf.

CRIDA designs for farm implements have been licensed to several industries spread across four states in the country. The institute has pioneered and furthered the concept of custom hiring centres in villages for ready and timely access to farm implements at an affordable cost.

Adequate emphasis was placed for training of stakeholders in the mandated area. CRIDA continued to cater to the educational needs of students and researchers. Several scientists and technical staff have been deputed for training as part of the human resource development.

A major effort was initiated to expand and improve the research farm at Hayatnagar. Development of Phase III (40 ha) has been initiated for the first time by taking up large-scale planting of bio-fuel yielding *Pongamia* and *Jatropha* and other tree-borne oilseed species such as *Simarouba* and *Mahua*. Seed production has been the major activity at Gunegal Research Farm for catering to the needs of large number of castor farmers in the region.

Several significant initiatives were made during the year under report. Research backstopping of network projects (AICRP on Agrometeorology and AICRP on Dryland agriculture) is being promoted as a key strategy to strengthen linkages and reinforce the research domain of CRIDA. As a first step towards this goal, a website www.cropweatheroutlook.org was launched during 2003 with the aim of providing wider use of value-added weather information by the planners, researchers and farmers.

Rainfed production system is complex and requires multi-pronged strategy to achieve progress. Our efforts towards overall improvement of the system have begun to show modest results. But there is still a long way to go. I assure all the stakeholders that CRIDA would continue to strive and excel to implement its mandate.

Y.S. Ramakrishna

Director

7 August, 2004

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केंद्रीय बारानी कृषि अनुसंधान संस्थान की स्थापना वर्ष 1985 में हुई। भारतीय कृषि अनुसंधान परिषद के प्राकृतिक संसाधन प्रबंधन प्रभाग के अंतर्गत बारानी कृषि अनुसंधान हेतु यह एक प्रमुख संस्थान है। यह संस्थान अखिल भारतीय समन्वित बारानी कृषि अनुसंधान परियोजना (AICRPDA) एवं अखिल भारतीय समन्वित कृषि मौसमविज्ञान अनुसंधान परियोजना (AICRPAM) के साथ मिलकर वर्षा आधारित क्षेत्रों की उत्पादकता को बढ़ाने में प्रमुख भूमिका निभाता आ रहा है। संस्थान का अनुसंधान मूलभूत एवं व्यावहारिक विषयों पर केंद्रित है जबकि समन्वयन केंद्रों द्वारा अनुसंधान स्थान-विशेष की समस्याओं पर केंद्रित है।

पिछले कुछ वर्षों से संस्थान राष्ट्रीय, अंतर्राष्ट्रीय एवं निचले स्तर के संस्थानों से निकट संबंध स्थापित किए हुए है। संस्थान को समेकित जलग्रहण प्रबंधन, जैव-भौतिक अनुसंधान विकास एवं वर्षा आधारित कृषि पारिस्थितिक क्षेत्रों हेतु बेहतर तथा कम लागत के कृषि उपकरणों के प्रचार-प्रसार के क्षेत्र में विशेष योगदान के लिए यथोचित मान्यता प्रदान की गई है। संस्थान को राष्ट्रीय कृषि प्रौद्योगिकी परियोजना (NATP) की वर्षा आधारित कृषि पारिस्थितिक प्रणाली निदेशालय का मुख्यालय एवं संस्थान की 29 परियोजनाओं सहित 110 लक्ष्योन्मुख परियोजनाओं का कार्यात्मक समन्वयन करने का गौरव भी प्राप्त है।

वर्ष 2003-04 के दौरान, अनुसंधान कार्यों को संसाधन लक्षण, समेकित पोषक प्रबंधन, वर्षा जल प्रबंधन, फसल एवं फसल प्रणालियां, वैकल्पिक भूमि उपयोग प्रणालियां, सामाजिक-आर्थिक मुद्दे, कृषि उपकरणों का विकास एवं प्रौद्योगिकी हस्तांतरण जैसे विषयों तक ही सीमित रखा गया है। विशिष्ट उपलब्धियों का सार निम्नलिखित है:

संसाधन लक्षण

ज्वार एवं अरहर की जल उपयोग क्षमता तथा शुष्क पदार्थ उत्पादन संबंधी आंकड़ों के विश्लेषण हेतु 'सेकेंड आर्डर पोलिनोमियल' अनुकूल पाया गया। इन फसलों

में शुष्क पदार्थ के एकत्रित करने की प्रक्रिया प्रारंभ होने से पहले ही 125 मिलीमीटर से अधिक जल वाष्पोत्सर्जित (evapotranspired) हो गया।

आंध्र प्रदेश में मूंगफली एवं अरहर के अंतर्गत भूमि उपयोग द्वारा जलवायु परिवर्तनशीलता के प्रभाव पर किए गए अध्ययनों से पता चला कि कर्नूल, अनंतपुर, कड़पा एवं महबूबनगर जिलों में इसके प्रभाव से मूंगफली के अंतर्गत क्षेत्र में 38 से 105 प्रतिशत तक की वृद्धि तथा चित्तूर जिले में 22 प्रतिशत की कमी आएगी। कड़पा, निजामाबाद, मेदक एवं नलगोण्डा जिलों में अरहर के अंतर्गत क्षेत्रफल में वृद्धि का अनुमान लगाया गया।

ज्वार की किस्म 'सी.एस.एच.-9' में स्पेक्ट्रल लक्षण के अंतर्गत आने वाले 'नार्मलाइज्ड डिफरेंस वेजिटेशन इंडेक्स' (NDVI) और साधारण अनुपात द्वारा बूटिंग एवं पुष्पण अवस्था में फसल उपज का अनुमान लगाने हेतु महत्वपूर्ण सिद्ध हुई।

जलवायु, मृदा एवं फसल वृद्धि मॉडलों को समेकित कर कपास के क्षेत्रीय स्तर के उत्पादन का अनुमान लगाने के लिए एक मॉडल का विकास किया गया।

आंध्र प्रदेश में पिछले वर्ष के अकाल के कारण कृष्णा एवं गोदावरी क्षेत्रों के अलावा अन्य सभी क्षेत्रों में कृष्य क्षेत्र में कमी आई। दक्षिण तेलंगाना क्षेत्र में यह कमी अत्यधिक थी। प्रदेश के सभी सातों क्षेत्रों में नमी घटने के परिणामस्वरूप उत्पादन में कमी आई।

संस्थान में स्थित कृषि मौसमविज्ञान डेटा बैंक में अब देश के विभिन्न भागों में फैले कृषि पारिस्थितिक खंडों के 120 केंद्रों के आंकड़े उपलब्ध हैं।

आंध्र प्रदेश के दो सूखाग्रस्त जिलों के कृषि जलवायु अध्ययनों से ज्ञात हुआ कि महबूबनगर जिले में ज्वार की खेती के लिए सूखे की संभावना लगभग 10 से 30 प्रतिशत है जबकि अनंतपुर में मूंगफली के लिए यह संभावना लगभग 50-80 प्रतिशत है।

जलवायु विज्ञान के प्राचलों पर आधारित अरहर में फली बेधक, धान में प्रध्वंस (blast) एवं वृक्षग्रण (gall) तथा मूंगफली में चेपा (aphids) के अनुमान के लिए विश्वसनीय जानकारी का विकास किया गया।

अखिल भारतीय समन्वित कृषि मौसमविज्ञान अनुसंधान परियोजना के अंतर्गत कृषि-जलवायु प्राचलों पर आधारित एकत्रित सूचना को प्रदान करने के लिए www.cropweatheroutlook.org नामक वेबसाइट जारी की गई। यह वेबसाइट संस्थान से ही संचालित है एवं योजनाकर्ताओं, अनुसंधानकर्ताओं, कृषक समुदाय इत्यादि के व्यापक उपयोग के लिए इसे भारतीय कृषि अनुसंधान परियोजना की वेबसाइट से भी जोड़ दिया गया है।

समेकित पोषक प्रबंधन

एक लम्बी अवधि के प्रयोग में कुलथी बायोमास को निरंतर जमीन में मिलाने से जैविक कार्बन एवं उपलब्ध नाइट्रोजन, फास्फोरस, सल्फर तथा पोटेशियम के स्तर को बढ़ाने में सहयोग मिला। जिससे ज्वार की किस्म 'एस.पी.वी. 462' और सूरजमुखी की किस्म 'मॉरडेन' के उत्पादन में वृद्धि पाई गई।

पंचवर्षीय समेकित पोषण प्रबंधन अध्ययनों से ज्ञात हुआ कि पारंपरिक कर्षण उपरांत 2 टन ग्लैरीसीडिया + 20 कि.ग्रा. नाइट्रोजन अथवा 4 टन कम्पोस्ट + 20 कि.ग्रा. नाइट्रोजन उपयोग करने से ज्वार की किस्म 'सी.एस.एच. 9' के उत्पादन में 80 प्रतिशत की वृद्धि प्राप्त हुई। मूंग के उत्पादन में 2 टन कम्पोस्ट + 1 टन ग्लैरीसीडिया अथवा 2 टन कम्पोस्ट + 10 कि.ग्रा. नाइट्रोजन के प्रयोग से 50 प्रतिशत की वृद्धि हुई। अतः यह अध्ययन दर्शाते हैं कि आने वाले समय में समेकित पोषक प्रबंधन एवं कर्षण प्रक्रियाओं के कमी करने से खेती में टिकाऊपन आएगा तथा मृदा में जैव पदार्थ, पोषक स्तर और जैविक सक्रियता के निर्माण को बढ़ावा मिलेगा।

टीक एवं सुबबूल के इर्द गिर्द लघू क्षेत्रों (माइक्रो साइट) में फ्लाई ऐश मिलाने से जैविक कार्बन में वृद्धि एवं पी.एच. तथा मृदा के घुलनशील लवण की मात्रा में कमी आई। फ्लाई ऐश के उपचार से पौधों के तनों में महत्वपूर्ण वृद्धि देखी हुई।

वर्षाजल प्रबंधन

प्रकाशम जिले के वर्षा आधारित क्षेत्रों में जलग्रहण आधारित समेकित संसाधन प्रबंधन हेतु युक्तियों के लिए ग्लैरीसीडिया की वानस्पतिक मेंड प्रणाली एवं मूंग, लोबिया तथा सनई की खेता से भूमि संरक्षी सस्यन

के सफल विकल्पों को प्रारंभ किया गया। इन प्रक्रियाओं के फलस्वरूप तंबाकू की गुणवत्ता व उत्पादन में सुधार पाया गया।

नलगोण्डा जिले के एस.एस. पल्ली जलग्रहण में जल इकाई आंकड़ों के विश्लेषणों से ज्ञात हुआ कि संरक्षण के प्रभावी उपायों जैसे मिट्टी के मिहीरोक बांधों, गबियन बूंदों, खुले पथरों द्वारा निर्मित संरचनाएँ, रेत बैग बांधों, अंतःस्खण गड्ढों एवं घुमावदार नालियों से संसाधन हानि में कमी आई। उपचारित टीलों में जल अपवाह को 90 प्रतिशत तक कम करने हेतु घुमावदार नालियों में अनुक्रम बद्ध अवसाद भंडारण उपयोगी सिद्ध हुए।

देश के 31 जलग्रहणों में जलग्रहण प्रबंधन प्रक्रियाओं के प्रभाव विश्लेषणों से ज्ञात हुआ कि जलग्रहण सफलता का आधार वर्षा जल संग्रहण, समुचित वनस्पति, अच्छा प्रशिक्षण, क्षमता निर्माण एवं कार्य योजना तथा इसके निष्पादन में भागीदारी का विकास करना है। जलग्रहण कार्यक्रमों की विफलताओं का प्रमुख कारण सी.पी.आर. का कुप्रबंधन, गुणवत्ताहीन कार्य, निष्पादनों में भागीदारी न होना एवं स्थान की अगम्यता पाए गये।

वर्षा जल प्रबंधन हेतु हैदराबाद एवं जबलपुर में कूंड बनाना, शोलापुर में बायोमास को जमीन में मिलाना एवं गुडाई और बीजापुर में बायोमास को जमीन में मिलाना तथा खंड मेढ़ बनाना उपयुक्त पाए गए।

फसल एवं फसल प्रणालियां

मूंग किस्म 'एम.एल. 267' एवं 'डब्ल्यू. जी.जी. 37' में पुष्पण तथा फली भरने के समय नमी उपलब्धता घटने के कारण पर्णजल क्षमता, परासरणी क्षमता, आपेक्षिक जल मात्रा, शुष्क पदार्थ संचयन एवं बीज उत्पादन में कमी देखी गई। पुष्पण तथा फली भरने के समय नमी की कमी के कारण फलियों की संख्या घटने के परिणामस्वरूप उत्पादन में भी कमी देखी गई।

समेकित अरंडी अर्धकुंडलक प्रबंधन अध्ययन दर्शाते हैं कि बी.टी. (Bt) (0.2%) एवं क्वीनालफास (0.05%) का अनुक्रमिक छिड़काव अत्याधिक प्रभावी था। तथा जब अर्धकुंडलकों की संख्या प्रति 10 पौधों के लिए 8 हों तो बुआई के क्रमशः 25, 30 एवं 60 दिनों के बाद नाशीजीव नियंत्रण उपाय प्रारंभ करने की सिफारिश की गई है।

अरहर एवं अरंडी आधारित अंतरा सस्यन प्रणालियों में समेकित नाशीजीव प्रबंधन के अवयवों को आधार मानकर सस्य एवं सस्य विविधता के अध्ययनों से पता चला कि एकल तथा अन्य अंतरफसलों की तुलना में अरंडी + ग्वार और अरहर + ज्वार में नाशीजीवों की आश्रय संख्या कम होती है।

समेकित नाशीजीव प्रबंधन मॉड्यूल-5 (नीम तेल का प्रोफेलाइटिक छिड़काव + 2 ग्रेनूलोसिस छिड़काव + बी.टी. या कीटनाशी की आधी मात्रा) को अरंडी अर्धकुंडलों के प्रबंधन के लिए सर्वश्रेष्ठ पाया गया। अरंडी नाशीजीव स्पोडोप्टेरा की रोकथाम हेतु इसका यांत्रिक संग्रहण कर तथा संक्रमित पत्तियों का विनाशकर आसानी से कम से कम एक कीटनाशी का छिड़काव बचाया जा सकता है।

यांत्रिक संग्रहण द्वारा अरंडी नाशीजीव स्पोडोप्टेरा को एकत्रित करना परांत उस पर कीटनाशी का छिड़काव कर एवं संदुषित करते हुए इसे बड़ी आसानी के साथ नियंत्रित किया जा सकता है। इस तकनीक का प्रदर्शन पांच गांवों में किया गया जहां अरंडी की फसल का विस्तार 100 हैक्टेयर था।

बढ़ी हुई कार्बन डाई आक्साइड के स्तर से ज्वार, अरंडी एवं उड़द के बीजों के अंकुरण दर में, विशेषकर अंकुरण के आरंभिक स्तरों में, वृद्धि पाई गई। उच्च कार्बन डाई आक्साइड स्तर ने तीनों फसलों में अंकुरण के दौरान जल का अंतःशोषण बढ़ाने में सहायता थी।

जैव तकनीकी द्वारा ज्वार को और अधिक अकाल सहिष्णु बनाने के लिए मैनिटाल के संग्रहण हेतु 'एमटीएल डी जीन' अंतर्जनित पौधों को विकसित करने की दिशा में प्रयास अग्रसर है। बायोलिस्टिक रूपांतरण के लिये Gene Pro 2000 He Gun के प्रयोग हेतु मानक तय कर लिए गए हैं। रूपांतरण के लिए 'एमटीएल डी जीन' को pCambia 1305.1 वेक्टर में निर्मित कर उपयोग उपरांत रूपांतरित कलियों का हाइग्रोमाइसिन माध्यम पर चयन किया गया। ग्यारह तथाकल्पित अंतर्जनित पौधों को npt II एवं hpt प्राइमरस् का उपयोग कर पी.सी.आर. धनात्मक पाया गया।

वर्षा आधारित क्षेत्रों के अंतर्गत अंतरा-सस्यन प्रणालियों हेतु विकास एजेन्सियों, विस्तार नेटवर्क और किसानों के लिए अनुसंधान अंतरालों, अनुसंधान के

मुद्दों एवं सिफारिशों की पहचान की गई। किसानों द्वारा फसलों के चयन के लिए उपयुक्त उपकरणों की कमी के साथ ही साथ किसानों की घरेलु आवश्यकताएं जिम्मेदार पाई गई। अंतरा सस्यन प्रणालियों पर पिछले तीन दशकों के दौरान किए गए अनुसंधान कार्यों के आलोचनात्मक विश्लेषणों पर एक पुस्तक का प्रकाशन भी किया गया।

वैकल्पिक भूमि उपयोग प्रणालियां

दस वर्ष के आम के पौधों में बारानी अवस्था की उपज 18.4 कि.ग्रा. प्रति पेड़ की तुलना में ट्रिप इरिगेशन 0.75, 0.5 तथा 0.25 ई.पी. देने से उत्पादन में क्रमशः 86,85 तथा 136 प्रतिशत की वृद्धि हुई। शत प्रतिशत नाईट्रोजन, फास्फोरस व पोटाशियम + 75 कि.ग्रा. गोबर की खाद का उपयोग करने से प्रति पेड़ 55 कि.ग्रा. तक अधिक फल उपज दर्ज की गई।

अन्य किस्मों की तुलना में सीताफल संकर किस्म 'अर्कासहन' को जब 'बालानगर किस्म' पर ग्राफ्ट विधि द्वारा स्थापित किया गया तो पौधे में अच्छी वृद्धि पाई गई। सीताफल का गूदा निकालने के लिए एक साधारण हस्त तकनीक का विकास किया गया।

आँवला से उसके गूदा एवं बीज को अलग करने हेतु प्रेशर कुकर में उबालकर गूदा निकालने की एक साधारण तकनीक का विकास किया गया। इस गूदे को आँवला की चटनी एवं मुरब्बा बनाने में उपयोग किया जा सकता है, जिनमें ग्रहण करने योग्य इन्द्रियग्राही गुण होते हैं।

केलिस ऑफ रॉसेल्ले (हाईबिसकस सबदरीफा) एक अकाल सहिष्णु सख्त वनस्पति है, जिसे फलोत्पादों को रंगदार बनाने के काम में लाया जा सकता है। उदाहरण के लिए अमरुद की जैली जिसका कोई आकर्षक रंग नहीं होता, अमरुद-रॉसेल्ले (85:15) में अच्छे इन्द्रियग्राही गुण देखे गए। रॉसेल्ले से रंग, अम्ल एवं पेक्टिन निकालने के बाद बनाई गई चटनी को भी लोग पसंद कर रहे हैं।

करी पत्ता अरक को बेहतर ढंग से निकालने के लिए एक संशोधित डिस्टिलेशन इकाई बनाई गई। 'स्थानीय' एवं 'सुवासिनी' किस्मों की तुलना में 'भुवनेश्वरी' किस्म कुल अरक की मात्रा में बेहतर पाई गई।

प्राकृतिक चरागाह पर चरने वाले भेड़ों की उत्पादकता को सुधारने के लिए अतिरिक्त खाद्य के रूप में सुबबूल पेड़ के पत्तों या ग्लैरीसीडिया या चारा शिंब स्टाइलो का अच्छा उपयोग किया जा सकता है। अन्य अध्ययनों द्वारा सिद्ध हुआ कि ज्वार की कड़बी के अलावा पेड़ के पत्तों को भी अतिरिक्त चारे के रूप में देकर भेड़ की वृद्धि को बेहतर बनाया जा सकता है।

तिलहन उत्पादन करने वाले पेड़ पोनगामिया पिन्नाटा के कुल 6500 पौधों को आंध्र प्रदेश राज्य के करीमनगर, नलगोण्डा जिलों और संस्थान के हयातनगर अनुसंधान फार्म में लगाया गया है। इसके अलावा जट्रोफा के 1200, सिमोरुबा के 300 एवं बसिया के 80 पौधों को भी हयातनगर अनुसंधान फार्म में लगाया गया है।

महबूबनगर एवं रंगारेड्डी जिलों में आम पर आधारित कृषि बागवानी - पशुचारा प्रणालियों पर विस्तीर्ण फार्म पर जारी प्रयोगों के परिणामों से पता चला कि मृदा एवं जल संरक्षण उपाय, पोषक तत्वों हेतु सिफारिश की गई मात्रा का प्रयोग, ज्वार, लोबिया, कुलथी एवं चारा शिंबों; जैसे - स्टाइलो, सेनकरस फसलों के उगाने के साथ पशु घटक इत्यादि का समावेश काफी उपयुक्त एवं लाभकारी है। इन जिलों में किए गए सर्वेक्षणों से पता चला कि बहुत सारे किसान मोटे अनाज की खेती को छोड़कर कृषि बागवानी प्रणाली की ओर आकर्षित हुए हैं।

नलगोण्डा एवं महबूबनगर जिलों में बेहतर तथा उच्च मूल्य के पेड़ की प्रजातियों के माध्यम से बारानी कृषि को मजबूती प्रदान करने वाले पैकेज के रूप में पांच बेहतर इमली वंशावलियों और दो उच्च उत्पादक चोब (drumstick) किस्मों की पहचान की गई।

कृषि यंत्र

संस्थान के साथ सात औद्योगिक प्रतिष्ठानों (महाराष्ट्र में तीन, आंध्र प्रदेश में दो एवं मध्य प्रदेश तथा राजस्थान में एक-एक) ने समझौता-पत्रों (MOU) पर हस्ताक्षर किए एवं उत्पादन तथा विक्रय के लिए संस्थान के विभिन्न उपकरणों के 11 ढाँचों को अपनाया। गुणवत्ता नियंत्रण एवं प्रौद्योगिकी की मानकता बनाए रखने के लाइसेंसधारी औद्योगिक प्रतिष्ठानों को परामर्श सेवाएं प्रदान की गईं।

महबूबनगर जिले के कल्लुकुर्ती गाँव में कस्टम हाइरिंग केंद्र का उद्घाटन किया गया, जिससे 350 हैक्टेयर क्षेत्र के 100 किसानों को लाभ हुआ। इस केंद्र की सफलता ने ग्रामीण समूहों में उद्यम की आर्थिक व्यवहार्यता का प्रदर्शन किया।

ग्रामीण क्षेत्रों में आमदनी एवं रोजगार को बढ़ावा देने के लिए पॉलिशर तथा अन्य अवयवों सहित उड़द हेतु कम क्षमता (150-200 कि.ग्रा. प्रति घंटा) वाली दाल चक्की का विकास किया गया।

सामाजिक-आर्थिक अध्ययन

आंध्र प्रदेश में जलग्रहण क्षेत्र विकास कार्यक्रम के कार्यान्वयन के पहले लगभग पूरी भागीदारी के लिए स्थानीय संस्थाओं की जानकारी एवं सामर्थ्य निर्माण की आवश्यकता को महसूस किया गया।

कृषक समुदाय को व्यापक आर्थिक लाभ दिलाने के दृष्टिकोण से गुणवत्तावाले अरंडी के बीजों को तैयार करने एवं वितरण पर संस्थान द्वारा किए गए खर्च को उचित माना गया। हालाँकि यह सुझाव दिया गया कि कम से कम आधार मूल्य की वसूली के लिए बीजों को उचित कीमत पर बेचा जाए।

आंध्र प्रदेश एवं उड़ीसा की खेतिहर महिलाओं पर किए गए अध्ययनों से पता चला कि कृषि में महिलाओं की बहुत सक्रिय भागीदारी है, विशेषकर फसलोत्पादन प्रौद्योगिकियों की जानकारी से युक्त महिलाओं की। उड़ीसा में मजदूरी में असमानता 20 प्रतिशत है लेकिन आंध्र प्रदेश में पुरुषों की दी जाने वाली मजदूरी की तुलना में महिलाओं की मजदूरी शोचनीय है। खेती से जुड़ी गतिविधियों पर निर्णय पुरुष एवं महिलाओं द्वारा संयुक्त रूप में लिया जाता है।

प्रौद्योगिकी हस्तांतरण/प्रशिक्षण

समेकित जलग्रहण प्रबंधन, चारा उत्पादन एवं उपयोग तथा सूचना प्रौद्योगिकी और कृषि विस्तार पर वैज्ञानिकों एवं कृषि अधिकारियों हेतु बारानी कृषि पर प्रशिक्षण के लिए 'सेंटर ऑफ एक्सिलेंस' ने तीन प्रशिक्षण पाठ्यक्रम आयोजित किए।

कृषि सीमांत एवं निम्नकृत भूमियों, बेहतर उपकरणों, समेकित पोषक प्रबंधन, समेकित नाशीजीव प्रबंधन, वर्षा

आधारित कृषि भूमियों का सुधार, समेकित जलग्रहण प्रबंधन तथा जलग्रहण विकास में समेकित पशुधन पर प्रशिक्षण पाठ्यक्रमों का आयोजन किया गया। यह पाठ्यक्रम वैज्ञानिकों, कृषि/पशुचिकित्सकों एवं सामुदायिक पर्यवेक्षकों/आयोजकों के लिए बहुत लाभकारी था।

कृषि विज्ञान केंद्र द्वारा खेतिहर किसानों, खेतिहर महिलाओं, ग्रामीण युवकों एवं कृषि स्तरीय विस्तार कार्यकर्ताओं के लाभ के लिए बारानी कृषि के विभिन्न पहलुओं पर कैंपस में एवं कैंपस के बाहर आवश्यकता आधारित एवं कौशलोन्मुख प्रशिक्षण कार्यक्रमों का आयोजन किया गया।

नलगोण्डा जिले के गड्डीपल्ली गांव में उत्तक संवर्धन द्वारा तैयार बेहतर रोपण सामग्री के व्यापक विस्तार के लिए एक जैव केंद्र की स्थापना की गई। यह एक विशेष जैव केंद्र है जिसमें उत्तक संवर्धित मातृ फलोद्यान, एक छायादार नेट, रसायनों एवं जल की नियमित आपूर्ति तथा मूलन ट्रे/माध्यम उपलब्ध है। इस केन्द्र को ग्रामीण युवक तथा लघु किसान चला सकते हैं।

शिक्षा

संस्थान में हैदराबाद, धारवाड एवं रायपुर में स्थित विश्वविद्यालयों के आठ विद्यार्थी स्नातकोत्तर डिग्री के लिए अनुसंधान कार्य कर रहे हैं जिनका मार्गदर्शन संस्थान के वैज्ञानिकों द्वारा किया जा रहा है। संस्थान के पांच वैज्ञानिक आचार्य एन.जी.रंगा कृषि विश्वविद्यालय एवं जवाहरलाल नेहरू प्रौद्योगिकी विश्वविद्यालय में उच्च शिक्षा प्राप्त कर रहे हैं। गत वर्ष संस्थान के दो वैज्ञानिकों ने मृदा एवं जल संसाधन विषयों में पी.एच.डी. की उपाधि ग्रहण की।

संस्थान में पी.जी. कॉलेज ऑफ साइन्स, उस्मानिया विश्वविद्यालय के सहयोग से संयुक्त रूप से चलाए जा रहे बारानी कृषि विषय पर तीन वर्षीय व्यावसायिक स्नातक कार्यक्रम ने सफलतापूर्वक तृतीय वर्ष पूरा कर लिया। इस समय तृतीय वर्ष के 12 और द्वितीय वर्ष के 18 विद्यार्थी अध्ययनरत हैं।

पुरस्कार एवं मान्यताएं

दक्षिण भारत में स्थित भारतीय कृषि अनुसंधान परिषद के संस्थानों में भारत सरकार की राजभाषा

नीति के सर्वश्रेष्ठ कार्यान्वयन के लिए भारतीय कृषि अनुसंधान परिषद, नई दिल्ली द्वारा वर्ष 2002-03 के लिए संस्थान को 'राजऋषि टंडन शील्ड' पुरस्कार स्वरूप प्रदान की गई।

डॉ. वाई.एस. रामकृष्णा, निदेशक को कृषि मौसम-विज्ञान में विशेष योगदान प्रदान करने के उपलक्ष्य में श्री सोमपाल, सदस्य, योजना आयोग द्वारा पुरस्कृत किया गया।

डॉ. वाई.एस. रामकृष्णा को ए.बी.आई. - इक्रीसेट के बोर्ड ऑफ गवर्नर्स का सदस्य नियुक्त किया गया।

डॉ. वाई.एस. रामकृष्णा को इक्रीसेट के अर्ध-शुष्क क्षेत्रों के लिए कल्पित अकादमी की विषय निर्वाचन समिति का सदस्य नियुक्त किया गया। अकादमी सूखा प्रबंधन पर कार्यरत है तथा संस्थान इसमें भागीदार है।

डॉ. के. श्रीनिवास, वैज्ञानिक (वरिष्ठ वेतनमान) को "गुणवत्ता को हस्तकौशल द्वारा पादप अवशेषों से नियामक खनिजीकरण" नामक विषय पर प्रस्तुत पी.एच.डी. शोधपत्र के लिए 'स्वर्ण पदक' प्रदान किया गया। इन्हें भारतीय मृदा विज्ञान सोसाइटी द्वारा श्रेष्ठ डॉक्टरल अनुसंधान प्रस्तुति पुरस्कार से भी सम्मानित किया गया।

डॉ. मोहम्मद उस्मान को सेंटर फॉर पीपुल्स फारेस्ट्री, हैदराबाद द्वारा पर्यावरणीय संबंधों (कृषि-वानिकी एवं जैव विविधता) से जुड़ी सलाहकार समिति का सदस्य नियुक्त किया गया।

डॉ. सी.एच. श्रीनिवास राव का भारतीय दलहन अनुसंधान एवं विकास सोसाइटी, कानपुर द्वारा 'फेलो' चयनित किया गया।

संपर्क

संस्थान राष्ट्रीय एवं अंतर्राष्ट्रीय संगठनों जैसे ए.सी.आई.ए.आर., डी.एफ.आई.डी, इक्रीसेट, आई.पी.ई., विभिन्न राज्य कृषि विश्वविद्यालयों, भारतीय कृषि अनुसंधान परिषद के विभिन्न संस्थानों एवं गैर-सरकारी संगठनों से अपना निकट संबंध जारी रखे हुए है।

Executive Summary

The Central Research Institute for Dryland Agriculture (CRIDA), established in 1985 is a premier institute under the Natural Resource Management division of ICAR. The Institute with its agglomerates - All India Coordinated Research Project on Dryland Agriculture (AICRPDA) and All India Coordinated Research Project on Agrometeorology (AICRPAM) - has been playing a vital role in augmenting the productivity of rainfed regions. The focus of research by CRIDA is on basic and strategic areas while that of Coordinating centres is on location specific problems.

Over the years, the Institute has established close linkages with national, international and grass root level institutions. CRIDA has been duly recognized through its contributions particularly in the field of biophysical research for integrated watershed management, development and spread of efficient and cost-effective farm implements for the rainfed agro-ecoregions. The Institute has the distinction of being the headquarters for the Rainfed Agro-ecosystem Directorate of NATP and coordinates the functioning of 110 target oriented projects, of which 18 are based at the Institute itself.

During the year 2003-04, research was pursued in the areas of resource characterization, integrated nutrient management, rainwater management, crop and cropping systems, alternate land use systems, socioeconomic issues, development of farm machinery, transfer of technology and the like. Significant achievements are summarized below:

Resource characterization

A second order polynomial was found to fit the data on water use efficiency and dry matter production of sorghum and pigeonpea. Over 125 mm water evapotranspired before accumulation of dry matter in these crops.

Study on influence of climate variability on land use under groundnut and pigeonpea in A.P. predicted 38 to 105% increase under groundnut in Kurnool, Anantapur, Kadapa and Mahabubnagar, and 22% decrease in Chittoor districts. Area under Pigeonpea was estimated to increase in Kadapa, Nizamabad, Medak and Nalgonda.

The spectral characteristics - Normalised Difference Vegetation Index (NDVI) and Simple Ratio - of sorghum cv CSH 9 between booting and flowering were found effective in estimating the yield of the crop.

A model was developed to predict the regional level production of cotton by integrating climate, soil, and crop growth models.

The impact of last year's drought in A.P. showed marked decrease in cultivated area in all the zones excepting Krishna - Godavari. The reduction was highest in South Telangana Zone. Moisture stress resulted in decline of yield in all the seven zones.

The Agromet Data Bank located at CRIDA has now databases of 120 stations spread across the agro-ecoregions of the country.

Agro climatic studies on two drought prone districts of A.P. indicated that the probabilities of agricultural drought for sorghum in Mahabubnagar district is about 10 to 30% while it is about 50-80% for groundnut in Anantapur.

Based on climatological parameters, thumb rules for prediction of pod borer in pigeonpea, blast and gall midge in rice, and aphids in groundnut were developed.

A website www.cropweatheroutlook.org was launched to provide information generated on agroclimatic parameters under AICRPAM. The website is operating from CRIDA, Hyderabad and is linked

to ICAR website for wider use by the planners, researchers, farming community and the like.

Integrated nutrient management

Horsegram biomass incorporation led to build up of organic carbon, and available N, P, S and K which in turn contributed to higher yield of sorghum cv SPV 462 and sunflower cv Morden.

A five year INM study indicated that conventional tillage followed by application of 2t gliricidia + 20 kg N or 4t compost + 20 kg N increased sorghum cv CHS 9 yield by 80% over control. For greengram, application of 2t compost + 1t gliricidia or 2t compost + 10 kg N led to 50% yield increase. The study thus showed that INM and reduced tillage practices over time would be sustainable and lead to build up of organic matter, plant nutrient status and biological activity in the soil.

Incorporation of flyash in the micro site of teak and subabul led to increase in organic carbon and decrease in soluble salt content of the soil. The flyash in combination with compost led to significant increase in the girth of the plants.

Rainwater management

Live bed system with gliricidia and cover cropping with greengram, cowpea and sunhemp were the successful options introduced for watershed-based NRM strategies for rainfed areas of Prakasam district. These practices resulted in better yield and quality of tobacco.

The analysis of hydrological data indicated the effectiveness of conservation measures like earthen check dams, gabion drops, loose boulder structures, sand bag checks, recharge pits and diversion channels in reducing resource losses in SS pally watershed of Nalgonda district. The treated hillocks having a series of depression storages in the diversion channel bed could reduce runoff by 90% compared to untreated ones.

Impact analysis of watershed management practices in 31 watersheds in the country indicated that the success of a watershed depended upon rainwater harvesting, proper vegetation, good training and capacity building, and participatory development of action plan and its execution. Failures of watershed programmes were largely due to mismanagement of CPRs, poor quality of work, non participatory executions, and inaccessibility of the site.

Conservation furrows at Hyderabad and Jabalpur, biomass incorporation + hoeing at Sholapur, biomass incorporation and compartmental bunding at Bijapur were found good practices for moisture conservation and rainwater management.

Crops and cropping systems

Moisture stress imposed at flowering and pod filling stages decreased leaf water potential, osmotic potential, relative water content, dry matter accumulation and seed yield in greengram cvs ML 267 and WGG 37. Yield reduction was more due to reduction in pod number when stress was imposed at flowering, and due to seed filling when imposed at pod filling.

Studies on integrated castor semilooper management indicated sequential spray of Bt (0.2%) and Quinalphos (0.05%) to be most effective. The initiation of pest control measure is recommended when the semilooper population per 10 plants is more than 8 and 25 at 30 and 60 days after sowing, respectively.

Crop-crop diversity studies as a key component of IPM in pigeonpea and castor-based intercropping systems showed castor + clusterbean and pigeonpea + sorghum to harbour lower population of insect pests than sole and other intercrops.

IPM Module 5 (prophylactic spray of neem oil + 2 granulosis sprays + half dose of Bt or insecticide) was found best for management of castor semi looper, followed closely by IPM Module 2

(*Trichogramma* release + 1 spray of Bt + 1 spray of granulosus virus).

One spray of insecticide could easily be saved for the control of castor pest *Spodoptera* by mechanical collection and destruction of infested leaves. This technique was demonstrated in five villages covering 100 ac of castor crop.

Elevated CO₂ levels enhanced the rate of germination of seeds of sorghum, castor and blackgram, especially at the initial stages of germination. Higher CO₂ levels also led to more imbibition of water during germination in all the three crops studied.

In order to improve sorghum for drought tolerance by biotechnological means, attempts are being made to develop transgenics with *mltD* gene for accumulation of mannitol. To this end, conditions were standardized for biolistic transformation. The transformed calli were selected on hygromycin. Eleven of the putative transgenic plantlets were found PCR positive using nptII and hpt primers.

Research gaps, researchable issues, and recommendations for development agencies, extension network and farmers on intercropping systems under rainfed regions were identified. Domestic needs of the farmer followed by lack of suitable implements were the criteria for selection of crops by the farmers. A critical review of the research work done during the past three decades on intercropping systems was published.

Alternate land use systems

Drip irrigation at 0.75, 0.5 and 0.25 Ep to 10 year old mango trees led to 86,85 and 136% increase in yield over no irrigation (18.4 kg tree⁻¹). 100%NPK + 75 kg FYM tree⁻¹ led to a maximum fruit yield of 55 kg tree⁻¹.

The custard apple hybrid Arka Sahan when *in situ* grafted on cv Balanagar showed better scion growth than other varieties.

A simple technique was developed for manual extraction of custard apple pulp by rotatory motion of a round hair comb in a stainless steel sieve containing the raw material.

A simple technique was developed for deseeding and separation of *amla* segments by steaming the fruit. These segments were used for preparation of *amla* pickle and *murabba* which had acceptable organoleptic properties.

Calyces of Roselle (*Hibiscus sabdariffa*), a drought tolerant hardy vegetable, could be a good source of colouring fruit products which do not have attractive colour, for example guava jelly. Guava-roselle (85:15) possessed good organoleptic properties. Roselle sauce made from the left over after extraction of colour, acids and pectin was also found very acceptable.

A modified Clevenger's distillation unit was fabricated for better extraction of curry leaf essence. Cultivar Bhuvaneshwari was found superior for total essence than cultivars Local and Suwasini.

Tree foliage from subabul or gliricidia, or forage legume stylo could be a good feed supplement to improve the productivity of sheep grazed on natural pasture. Another study suggested that the tree foliage could also be used as a supplement to sorghum stover for improving the feed intake and growth of sheep.

Oil seed bearing tree *Pongamia pinnata* seedlings, 6500 in all, were planted in HRF and in Karimnagar and Nalgonda districts of A.P. In addition, 1200 seedlings of *Jatropha*, 300 of *Simarouba* and 80 of *Bassia* were raised in HRF.

Results from extensive on-farm experimentation on mango-based agri-horti-pastoral systems in Mahabubnagar and R.R. Districts showed that soil and water conservation measures, application of recommended doses of nutrients, growing intercrops, like sorghum, cowpea, horsegram, and forage legumes like stylo and grass cenchrus, and inclusion

of animal component were found highly suitable and remunerative. A survey conducted in these districts indicated a substantial shift from coarse cereals to agri-horticultural systems.

Five superior tamarind lines and two high yielding drumstick cultivars were introduced in Nalgonda and Mahabubnagar districts as a package to strengthen the dryland agriculture programme with efficient and high value tree species.

Farm machinery

Seven industries (three in Maharashtra, two in A.P. and one each in M.P. and Rajasthan) signed MoUs with CRIDA and adopted 11 designs of different CRIDA implements for production and sale. Consultancy services were provided to licenced industries for quality control and standardization of production technology.

Custom hiring centre was opened at Kalwakurthy village in Mahabubnagar district which benefited 100 farmers holding an area of 350 ha. The success of this center demonstrated the economic feasibility of the enterprise in rural clusters.

A low capacity (150-200 kg h⁻¹) *dal* mill for blackgram was developed with polisher and other components to enhance generation of income and employment in rural areas.

Socio-economic studies

Awareness and capacity building of local institutions prior to implementation of watershed area development programmes in A.P., was felt necessary to bring about complete participation.

The investment incurred by CRIDA in multiplying and distributing quality castor seed was justified from the point of view of wider economic benefit to the farming community.

Studies on women in agriculture in A.P. and Orissa indicated very active participation of women, particularly by those who were exposed to crop production technologies. The disparity in wages

was 20% in Orissa, but women in A.P. were paid deplorably lower than the amount paid to males. Decisions on farm activities were taken by men and women jointly.

Transfer of technology / training

The Centre of Excellence for Training on DLA conducted three training courses for scientists and agricultural officers on Integrated Watershed Management, Fodder Production and Utilization, and Information Technology and Agricultural Extension.

The Trainers' Training Center organized six training courses on Development of marginal and degraded lands, Improved implements, INM, IPM, Improvement of rainfed lands, Integrated Watershed Management, and Integration of livestock in watershed development. These courses benefited scientists, agricultural/ veterinary officers and community supervisors / organizers.

The Krishi Vigyan Kendra organized 85 on - and off - campus, need - based and skill oriented training programmes on various aspects of dryland agriculture to benefit practicing farmers, farm women, rural youth and field level extension functionaries.

In order to achieve wider diffusion of improved planting material generated through tissue culture, a rural bio center was set up in Gaddipally village Nalgonda district for low cost multiplication of teak plants. A typical bio center consists of a tissue cultured mother orchard, a shade net, rooting trays/media, with regular supply of chemicals and water. It can be operated by small farmers/rural youth.

Education

Eight students from universities located in Hyderabad, Dharwad and Raipur were engaged in research leading to post-graduate degrees, and are being guided by the institute scientists. Five

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scientists of the institute are pursuing higher studies at ANGRAU and JNTU, Hyderabad. Two scientists received their Ph.Ds in Soil Science and Water Resources.

The 3-year vocational bachelor's degree programme on Dryland Agriculture jointly offered in collaboration with the P.G.College of Science, Saifabad, Osmania University has successfully completed its third year. At present 12 students in the third, and 18 in the second are on rolls.

Awards and recognition

CRIDA was awarded "Rajrishi Tandan Rajbhasha Puraskar" for the year 2002-03 by the Indian Council of Agricultural Research (ICAR), New Delhi for the best implementation of the Official Language policy of the Govt. of India amongst the ICAR Institute's situated in Southern Region.

Dr. Y.S.Ramakrishna, Director was awarded by Shri Sompal, Member, Planning Commission for outstanding contribution on Agricultural Meteorology.

Dr. Y.S.Ramakrishna was appointed as a Member on the Board of Governors of Agri-business Incubator, ICRISAT.

Dr. Y.S.Ramakrishna has been appointed as a Member on the Steering Committee of the programme on Virtual Academy for Semi-Arid Tropics of ICRISAT which is working on drought management in which CRIDA is a partner.

Dr. K.Srinivas, Scientist (Sr. Scale) was awarded gold medal for his Ph.D. thesis on "Regulating Mineralization from Plant Residue by Manipulation of Quality". He was also conferred with the Best Doctoral Research Presentation Award - 2003 by the Indian Society of Soil Science, New Delhi.

Dr. Md. Osman was appointed as a Member of Advisory Committee of "Ecological Concerns" (Agroforestry and Bio-diversity), Centre For People's Forestry, Hyderabad.

Dr. Ch. Srinivasa Rao was admitted as a Fellow of the Indian Society of Pulse Research and Development, Kanpur.

Linkages

The Institute continued its close collaboration with national and international organizations like ACIAR, DFID, ICRISAT, IPE and several SAUs, ICAR Institutes and NGOs.

1 Introduction

1.1 Historical perspective

Indian agriculture is predominantly dependent on rainfall and over 65% of the cultivated area is under dryland farming in the country. Though dryland farming in India has been practiced since time immemorial, systematic attempts to augment production in dryland / rainfed areas started in 1923 with the establishment of the first Dryfarming Research Center in 1923 at Manjri, near Pune. Subsequently the same was upgraded as Dryland Research Scheme with the addition of five more research centers at Raichur, Bellary, Hagari, Rohtak and Solapur. Unfortunately, after this scheme was terminated in 1943, dryland agriculture in India did not get the deserved attention. Green Revolution, although helped the country tide over the crisis, widened the gap between irrigated and rainfed areas. In order to address this, Indian Council of Agriculture Research (ICAR) launched in 1970 the All India Coordinated Research Project for Dryland Agriculture (AICRPDA) for addressing the production problems of rainfed areas. The project emphasized on location specificity and interdisciplinary approach for problem identification and analysis. The focus was to increase productivity in rainfed areas by developing suitable soil, water and crop management strategies. Further, research on rainfed agriculture was strengthened by the establishment in 1983 of All India Coordinated Research Project on Agrometeorology (AICRPAM) for providing much needed agroclimatic input.

In order to provide a cutting edge to rainfed agricultural research, ICAR embarked on the establishment of an institute to carry out basic and strategic research in the area. Thus came into being the Central Research Institute for Dryland Agriculture (CRIDA) in 1985. Within a span of 10 years of its establishment, CRIDA emerged as a pioneering institute for rainfed agriculture. Recognizing

the services rendered by this Institute to the farming community of rainfed areas, ICAR bestowed on it the Best Institute Award in 1995. With the launching of National Agriculture Technology Project (NATP) in 1998, CRIDA has been given the additional responsibility of leading Rainfed Agro Ecosystem Directorate. Over 100 research projects are being coordinated by the Directorate in a production systems mode in rice, pulses, oil seeds, nutritive cereals and cotton- based production systems.

1.2 Mandate

CRIDA conducts problem oriented interdisciplinary research. Its mandate is:

- To undertake basic and applied research that will contribute to the development of strategies for sustainable farming systems in the rainfed areas.
- To act as a repository of information on rainfed agriculture in the country.
- To provide leadership and co-ordinate network research with state agricultural universities for generating location-specific technologies for rainfed areas.
- To act as a center for training in research methodologies in the field basic to management of rainfed-farming systems.
- To collaborate with relevant national and international agencies in achieving the above objectives.
- To provide consultancy.

To fulfill the mandate, research and training activities are carried out in the thrust areas viz., resource characterization, rainwater management, crops and cropping systems, watershed management, soil and nutrient management, alternate land use systems, farm machinery, socio economics and

transfer of technology. The institute aims to provide leadership in rainfed agricultural research both through networking with state agriculture universities, and through national and international organisations. CRIDA endeavors to foster values of team spirit and collaboration to achieve its major missions which are pervasive as well as location specific.

1.3 Past achievements

Some of the accomplishments of the institute are as follows:

- Resource characterization and inventorisation of natural, bio-physical and socio-economic resources at micro-level.
- Evolved strategies for rainwater harvesting and recycling through cost-effective water conservation practices. Provided technical backstopping for watershed development activities of government and non-government organizations, and meeting their HRD requirement.
- Natural resource management by designing the strategies for sustainable and judicious use of resources to generate optimum output.
- Ensured sustainability through development of sequence cropping systems, management practices, and crop rotation specific to dryland areas.
- Designed alternate land use systems for provision of better land cover, employment opportunities and staggered income to farming community.
- Developed cost-effective implements for sowing, intercultural operations and harvesting.
- Conducted studies on the impact of improved and economically viable dryland technologies in terms of socio-economic issues to bridge the gap between technology development and technology transfer.
- Development of co-learning strategies for farmers and scientists through action learning application on farm and watershed scale.

Weather-based forewarning of crop pests and disease incidence.

- Enhancing keeping quality of perishable fruits and vegetables.

1.4 Infrastructure

CRIDA has the state-of-the-art facilities to fulfill its mandate and to support basic and strategic research and training activities being conducted at the institute.

The Institute has a spacious building complex with well equipped laboratories, office, guesthouse, trainees hostels, seminar halls, museum, and auditorium and well laid out research farms. An over-view of the facilities is provided below:

Laboratories - CRIDA has a number of well-equipped laboratories on soil physics, soil chemistry, central laboratory, plant physiology, agronomy, microbiology, tissue culture plant breeding, plant pathology and entomology, biochemistry, animal science, agroforestry and biotechnology to facilitate research on natural resource management and crop and livestock production.

Research farms - Two well laid out research farms one at Hayathnagar (280 ha) and the other at Gunegal (80 ha) cater the needs of generation and transfer of location specific technologies and demonstrations.

ARIS net - The network is being used effectively for e-mail, internet and file transfer protocol (FTP).

During the year a 24 port patch panel and 9 U hub rack was installed for efficient networking. Windows 2003 Server Enterprise edition was procured for internet server. 1 KVA online UPS was installed for hub racks. J WATCH software was developed to help easy search of research articles.

Library - Extensive information is collected and maintained on all aspects of dryland agriculture. The library has a collection of over 6800 books

and 3445 back volumes, and subscribes to 120 Indian and 29 international journals. The library has also established an Agri-Information Centre for catering to information needs of scientists with AGRICOLA, AGRIS, CROP-CD and SOIL-CD. It is also connected with the ICRISAT e-library besides being able to extend online access to a host of foreign journals through the subscription of full text databases.

Museum - The Institute maintains a Dryland Gallery where the history of dryland research and research achievements are highlighted through charts, photographs and models. During the year

the gallery was fully renovated by updating the content.

Conference and training facilities - The Institute has two air-conditioned conference halls with a seating capacity of 30 and 100, besides a large auditorium for 250 persons. CRIDA complex houses International Guest House (IGH) with four suites, 16 air conditioned and 16 non-air conditioned rooms for dignitaries and international visitors. Besides, there is also a 32 room trainees' hostel. The KVK is provided with a 20 room hostel facility at HRF. All these facilities are open to sister institutes as well as other organizations.

1.5 Financial outlay for 2003-04

Rupees in lakhs

	CRIDA		AICRPDA		AICRPAM	
	Sanctioned	Utilized	Sanctioned	Utilized	Sanctioned	Utilized
Non-Plan	652.00	617.43	20.00	17.70	19.00	16.18
Plan	195.00	183.18	610.00	610.00	234.00	234.00
Total	847.00	800.61	630.00	627.70	253.00	250.18

1.6 Staff position as on 31 March, 2004

Staff	Positions	
	Sanctioned	Filled
Scientific	68	61
Technical	85	84
Administrative	51	49
Supporting	70	63
TOTAL	274	257

2 Research Achievements

2.1 Resource Characterization

2.1.1 Weather conditions

The southwest monsoon set in on June 9. The rainfall received at Hayathnagar Research Farm was 665 mm as compared to the average (1971-2002) of 740 mm.

Sowing of the crops commenced during 24 SMW (June 11-17) but could not continue due to highly deficient (-69%) rainfall in the month. Most of the kharif crops were sown during second/third week of July. A rather well distributed rainfall of 236 mm (+88%) was received during July. The 167 mm received during August was also helpful for good growth. At the same time, the climatic

conditions were also conducive for pest infestation. Therefore, the crops did suffer at different growth stages due to moderate/severe pest infestation though the effects were moderated by control measures. Delayed sowing and moisture stress towards maturity resulted in below normal yield of sorghum. Long duration crops (pigeonpea and castor) also underwent soil moisture stress at later stages as no rains were received beyond October.

The southwest monsoon withdrew from the region on October 11. Post-monsoon rains were, however, received during 2nd fortnight of October. The weekly weather data are given in Table 2.1.

Table 2.1 Weekly meteorological parameters recorded at Hayathnagar Research Farm, Hyderabad

Standard meteorological week	Rainfall (mm)	Soil temperature (°C) at 10 cm		Air temperature (°C)		Relative humidity (%)		Sunshine (h)	Wind speed (km h ⁻¹)	Pan evaporation (mm)
		0716 h	1416 h	Max.	Min.	0716 h	1416 h			
1	0	22.8	30.3	27.7	15.8	75	46	6.4	5.0	4.6
2	0	22.3	28.7	27.9	15.3	86	40	5.3	3.9	4.0
3	0	20.2	28.7	27.0	12.4	84	31	7.6	3.6	4.1
4	0	22.7	32.0	31.6	15.7	83	28	9.0	3.3	5.2
5	0	23.7	32.7	31.5	16.6	82	29	9.7	6.6	6.6
6	0	25.0	33.3	30.1	17.8	88	36	8.3	6.6	5.7
7	4.8	26.4	35.0	32.6	19.4	86	36	9.3	7.3	6.8
8	0	26.1	35.9	32.4	19.1	83	33	8.7	4.9	6.1
9	0	28.0	37.1	34.5	2.3	81	27	8.6	5.0	7.0
10	0	27.2	36.3	33.5	18.8	60	23	8.3	5.4	8.0
11	23.5	27.1	34.4	32.9	21.4	82	46	6.5	7.6	6.4
12	0	28.1	38.9	34.5	22.6	67	29	8.6	6.1	8.6
13	0	29.9	40.3	37.1	23.0	62	21	8.6	5.7	9.9
14	16.8	29.9	37.7	37.3	24.0	60	27	8.8	6.1	9.9
15	0	29.7	40.8	35.6	23.6	73	34	8.3	6.0	8.0
16	0	32.6	42.1	37.7	26.1	62	25	8.5	5.3	9.9
17	0	32.4	42.2	38.8	25.3	47	24	9.4	7.2	12.7
18	0	33.5	43.7	38.6	26.4	49	22	9.9	7.7	13.2
19	0	33.1	43.0	39.4	25.7	47	21	7.6	6.0	11.9
20	0	33.2	42.7	40.8	28.3	43	15	7.6	7.9	15.7
21	0	34.3	44.9	40.9	29.5	30	15	9.1	8.4	18.0
22	0	35.3	46.2	42.0	30.3	30	16	8.9	9.5	19.8

Standard meteorological week	Rainfall (mm)	Soil temperature (°C) at 10 cm		Air temperature (°C)		Relative humidity (%)		Sunshine (h)	Wind speed (km h ⁻¹)	Pan evaporation (mm)
		0716 h	1416 h	Max.	Min.	0716 h	1416 h			
23	8.8	34.6	43.8	39.5	29.1	51	27	7.0	11.3	16.3
24	19.3	28.3	38.2	34.9	24.3	78	42	6.7	9.0	8.0
25	2.7	29.9	37.0	34.0	24.6	73	44	5.1	14.2	10.4
26	1.6	29.2	36.2	32.2	24.3	74	46	2.9	11.4	8.3
27	56.5	28.2	33.5	30.7	23.5	80	51	10.4	2.9	4.3
28	97.6	25.9	32.3	31.3	23.3	85	65	8.6	2.6	3.3
29	43.4	25.4	30.7	28.9	23.1	88	65	8.2	0.9	2.6
30	38.5	26.3	30.5	28.9	22.6	84	66	11.1	3.5	3.5
31	68.6	25.7	31.6	29.7	22.7	82	63	6.7	2.2	3.3
32	23.3	24.9	30.8	27.9	23.0	88	71	7.4	3.2	2.8
33	1.2	27.1	33.2	31.1	23.5	81	60	6.9	5.4	4.6
34	74.2	24.6	29.2	27.5	21.9	88	74	7.4	3.3	2.6
35	0	26.5	33.2	29.5	22.9	81	57	8.6	5.3	4.7
36	7.1	27.0	35.7	30.7	23.0	80	51	7.9	6.4	5.7
37	0	27.3	36.4	30.8	23.2	76	51	7.4	5.4	5.6
38	39.2	27.2	35.2	31.0	22.7	86	59	5.5	5.2	4.3
39	21.2	25.7	32.4	29.2	22.2	92	67	1.8	4.1	2.7
40	15.6	26.3	34.7	30.4	22.1	88	61	6.7	4.6	4.0
41	7.6	25.6	35.1	30.6	21.4	86	47	6.8	4.1	4.7
42	21.0	26.0	34.3	31.0	20.8	84	51	4.9	3.3	4.1
43	44.8	22.5	29.9	27.2	18.7	87	57	5.6	3.5	3.3
44	27.2	24.0	32.6	28.9	19.3	94	63	7.9	3.1	3.1
45	0	24.1	34.2	28.8	17.2	87	47	8.8	2.7	3.9
46	0	23.6	33.5	28.7	16.2	86	52	7.3	2.8	3.5
47	0	22.2	32.3	28.3	14.4	92	47	8.8	3.3	3.5
48	0	22.3	31.5	28.5	14.5	91	46	9.0	3.3	3.7
49	0	20.5	30.8	28.4	12.2	84	28	9.9	3.3	4.4
50	0	21.1	29.9	28.0	14.1	83	37	8.0	4.6	4.5
51	0	20.4	30.0	27.5	12.2	87	32	9.8	3.5	4.1
52	0	22.2	29.1	26.6	16.1	85	56	4.2	4.6	3.3

2.1.2 Influence of climatic variability on rainfed crops

Crop production depends not only on the yield but also on the area harvested. The yield response to climate change has been widely examined, but the sensitivity of crop land use to hypothetical climate change has not been studied directly. Hence, in the present study, it has been examined whether the amount of land area used in crop production is itself related to climate by using crop land use regression models for groundnut and pigeonpea crops.

For database, information (1971 - 1995) on groundnut and pigeonpea acreage for all the districts of Telangana and Rayalaseema (A.P.) was collected from Season and Crop reports (Bureau of Economics and Statistics, A.P.). The data on monthly rainfall, maximum and minimum temperature were obtained from India Meteorological Department, Pune for the same period for all these districts.

Model Development

Multiple regression equations were developed for all the districts and these were used to derive

crop area index (CAI) values for groundnut and pigeonpea in the no change scenario (i.e. no change in independent variables) and for different climate change scenarios. These scenarios were developed by pairing various assumed temperatures and precipitation changes. Precipitation changes ranged from -20 to +20% and temperature changes ranged from -4 to +4°C. These were chosen to encompass the GCM predictions of precipitation and temperature change. The amount of land used for these crops in the each climate change scenario was then compared to the “no change” model estimates of land use to derive the change in the land use for groundnut and pigeonpea crops. Using these equations, predicted change (%) in the land used for groundnut and pigeonpea crops in these districts were calculated for various precipitation and temperature changes and these were given in Table 2.2 and 2.3.

Sensitivity to Climate Change

The net change in the land used for groundnut production is predicted to be positive in Kurnool, Anantapur, Kadapa and Mahabubnagar districts and negative in Chittoor district in warming scenarios irrespective of whether climate is wet or dry. The increase in the area ranged from 38 to 105% associated with changes of 2°C and with no change in precipitation. In case of Chittoor, a temperature increase of 2°C and with no change in rainfall would result in a 22% reduction in the land used for groundnut crop. Land use for pigeonpea is estimated to expand more in a warmer, wetter climate in Kadapa, Nizamabad, Medak and Nalgonda districts. On the other hand, decrease in precipitation accompanied by cooling is estimated to lead to an increase in pigeonpea area. Increases upto 100% are suggested for cooling of 2°C and 20% reduction in precipitation in other districts.

Table 2.2 Predicted changes (%) in the land use for groundnut in Telangana and Rayalaseema

Precipitation change (%)	Temperature change (°C)								
	- 4	- 3	- 2	- 1	0	+ 1	+ 2	+ 3	+ 4
Kurnool									
+20	-78	-59	-40	-21	-2	18	37	56	75
15	-78	-59	-39	-20	-1	18	37	56	75
10	-77	-58	-39	-20	-1	18	38	57	76
5	-77	-58	-39	-20	0	19	38	57	76
0	-77	-57	-38	-19	0	19	38	57	77
-5	-76	-57	-38	-19	0	20	39	58	77
-10	-76	-57	-38	-18	1	20	39	58	77
-15	-75	-56	-37	-18	1	20	39	59	78
-20	-75	-56	-37	-18	2	21	40	59	78
Anantapur									
+20	-100	-100	-100	-58	-5	47	100	152	205
15	-100	-100	-100	-56	-4	49	101	154	206
10	-100	-100	-100	-55	-3	50	102	155	207
5	-100	-100	-100	-54	-1	51	104	156	209
0	-100	-100	-100	-52	0	52	105	157	210
-5	-100	-100	-100	-51	1	54	106	159	211
-10	-100	-100	-100	-50	3	55	107	160	212
-15	-100	-100	-100	-49	4	56	109	161	214
-20	-100	-100	-100	-47	5	58	110	162	215

Precipitation change (%)	Temperature change (°C)								
	- 4	- 3	- 2	- 1	0	+ 1	+ 2	+ 3	+ 4
Kadapa									
+20	-100	-100	-79	-41	-3	35	73	111	149
15	-100	-100	-78	-40	-2	36	74	112	150
10	-100	-100	-77	-39	-1	37	75	113	151
5	-100	-100	-77	-39	-1	37	75	113	151
0	-100	-100	-76	-38	0	38	76	114	152
-5	-100	-100	-75	-37	1	39	77	115	153
-10	-100	-100	-75	-37	1	39	77	115	153
-15	-100	-100	-74	-36	2	40	78	116	154
Mahabubnagar									
+20	-65	-51	-36	-21	-6	9	24	39	54
15	-64	-49	-34	-19	-4	11	25	40	55
10	-63	-48	-33	-18	-3	12	27	42	57
5	-61	-46	-31	-16	-2	13	28	43	58
0	-60	-45	-30	-15	0	15	30	45	60
-5	-58	-43	-28	-13	2	16	31	46	61
-10	-57	-42	-27	-12	3	18	33	48	62
-20	-100	-100	-73	-35	3	41	79	117	155
Chittoor									
+20	28	20	13	6	-1	-8	-16	-23	-30
15	28	21	14	6	-1	-8	-15	-23	-30
10	28	21	14	7	-1	-8	15	-22	-29
5	29	21	14	7	0	-8	-15	-22	-29
0	29	22	14	7	0	-7	-14	-22	-29
-5	29	22	15	8	0	-7	-14	-21	-29
-10	29	22	15	8	1	-7	-14	-21	-28
-15	-55	-40	-25	-11	4	10	34	49	64
-20	-54	-39	-24	-9	6	21	36	51	65

Table 2.3 Predicted changes (%) in the land use for pigeonpea in Telangana and Rayalaseema

Precipitation change (%)	Temperature change (°C)								
	- 4	- 3	- 2	- 1	0	+ 1	+ 2	+ 3	+ 4
Kurnool									
+20	36	26	16	6	-4	-14	-24	-34	-44
15	37	27	17	7	-3	-13	-23	-33	-43
10	38	28	18	8	-2	-12	-22	-32	-42
5	39	29	19	9	-1	-11	-21	-31	-41
0	40	30	20	10	0	-10	-20	-30	-40
-5	41	31	21	11	1	-9	-19	-29	-39
-10	42	32	22	12	2	-8	-18	-28	-38
-15	43	33	23	13	3	-7	-17	-27	-37
-20	44	34	24	14	4	-6	-16	-26	-36

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Precipitation change (%)	Temperature change (°C)								
	- 4	- 3	- 2	- 1	0	+ 1	+ 2	+ 3	+ 4
Anantapur									
+20	173	128	82	37	-9	-55	-100	-100	-100
15	175	130	84	39	-7	-52	-98	-100	-100
10	178	132	87	41	-5	-50	-96	-100	-100
5	180	134	89	43	-2	-48	-93	-100	-100
0	182	137	91	46	0	-46	-91	-100	-100
-5	185	139	93	48	2	-43	-89	-100	-100
-10	187	141	96	50	5	-41	-87	-100	-100
-15	189	144	98	52	7	-39	-84	-100	-100
-20	191	146	100	55	9	-37	-82	-100	-100
Kadapa									
+20	-45	-33	-20	-8	5	17	30	43	55
15	-46	-34	-21	-9	4	16	29	41	54
10	-48	-35	-23	-10	3	15	28	40	53
5	-49	-36	-24	-11	1	14	26	39	51
0	-50	-38	-25	-13	0	13	25	38	50
-5	-51	-39	-26	-14	-1	11	24	36	49
-10	-53	-40	-28	-15	-3	10	23	35	48
-15	-54	-41	-29	-16	-4	9	21	34	46
-20	-55	-43	-30	-17	-5	8	20	33	45
Chittoor									
+20	114	83	52	21	-10	-41	-72	-100	-100
15	117	86	55	24	-7	-38	-69	-100	-100
10	119	88	57	26	-5	-36	-67	-98	-100
5	122	91	60	29	-2	-34	-65	-96	-100
0	124	93	62	31	-0	-31	-62	-93	-100
-5	127	96	65	34	2	-29	-60	-91	-100
-10	129	98	67	36	5	-26	-57	-88	-100
-15	131	100	69	38	7	-24	-55	-86	-100
-20	134	103	72	41	10	-21	-52	-83	-100
Ranga Reddy									
+20	44	33	23	13	3	-8	-18	-28	-39
15	43	33	22	12	2	-8	-19	-30	-39
10	42	32	22	12	1	-9	-19	-30	-40
5	42	31	21	11	1	-10	-20	-30	-40
0	41	31	21	10	0	-10	-21	-31	-41
-5	41	30	20	10	-1	-11	-21	-32	-42
-10	40	30	19	9	-1	-12	-22	-32	-42
-15	39	29	19	8	-2	-12	-22	-33	-43
-20	39	28	18	8	-3	-13	-23	-33	-44
Nizamabad									
+20	-15	-11	-6	-2	2	7	11	15	19
15	-16	-11	-7	-3	2	6	10	15	19

Precipitation change (%)	Temperature change (°C)								
	- 4	- 3	- 2	- 1	0	+ 1	+ 2	+ 3	+ 4
10	-16	-12	-7	-3	1	5	10	14	18
5	-17	-12	-8	-4	1	5	9	13	18
0	-17	-13	-9	-4	0	4	9	13	17
-5	-18	-13	-9	-5	-1	4	8	12	17
-10	-18	-14	-10	-5	-1	3	7	12	16
-15	-19	-15	-10	-6	-2	3	7	11	16
-20	-19	-15	-11	-7	-2	2	6	11	15
Medak									
+20	-4	-1	+1	+4	6	8	11	13	16
15	-5	-3	0	+2	5	7	9	12	14
10	-7	-4	-2	1	3	5	8	10	13
5	-8	-6	-3	-1	2	4	6	9	11
0	-10	-7	-4	-2	0	2	5	7	10
-5	-11	-9	-6	-4	-2	1	3	6	8
-10	-13	-10	-8	-5	-3	-1	2	4	7
-15	-14	-12	-9	-7	-5	-2	0	3	5
-20	-16	-13	-11	-8	-6	-4	-1	1	4
Mahabubnagar									
+20	87	66	45	24	3	-19	-39	-60	-82
15	87	65	44	23	2	-19	-40	-61	-82
10	86	65	44	23	1	-20	-41	-62	-83
5	85	64	43	22	1	-20	-42	-63	-84
0	84	63	42	21	0	-21	-42	-63	-84
-5	84	63	42	20	-1	-22	-43	-64	-85
-10	83	62	41	20	-1	-23	-44	-65	-86
-15	82	61	40	19	-2	-23	-44	-65	-87
-20	82	60	39	18	-3	-24	-45	-66	-87
Nalgonda									
+20	-7	-4	-1	2	5	8	11	14	17
15	-8	-5	-2	1	4	7	10	13	16
10	-9	-6	-3	-1	3	6	8	11	14
5	-11	-8	-5	-2	1	4	7	10	13
0	-12	-9	-6	-3	0	3	6	9	12
-5	-13	-10	-7	-4	-1	2	5	8	11
-10	-14	-11	-8	-6	-3	1	3	6	9
-15	-6	-13	-10	-7	-4	-1	2	5	8
-20	-17	-14	-11	-8	-5	-2	1	4	7
Hanumakonda									
+20	56	43	30	16	3	-10	-23	-36	-49
15	55	42	29	16	3	-11	24	-37	-50
10	54	41	28	15	2	-12	-25	-38	-51
5	53	40	27	14	1	-12	-25	-39	-52
0	52	39	26	13	0	-13	-26	-39	-52

Precipitation change (%)	Temperature change (°C)								
	- 4	- 3	- 2	- 1	0	+ 1	+ 2	+ 3	+ 4
-5	52	39	25	12	-1	-14	-27	-40	-53
-10	51	38	25	12	-2	-15	-28	-41	-54
-15	50	37	24	11	-3	-16	-29	-42	-55
-20	49	36	23	10	-3	-16	-30	-43	-56
Khammam									
+20	31	26	20	15	10	5	0	-6	-11
15	28	23	18	13	8	2	-3	-8	-13
10	26	21	15	10	5	0	-5	-11	-16
5	23	18	13	8	3	-3	-8	-13	-18
0	21	16	10	5	0	-5	-10	-16	-21
-5	18	13	8	3	-3	-8	-13	-18	-23
-10	16	11	5	0	-5	-10	-15	-21	-26
-15	13	8	3	-2	8	-13	-18	-23	-28
-20	11	6	0	-5	-10	-15	-20	-26	-31
Karimnagar									
+20	86	66	46	25	5	-15	-35	-55	-76
15	85	64	44	24	4	-16	-36	-57	-77
10	83	63	43	23	3	-18	-38	-58	-78
5	82	62	42	22	1	-19	-39	-59	-79
0	81	61	40	20	0	-20	-40	-61	-81
-5	79	59	39	19	-1	-22	-42	-62	-82
-10	78	58	38	18	-3	-23	-43	-63	-83
-15	77	57	36	16	-4	-24	-44	-64	-85
-20	76	55	35	15	-5	-25	-46	-66	-86
Adilabad									
+20	26	20	15	10	4	-1	-7	-12	
15	24	19	14	8	3	-2	-8	-13	-18
10	23	18	13	7	2	-3	-9	-14	-19
5	22	17	12	6	1	-4	-10	-15	-20
0	21	16	11	5	0	-5	-11	-16	-21
-5	20	15	13	4	-1	-6	-12	-17	-22
-10	1	-5	-10	-15	-21	-26	-31	-37	-42
-15	19	14	9	3	-2	-7	-13	-18	-23
-20	18	13	8	2	-3	-8	-14	-19	-24

2.1.3 Radiation and water use efficiency of sorghum and pigeonpea

RUE and WUE are the two very important inputs for crop weather modelling. These two crucial parameters were studied on sorghum + pigeonpea (2:1) grown at HRF. The following observations were made:

- The maximum leaf area index (LAI) was 2.53 for sorghum cv SPV-462, and 2.03 for pigeonpea cv PRG-158. These indices were low this year not only due to lesser plant population but also because of biotic and abiotic stress conditions prevailing during crop growth period. The extinction coefficient 'k' for pigeonpea was 0.52 (Fig. 2.1).

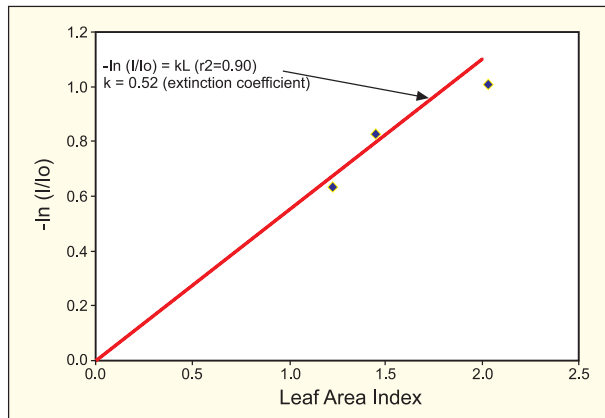


Fig.2.1 A plot of transmitted PAR (logarithmic) vs LAI for pigeonpea

- The RUEs (Fig. 2.2) were 2.283 ($r^2 = 0.842$) for sorghum, and 0.597 ($r^2 = 0.987$) g MJ⁻¹ for pigeonpea (Fig. 2.3). These values appear to be low particularly for pigeonpea mainly due to prevalent stress conditions.

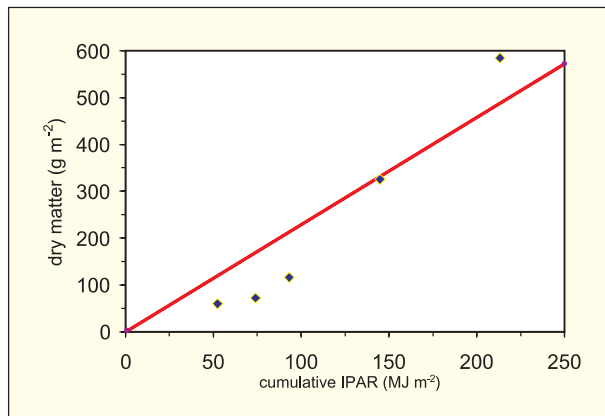


Fig.2.2 Relationship between cumulative IPAR and drymatter production for sorghum

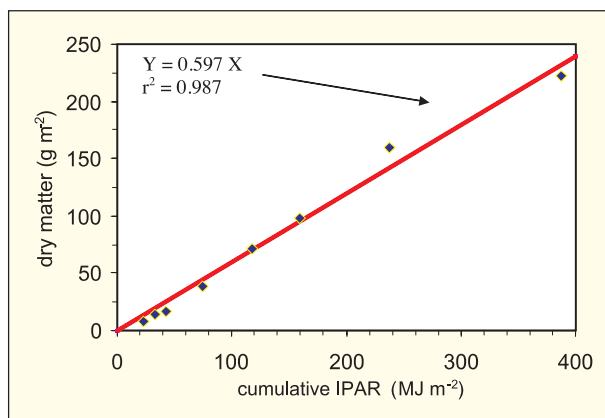


Fig.2.3 Relationship between cumulative IPAR and drymatter production for pigeonpea

- A second order polynomial was found to fit the data on WUE and dry matter production (Fig. 2.4 & 2.5). WUE increased with advancement in growth stage. It was observed that about 125 mm of water evapo-transpired before accumulation of dry matter started in either of the crops.

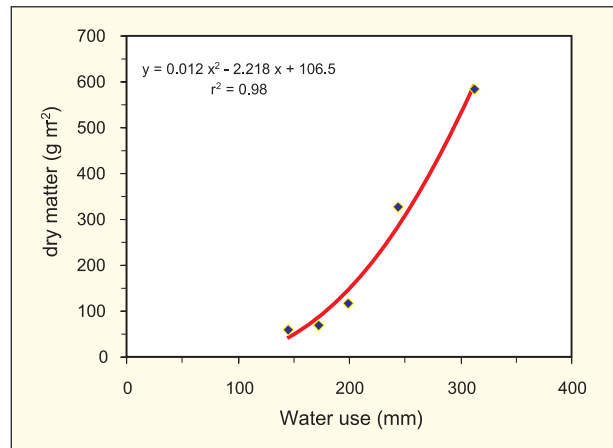


Fig.2.4 Relationship between drymatter and water use for sorghum

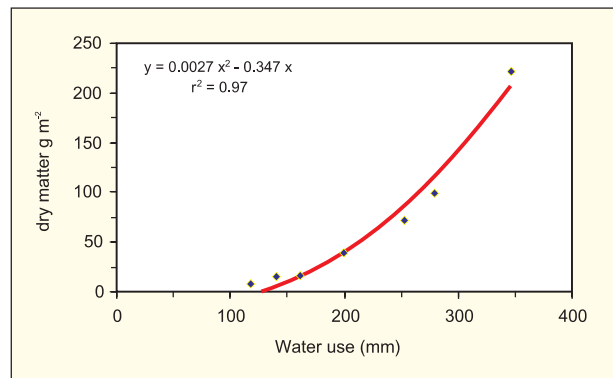


Fig.2.5 Relationship between drymatter and water use for pigeonpea

- Considering the cumulative evapo-transpiration and total dry matter produced, the average WUE was 1.87 for sorghum, and 0.64 g kg⁻¹ for pigeonpea, respectively.

2.1.4 Spectral characteristics of rainfed kharif sorghum

The spectral reflectance of sorghum cv CSH-9 was measured using a portable spectroradiometer (model LI-1800, LI-COR, Inc., USA). Canopy reflectance was monitored from

Table 2.4 Relationship between yield with NDVI and Simple Ratio in sorghum

Phenological stage	Days after sowing	R ²	
		Yield: NDVI	Yield: Simple Ratio
Early tillering	20	0.029	0.028
Tillering	28	0.105	0.101
Late tillering to booting	43	0.364*	0.203
Booting to heading	49	0.492*	0.36*
Heading to flowering	57	0.675*	0.644*
Flowering	64	0.581*	0.533*
Flowering to Maturity	72	0.377*	0.322
Maturity	81	0.036	0.032

* significant at 1% level

early tillering (13 Days after sowing (DAS)) to maturity stage (94 DAS) of the crop within the range of 300-1100 nm. Reflectance values within the range of 600-700 nm (R_r) and 800-900 nm range (IR_r) were used to calculate the Simple Ratio i.e., Infra Red/Red ratio and normalized difference vegetation index (NDVI). The temporal changes of Simple Ratio and NDVI during the growth period showed that these in general increased up to heading stage of the crop, and then decreased during senescence. The leaf area index (LAI) varied between 0.024 (13 DAS), to 5.81 (64 DAS), and the green and dry biomass varied between 2.97 g m⁻² (13 DAS) and 5489.3 g m⁻² (64 DAS), and 0.99 g m⁻² (13 DAS) and 2831.1 g m⁻² (72 DAS), respectively. The r^2 values between yield and NDVI and Simple Ratio in different phenological stages is given in Table 2.4. The spectral characteristics between booting to flowering stages were effective to estimate the yield of the crop.

2.1.5 Refining regional level prediction of yield for cotton (Technology Mission on Cotton)

The project aims to estimate the regional level production of cotton before the harvest of the crop by integrating climate, soil, crop growth models. Besides CRIDA, the project involves CICR, Nagpur, NBSS&LUP, Nagpur, UAS, Dharwad, GAU, Surat and NRSA, Hyderabad. The main findings were:

- Development of digital database of soils for Bharuch and Surat districts of Gujarat were completed.

- An interface for linking the spatial information of soil properties and raingauge stations in GIS mode with crop model was developed by using the ArcView software. The interface would be a part of the GIS software as a script and the user has the option to run the model from the GIS system by choosing the area of interest. In addition to soil parameters and rainfall, the necessary parameters for running the model can be given through as a database table for all the polygons in the associated database and through an interactive tabular format for a single polygon in GIS itself which would then be passed on to the model while it is being executed.

2.1.6 Delineation of efficient productive zones for cotton production system using GIS-based crop models (NATP)

Various available models on cotton and an indigenously developed one were being used to estimate yield and yield attributing parameters. WOFOST, a general crop growth simulation model was used for estimating the cotton yields for Abhadita and NHH-44 for different basic simulation units for 10 year period from 1990-99 for Nagpur district. The basic simulation units were obtained by super imposing spatial information layers of climate, soil depth and soil type. The model was run for both drought and water logging conditions. Average productivity maps for Abhadita and NHH-44 for Nagpur district is shown in Fig. 2.6 & 2.7.

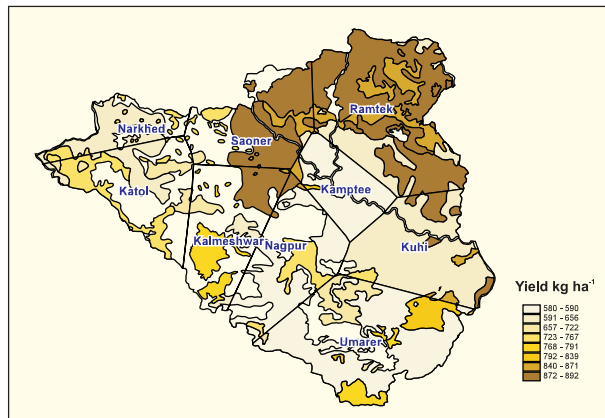


Fig.2.6 Predicted yield of cotton (Abhadita) - Drought and Waterlogging

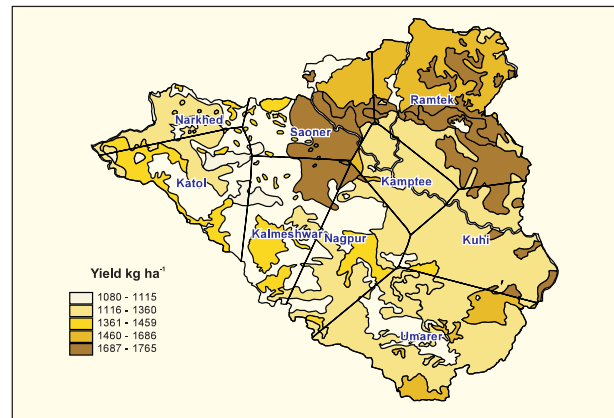


Fig.2.7 Predicted yield of cotton (NHH-44) - Drought and Waterlogging

2.1.7 Identifying systems for carbon sequestration and increased productivity

Field studies on soil respiration was carried out in the ongoing long term experiments on various fertilizers and crop residue trials in Alfisol and Vertisol at CRIDA and ICRISAT. These were intended to get useful information on the amount of CO₂ released and its flow based on microbial activities in the soil and the root compartment in relation to soil conditions representing Forest, Grassland, Fallow, and Cultivated systems. Some salient findings can be listed as follows:

- Initial soil respiration (prior to sorghum crop) ranged from 11.7 - 19.6 micromole of CO₂ / m² / min at the soil temperature of 40.5 - 42.9°C.

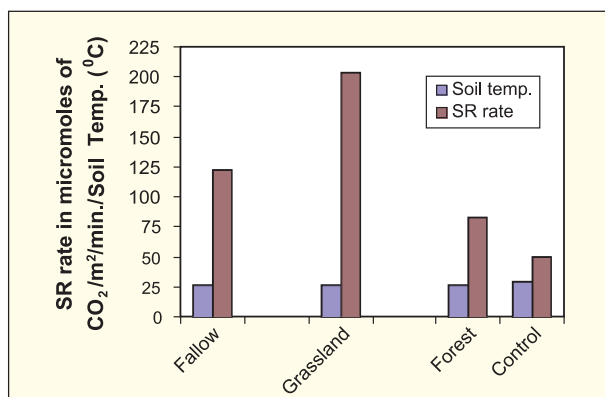


Fig.2.8 Soil respiration under different systems at HRF, CRIDA

- Soil respiration under zero tillage was higher than conventional tillage irrespective of crop stage in cultivated system where as among other systems, it was highest in Grassland (Fig. 2.8).
- With progress in season and sorghum crop growth, the soil respiration also increased at a soil temperature of 24 - 26°C while the lowest value was recorded in control.

2.1.8 Validation of indigenous rain gauge (NATP)

The indigenous rain gauge (*Rolu*) with a hole of 7.4" depth and 9.0" diameter was evaluated along with standard rain gauge for validation under both on-station (GRF) and on-farm (Nallavelli, Nazdiksingaram and Gollapally) conditions. The salient findings of the project were:



Measuring rainfall by indigenous rain gauge

- A correction factor was developed and calculated to correlate the quantity of rainfall received in indigenous rain gauge with that of standard rain gauge.
- When the indigenous rain gauge was full with rainwater, farmers proceeded to sow sorghum + pigeonpea and castor for about 4-5 days. If the gauge is not full, sowing for 1-2 days would be carried out. If the monsoon is delayed, only castor crop would be sown.
- Refinement is to be carried out for its wider applicability, taking into account the wide surface area, losses due to splash and human interference, and variation in rainfall intensity.
- The gauge is simple and can be installed in remote villages.

2.1.9 Effect of rock fragment cover on soil infiltration, runoff and erosion

A field experiment was carried out in a micro watershed at HRF to evaluate the influence of surface rock fragments on soil infiltration, runoff and erosion using portable rainfall simulator on bare areas of natural soils within semiarid tropical

Alfisol soils in India. Four fields with 3.5% (low), 17.6% (average), 41.7% (medium) and 64.7% (high) rock fragment cover along with rainfall intensities of 48.5, 89.2, and 136.8 mm h⁻¹ were selected as treatments for the experiment. The following conclusions were drawn:

- Surface rock-fragments retarded surface runoff (Fig. 2.9), increased final infiltration rates and diminished runoff discharge, sediment concentration and soil loss. The final infiltration was 26%, 39%, 62% and 83% of rainfall when the rainfall intensity is 136.8 mm h⁻¹ in fields having low, average, medium and high rock coverage, respectively (Table 2.5).
- The reduction in runoff and soil erosion, and increase in infiltration was more effective when rock fragments rest on the soil surface rather than getting completely embedded in the surface seal.
- The sediment yield increased from 2 g l⁻¹ for 64.7% stone cover with rainfall of 48.5 mm h⁻¹ to 70 g l⁻¹ for 3.5% stone cover with 136.8 mm h⁻¹ of rainfall (Fig. 2.10).

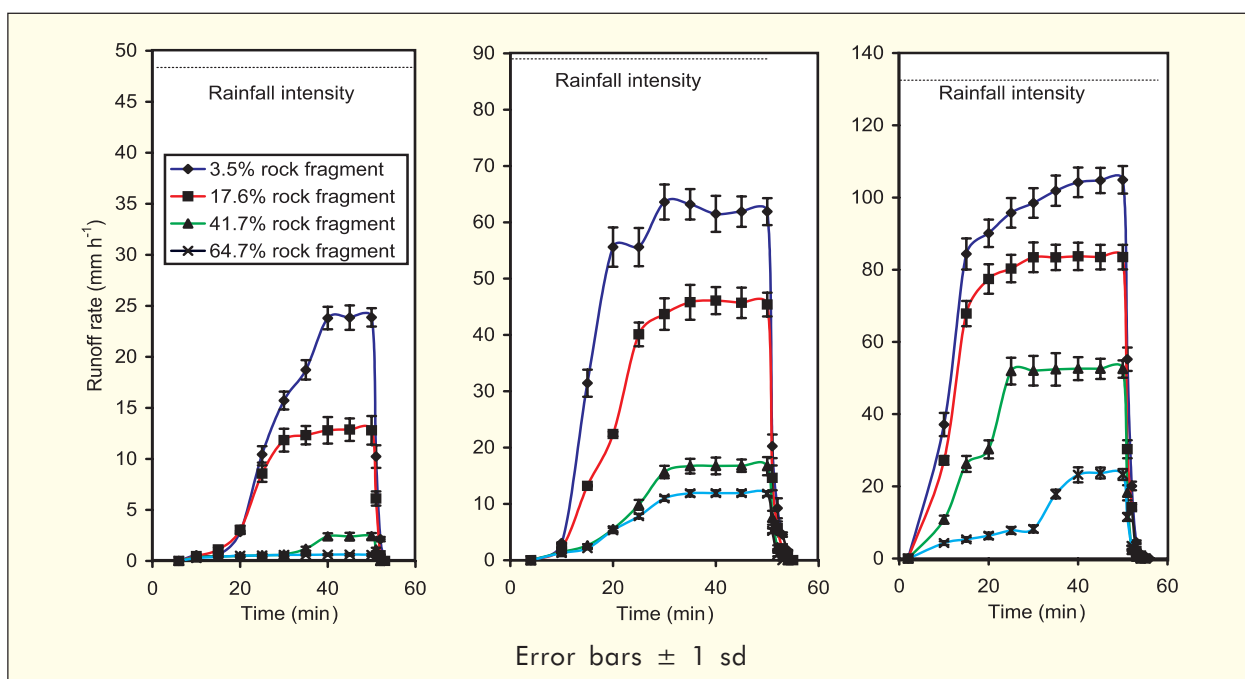


Fig.2.9 Runoff hydrograph under rock cover with different intensities of rainfall

Table 2.5 Effect of rock cover on final infiltration and soil loss under different rainfall intensity

Rock fragments	Final infiltration (mm h ⁻¹)				Soil loss (t ha ⁻¹ h ⁻¹)			
	Rainfall intensity (mm h ⁻¹) (I)				Rainfall intensity (mm h ⁻¹) (I)			
cover (%) (R)	136.08	89.20	48.50	Mean	136.8	89.20	48.50	Mean
64.7	113.57	77.40	47.92	79.63	0.910	0.546	0.013	0.489
41.2	84.83	72.50	46.10	67.81	2.657	1.117	0.017	1.264
17.6	53.01	43.40	35.66	44.02	5.695	2.716	0.349	2.920
3.5	35.60	27.70	23.63	28.98	16.597	8.393	0.729	8.573
Mean	71.75	55.25	38.33		6.465	3.193	0.277	
Components	S.E. difference		LSD(0.05)		S.E. difference		LSD(0.05)	
R	2.48		5.13		0.434		0.896	
I	2.15		4.44		0.376		0.776	
R X I	4.30		8.88		0.752		1.553	

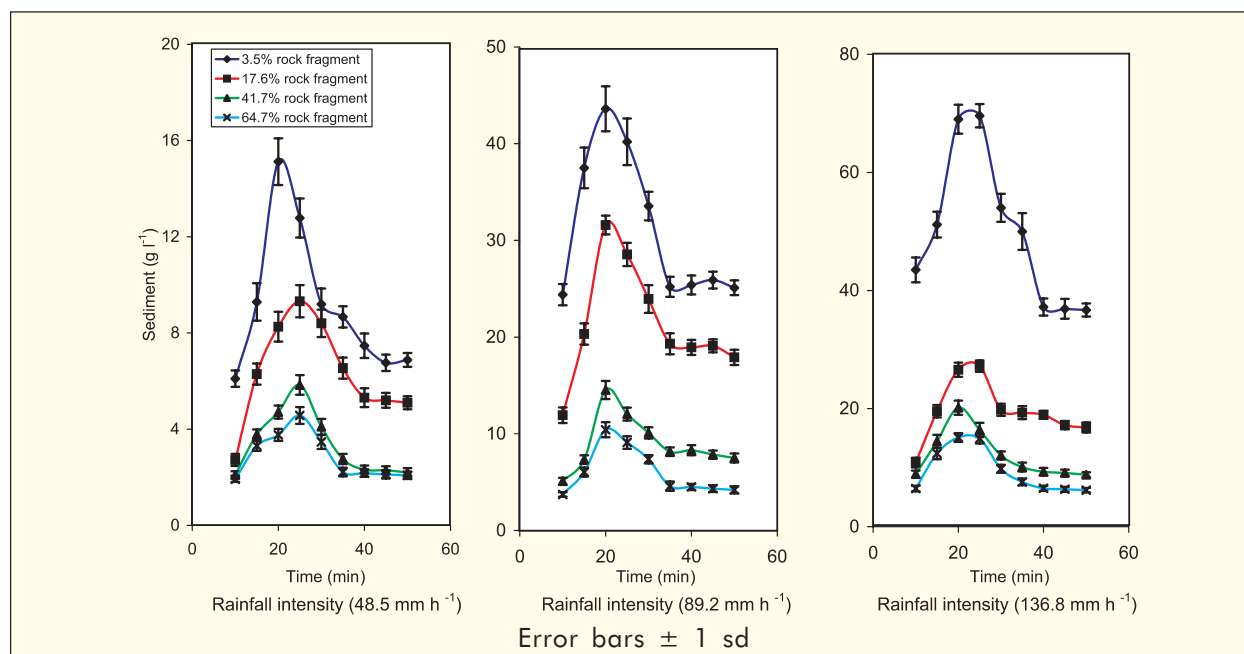


Fig.2.10 Sediment concentration under rock cover with different intensities of rainfall

- The soil loss was less than 2 t ha⁻¹h⁻¹ for 64.7% stone cover even when the rainfall intensity was 136.8 mm h⁻¹.
- The particle size distribution of sediment revealed that runoff is mostly loaded with silt size sediment which is mostly responsible for soil crusting.

2.1.10 Bio-physical characterization of HRF Phase III

A major development and experimental activity was initiated at Phase-III of Hayatnagar

Research Farm. This area consists of 40 ha and is adjacent to Phase-II. The whole area was divided into four physiography categories: Cultivable soils, soils of Foot Hills, soils of Hills, and soils of Rock out crop areas. Soils were sampled at regular intervals at 0-15 and 15-30 cm depth and analyzed for major soil physical properties (Tables 2.6 and 2.7). The salient characteristics were:

- The silt content was less, and varied from 6-9% at 0-30 cm depth. Clay content was highest in cultivated soils and in sub-surface layer (15-30 cm depth).

Table 2.6 Particle size distribution (%) in Phase-III Soils

	0-15 cm			15-30 cm		
	Sand	Silt	Clay	Sand	Silt	Clay
Cultivable	72	7	21	61	11	28
Foot Hills	75	7	48	71	5	24
Hills	67	8	25	78	8	14
Rock out Crops	68	7	25	79	7	14

Table 2.7 Water retention properties of Phase-III soils

	0-15 cm			15-30 cm		
	0.33 Bar (%)	15 Bar (%)	AWC*	0.33 Bar (%)	15 Bar (%)	AWC*
Cultivable	6.5	3.2	3.3	6.6	3.9	2.7
Foot Hills	5.2	3.6	1.6	5.3	2.7	2.6
Hills	3.6	1.8	1.8	8.7	1.8	6.9
Rock out Crops	5.5	3.2	2.3	6.3	3.1	3.2

AWC - Available Water Capacity

- The available water capacity of cultivable soil was highest at 0-15 cm depth than at the other three categories.
- The chemical properties of the HRF phase III soils are given in Table 2.8. The soils were acidic to neutral in reaction. All soils were low in organic carbon, available N, P, K and S. Among the micronutrients available Zn was deficient in all the surface soils whereas available Fe, Cu and Mn were sufficient. Available sulphur

was higher in surface layers whereas zinc status increased in 15 -30 cm soils.

2.1.11 Near real-time monitoring for contingency planning in A. P. (NATP)

Weekly rainfall departure, soil moisture index, and the aridity index maps for Andhra Pradesh for 2002 and 2003 were prepared and supplied to the Commissionerate of Agriculture, Department of Agriculture, Government of Andhra

Table 2.8 Chemical properties and nutrient status of Phase III soils

Soil group	pH (1:2.5)	Org. C. (%)	Macro nutrients (kg ha ⁻¹)				Micronutrients (mg kg ⁻¹)			
			N	P	K	S	Zn	Fe	Cu	Mn
Cultivable										
0-15	6.38	0.36	68.8	8.8	96.3	6.7	0.42	16.8	0.54	9.6
15-30	6.69	0.36	67.1	8.4	81.7	5.6	0.86	16.2	0.66	14.1
Foot hills										
0 -15	6.3	0.49	75.6	8.5	89.6	6.4	0.28	12.1	0.56	13.4
15 -30	6.34	0.43	75.5	8.45	92.3	5.2	0.80	9.7	0.54	11.9
Hills										
0- 15	7.05	0.42	79.9	8.4	117.3	4.9	0.26	11.6	0.42	11.5
15 -30	6.64	0.47	84.3	8.1	117.1	5.0	0.80	9.6	0.54	11.9
Rocky out										
0 -15	5.83	0.29	79.2	8.1	81.6	5.7	0.24	11.0	0.42	10.5
15 -30	5.82	0.34	59.9	7.9	67.9	3.8	0.90	13.4	0.40	15.2

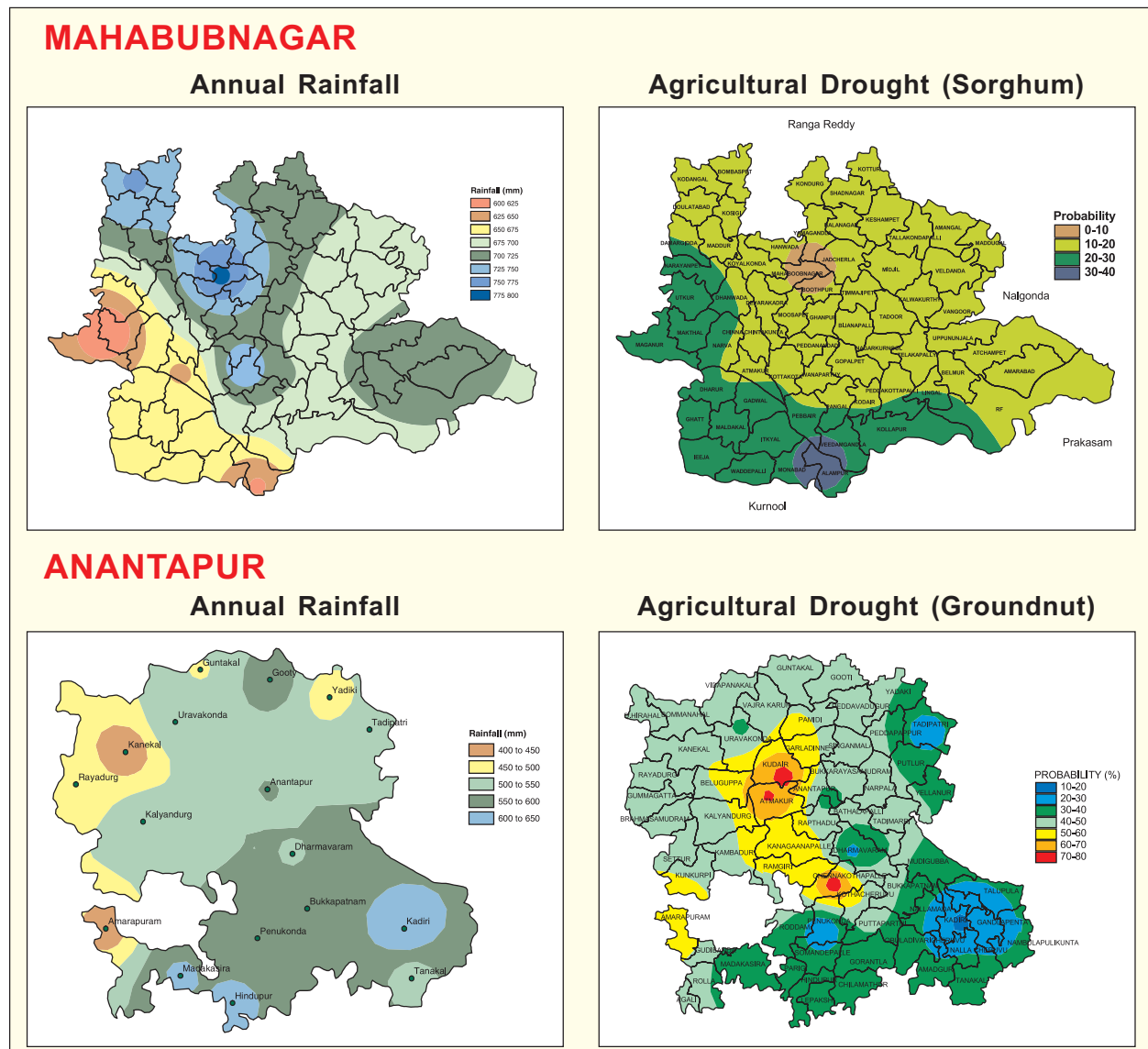


Fig.2.11 Spatial distribution of annual rainfall and agricultural drought situations

Pradesh. Aridity index and soil moisture index values were computed using climate Water Balance Model of Thornthwaite and Mather (1955). Under Agroclimatic Studies of two drought prone districts, Anantapur and Mahaboobnagar, the spatial distribution of annual rainfall and probabilities of agricultural droughts were prepared (Fig. 2.11). These show that the probabilities of agricultural droughts for sorghum in Mahaboobnagar is about 10to30% while for groundnut in Anantapur, it is 50 to 80% indicating frequent failure of monsoon. Least drought prone areas in this district were confined to eastern parts where rainfall is higher.

2.1.12 National facility of Agromet Data Bank at CRIDA (AP-Cess Fund)

- Sixty more stations were added to the existing database (60).
- The data on normal weekly rainfall and its probabilities for 310 stations, monthly climatic normal for about 300 stations, and weekly climatic normal for 170 stations were computerized.
- A program in Vbasic to convert the basic data to estimate PET and water balance was made.
- Database on daily rainfall collected under NATP (RRPS-1) project from 700 raingauge stations

situated in eastern Indian states over the last 15 years along with crop statistics at block level were added to the database.

- The pests and disease data of 6 principal crops collected under NATP Mission Mode Project (MM-III-17) were added to the database.
- The data were checked for quality before being stored.

2.1.13 Integrated National Agricultural Resources Information System (INARIS) (NATP)

Collection and compilation of meteorological data is a continuous process. Therefore, data on basic weather parameters like maximum temperature, minimum temperature, relative humidity-1, relative humidity-2, wind speed, sunshine, evaporation and rainfall of 45 stations was collected and updated up to December, 2003. The process is continuous. Before entering the data into oracle database and subsequent analysis, the data was subjected to quality checking for predefined range and normal data using an application program developed in Visual Basic. After quality check, analysis of climate data in computing weekly totals of rainfall and the averages of the rest of other parameters were worked out. The derived climatic water balance parameters viz., PET, soil moisture, aridity, humidity, moisture index, water surplus, and water deficit were computed simultaneously for quick and easy retrieval of data from the database.

The database on rainfall percentage probabilities and temperature distribution was calculated using PL/SQL Program and stored in the Oracle database. Percentage frequency probabilities of getting No rain, up to 10mm rain and at least 10, 20, 30, 40, 50, 100 and 200 mm rain was computed. Rainfall probabilities at 50, 60, 70, 80 and 90% using Incomplete Gamma Distribution analysis was carried out. Also the probability of getting greater than 45, 40, 35°C in the summer months of April, May and June and

probability of getting less than 15, 10, 5°C in the winter months of December, January and February was computed using Normal Distribution method. Thematic maps showing the spatial distribution of water balance parameters viz., Index of Moisture Adequacy (IMA), Aridity Index (Ia), Humidity Index (Ih) and Soil Moisture Index (SMI) over the country using water balance computations of 260 stations data published by NBSS&LUP were prepared through GIS analysis.

2.2 Integrated Nutrient Management

2.2.1 Effect of horsegram incorporation on soil quality and grain yield

Long term field experiment is under progress on Alfisols of Gunegal Research farm. Experiments were started in the year 1994, with sorghum and sunflower crops with different nutrient management options under horse gram incorporation and fallow. Grain yields and soil quality parameters are being monitored over years. Among soil quality parameters, organic carbon content was significantly higher under horse gram incorporation as compared to fallow irrespective of fertilizer treatments (Fig.2.12). Organic carbon content did not vary significantly among fertilizer treatments. Available nitrogen status of soils also improved considerably with N application and horsegram incorporation. Similarly available nutrient status of P, S and K were improved with incorporation.

Grain yield of sorghum and sunflower were significantly influenced by horse gram biomass

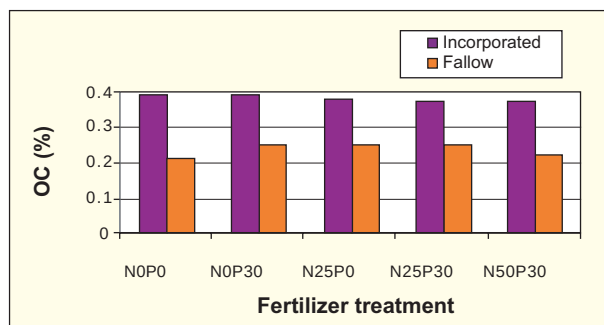


Fig. 2.12 Effect of horsegram incorporation and fertilizer application on organic carbon content in soil

Table 2.9 Effect of sorghum and sunflower grain yield (kg ha^{-1}) as influenced by horsegram incorporation and fertility treatments

Fertilizer Treatment	Sorghum (cv SPV-462)		Sunflower (cv Morden)	
	Incorporated	Fallow	Incorporated	Fallow
$N_0 P_0$	1332	880	533	387
$N_{25} P_0$	2570	2135	777	599
$N_0 P_{30}$	2044	1578	644	533
$N_{25} P_{30}$	3904	3280	995	777
$N_{50} P_{30}$	4350	3630	1269	999



Incorporation of horsegram at pre-flowering stage

incorporation as well as fertilizer treatments (Table 2.9). Highest grain yields were recorded in $N_{50}P_{30}$ treatment in both the crops. Biomass incorporation led to higher yields over fallow. Improved yield in sorghum and sunflower under biomass addition and fertilization were due to low fertility of soil, which is deficient in available N, S and K besides low in organic carbon content. These yield increases are in accordance with improved soil quality parameters such as organic carbon and nutrient build up in the soil.

2.2.2 Low tillage and INM strategies

Sorghum and Greengram

Organic matter depletion in rainfed Alfisols is a serious problem resulting in low soil fertility, poor soil physical health and low moisture retention capacity. Dismally low recycling of organic materials to soil is yet another aggravating feature in dryland regions. Consequently, these soils have

been found deficient in many plant nutrients. Further, because of escalating cost, farmers are incapable of using fertilizers in the desired quantity. Of the possible strategies to enhance soil organic matter and to restore soil fertility, two could be integrated nutrient management (INM) and reduced tillage. Considering this, a long-term experiment with sorghum (cv CSH-9) and greengram (cv ML-267) as test crops was conducted at HRF to identify effective INM treatments, and to enhance organic matter in dryland soils. The experiment was laid in a strip plot design with two tillage [conventional (CT) and reduced (RT)] and five INM treatments (control, 40 kg N through urea, 4 t compost + 20 kg N, 2 t *Gliricidia* loppings + 20 kg N, and 4 t compost + 2 t *Gliricidia* loppings). Following were the results:

- Based on the five-year experimental data (Fig 2.13), it was found that conventional tillage maintained 14.5% higher sorghum grain yield over reduced tillage. 2 t *gliricidia* loppings + 20 kg N, and 4 t compost + 20 kg N were most effective in increasing sorghum grain yield by 85 and 78% over control.
- In case of greengram, 2 t compost + 1 t *gliricidia* loppings followed by 2 t compost + 10 kg N were found most promising in increasing the grain yield by 52 and 51% over control, respectively.
- Results clearly indicated that 50% of N demand of sorghum and greengram could be met through farm-based organic materials like compost or



INM through *in situ* composting, gliricidia loppings, and inorganic fertilizers in sorghum + greengram strip cropping

- gliricidia loppings under conventional and reduced tillage.
- Highest agronomic efficiency (Fig. 2.14) was observed in 2 t gliricidia loppings + 20 kg N ($20.32 \text{ kg grain kg N}^{-1}$) followed by 40 kg N through urea ($18.61 \text{ kg grain kg}^{-1} \text{ N}$) in case of sorghum. For greengram, the highest agronomic efficiency was ($13.75 \text{ kg grain kg}^{-1} \text{ N}$) observed in 2 t compost + 1 t gliricidia loppings followed by 2 t compost + 10 kg N ($13.56 \text{ kg grain kg}^{-1} \text{ N}$).
- Reduced tillage maintained significantly higher organic carbon content (0.74%) compared to conventional tillage (0.71%). Highest amount (0.82%) of organic carbon content was recorded with 4 t compost + 2 t gliricidia loppings (Table 2.10).
- Soil parameters such as available N content, DTPA extractable iron and copper contents, and dehydrogenase activity were also significantly influenced by INM treatments studied.

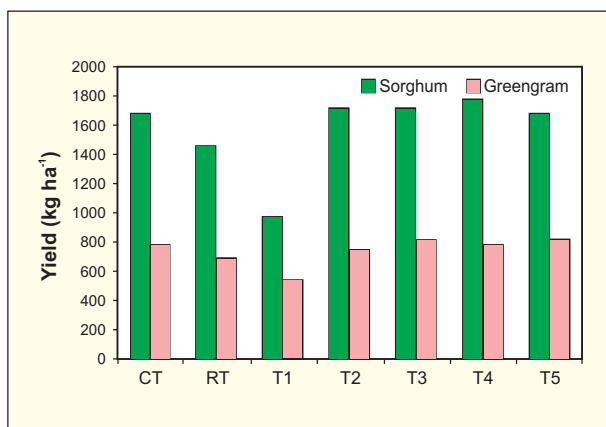


Fig.2.13 Yield of sorghum and greengram as influenced by tillage and INM treatments

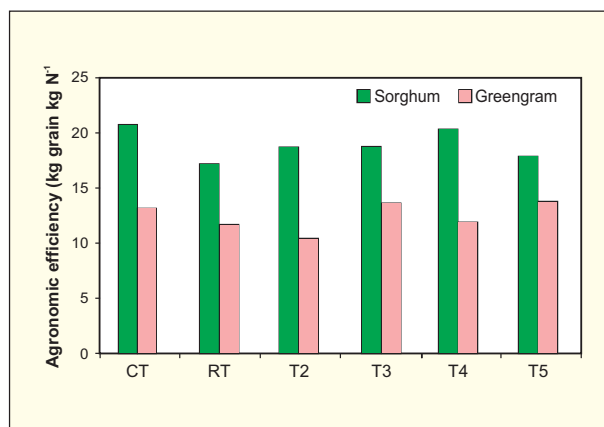


Fig.2.14 Agronomic efficiency of sorghum and greengram as influenced by tillage and INM treatments

Table 2.10 Effect of INM on soil under conventional and reduced tillage systems after 5 years of experimentation

Treatments	OC (%)	Avail. N (kg ha ⁻¹)	Avail. P (kg ha ⁻¹)	Avail. K (kg ha ⁻¹)	Zn (ppm)	Fe (ppm)	Cu (ppm)	Mn (ppm)	DHA (μg TPF h ⁻¹ g ⁻¹)
CT	0.71	172.97	32.43	186.29	1.61	22.89	1.54	27.74	74.18
RT	0.74	180.37	26.95	165.15	1.50	23.11	1.47	28.60	75.17
T1	0.53	140.95	23.79	153.77	1.46	20.96	1.40	27.60	53.53
T2	0.72	183.35	29.16	175.72	1.56	24.03	1.57	29.38	78.60
T3	0.78	186.24	29.61	176.93	1.52	23.89	1.63	27.71	88.82
T4	0.76	180.27	29.02	182.14	1.54	24.05	1.44	27.84	78.41
T5	0.82	192.54	36.89	190.05	1.68	22.06	1.50	28.34	74.01
CTT1	0.51	140.78	28.24	164.52	1.54	20.02	1.39	27.96	47.32
CTT2	0.71	179.99	32.12	181.24	1.58	22.74	1.62	28.01	77.50
CTT3	0.76	181.29	33.59	187.18	1.59	24.00	1.81	27.25	83.27
CTT4	0.75	173.98	33.05	201.54	1.64	22.04	1.44	27.41	81.22
CTT5	0.80	188.82	35.16	196.98	1.68	23.65	1.46	28.07	81.59
RTT1	0.55	141.12	19.33	143.01	1.39	19.90	1.41	27.23	59.74
RTT2	0.73	186.72	26.20	170.19	1.54	25.32	1.52	30.74	79.70
RTT3	0.80	191.19	25.62	166.69	1.44	23.79	1.44	28.16	94.38
RTT4	0.78	186.56	24.99	162.74	1.44	26.07	1.44	28.72	75.59
RTT5	0.85	196.25	38.61	183.28	1.67	20.49	1.54	28.61	66.43
Tillage	0.032	4.76	2.52	8.19	NS	NS	0.011	NS	NS
CD @ 5%									
INM levels	0.05	7.52	3.99	12.96	NS	2.01	0.018	NS	3.58
CD @ 5%									
T x INM levels	NS	NS	5.65	NS	NS	2.84	0.025	NS	5.07
CD @ 5%									

CT - conventional tillage; RT - reduced tillage; T1 - control; T2 - 40 kg N through urea; T3 - 4t compost + 20 kg N; T4 - 4t gliricidia + 20 kg N; T5 - 4t compost + 2t gliricidia; OC - organic C; DHA - dehydrogenase activity

The study thus clearly indicated that fertilizer N requirement of dryland rainfed sorghum and green gram can be considerably reduced by following INM approach. The practice covers non-monetary input use involving conservation of farm-based resources which will not be burden to the farmer. Reduced tillage, though tended to decrease crop yield, nevertheless, was found effective in improving organic carbon and dehydrogenase activity. This practice over a period of time will prove to be a sustainable agronomic practice leading to build up of organic matter, plant nutrient status and biological activity of soils.

Castor

A similar type of long term experiment on castor cv DCS - 9 conducted since 1999 has led to the following conclusions:

- Integrated nutrient management treatment supplying recommended 50% N through inorganic + 50% N through FYM was on par with all inorganic treatments, and both yielded higher than the control. This indicated that 50% of the recommended inorganic N can be safely substituted by supplying it through FYM.

- Conventional and reduced tillage treatments resulted in similar yield indicating that one preparatory tillage can safely be saved.

2.2.3 Assessment and improvement of soil quality and resilience (NATP)

Following were the results obtained from a long-term experiment involving 24 INM treatments. The objective was to identify appropriate land management treatments and to identify key indicators of soil quality for dryland semi-arid tropical Alfisols. The experiment was laid out in a strip split-split plot design with 3 replications and was maintained since 1995 with sorghum cvs CSH 5 or 6 and castor cv Aruna in a two-year rotation. The strip constituted two tillage treatments: zero tillage (ZT) and conventional tillage (CT). The main plot treatments constituted three residue treatments: dry sorghum stover (SS), fresh gliricidia loppings (GL) and no residue (NR). Sub plot treatments consisted of four N rates 0 (N_0), 30 (N_{30}), 60 (N_{60}) and 90 (N_{90}) kg N ha⁻¹.

- Among the 24 treatments, the Soil Quality Index (SQI) ranged from 0.76 to 1.06. It was

highest in CTGLN₉₀ (1.06) followed by CTGLN₆₀ (1.01) and CTSSN₆₀ (0.99), while the lowest was under ZTNRN₃₀ (0.76) followed by ZTNRN₀ (0.80), indicating relatively less aggradative effects. CTGLN₉₀ / N₆₀ hold promise for sustainability, maintaining higher yield levels and better soil quality under sorghum-castor rotation.

- The application of 90 kg N ha⁻¹ under zero tillage even without any residue (ZTNRN₉₀) proved quite effective in maintaining SQI (0.93).
- The key indicators which contributed considerably towards SQI were available N, K, S, microbial biomass carbon (MBC) and hydraulic conductivity (HC). On an average, the order of relative percent contribution of these indicators towards SQI was: available N (29.33%) > MBC (28.22%) > HC (18.19%) > available K (18.05%) > S (6.31 %).
- From the viewpoint of yield and sustainability yield index (SYI), CT approach remained superior to ZT.
- The average yield of sorghum was highest under CTGLN₉₀ (1589 kg ha⁻¹) followed by



INM options in castor and sorghum

CTSSN₉₀ (1476 kg ha⁻¹) and CTGLN₆₀ (1459 kg ha⁻¹).

- In case of castor, highest average yield was recorded under CTGLN₉₀ (1090 kg ha⁻¹) followed by CTGLN₆₀ (1039 kg ha⁻¹) and CTNRN₉₀ (1037 kg ha⁻¹).
- Application of gliricidia loppings @ 2t ha⁻¹ resulted in significantly higher yield of crops compared to sorghum residue and 'no' residue application.

These studies thus clearly indicate that to maintain yield as well as soil quality in Alfisols, primary tillage supplemented with organic residue and nitrogen is the best management practice.

2.2.4 Nutrition studies in vegetable pigeonpea

To workout the manurial requirement of vegetable type pigeonpea cv ICP 7035, a trial was conducted with the following INM treatments: recommended N and P₂O₅ (@ 10 and 20 kg ha⁻¹) all inorganic, recommended N and P₂O₅ through vermi-compost (2 t ha⁻¹) + single super phosphate (62.5 kg ha⁻¹), recommended N and P₂O₅ through bone meal (150 kg ha⁻¹) + urea (4.4 kg ha⁻¹), and control (No N and no P₂O₅). Results were as follows:

- All the integrated nutrient management treatments were on par for fresh pod produce, and yielded higher than the control, indicating that major



Vegetable type pigeonpea

portion of recommended N and P₂O₅ can be supplied through either vermi-compost (100% N and 50% P₂O₅) or bone meal (80% N and 100% P₂O₅).

2.2.5 Studies on nutrient supply and moisture availability in cotton based production system (NATP)

A laboratory incubation experiment was conducted to study N mineralization from rainfed cotton growing soils. Twenty four soil samples from 15 villages of A.P, Karnataka and Maharashtra were analyzed for soil water characteristics, pH, E.C, organic carbon, available N and total N. The 24 soils were incubated at field capacity (FC) and 75% FC soil water contents and the mineralization of N was monitored. Results showed that the soils differed considerably in the quantities of N mineralized, both by absolute amounts and as per cent of total soil N (Fig. 2.15). Nitrogen mineralization from all the soils was considerably higher at FC compared to 75% FC.

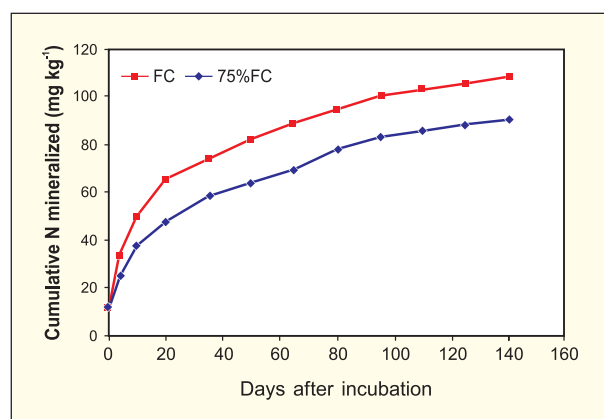


Fig.2.15 Nitrogen release from rainfed cotton growing soils (mean of 24 soils) as influenced by moisture regime

2.2.6 Regenerative agricultural technology with low external inputs (AP-Cess)

The food production systems over years suffer degradation of the natural base for which restoration is not done by the farmers. Seeking ways to restore or regenerate them toward their original state through making maximum use of the

internal resources, which are renewable, is the need of the hour.

Keeping this in view, on-farm trials focusing groundnut shell as a manure to reduce the cost of fertilizer and maintain sustainable yield of groundnut, were conducted with the involvement of 15 farmers in Tadiparthi and Eddamagadda villages of Mahaboobnagar district. As a part of the implementation of the programme 15 farmers in each village were trained in preparing groundnut shell manure using groundnut shell as a bedding material in the cattle shed. The spread shell got soaked in urine within one or two days. This soaked groundnut shell was scrapped out to make a heap. After two months, this manure was applied as per the treatments during *kharif* and *rabi*.

Preliminary results obtained were as follows:

- Raw groundnut shell contains 1.25% N, traces of P, 0.62% K₂O and 0.34% calcium. After bedding, this gets reinforced and groundnut shell manure now contains 1.75% N, 0.15% P₂O₅ and 0.8% K₂O.
- The farmers are very enthusiastic about the advantages of utilizing crop residues for recycling which is reflected in farmers using even castor shell as bedding material on their own.
- Application of this manure to groundnut crop led to improvement in growth parameters and reflected in reaping about 10-15% more yield over farmer's practice.



Groundnut shell as bedding material which can later be utilized as organic manure

2.2.7 Alternate uses of fly ash

The long term effect of fly ash on soil physical and chemical properties are being investigated at CRIDA farm in a two year old agrisilviculture system. The results obtained this year are presented below:

- The treatment receiving the maximum dose of fly ash in teak significantly increased the diameter of two year old teak plants. The effect of flyash was non-significant in *subabul* (Table 2.11).
- A decrease in soluble salt content was observed in fly ash treated pits as compared to other treatments in both teak and *subabul* while a decrease in soil pH was noticed in *subabul*.
- The organic carbon content improved in the micro sites that received maximum quantity of fly ash along with compost in both tree species.

Table 2.11 Influence of fly ash in an agrisilviculture system

Treatment	Teak				Subabul			
	DBH (cm)	pH	EC (dSm ⁻¹)	OC (g kg ⁻¹)	DBH (cm)	pH	EC (dSm ⁻¹)	OC (g kg ⁻¹)
S:TS:C 1:1:1	4.14	6.7	0.34	6.0	6.16	6.9	0.38	7.1
FA:C 2:1	4.81	6.6	0.20	8.4	6.16	6.2	0.16	8.4
S:FA+TS:C 1:1:1	4.34	6.4	0.37	4.7	6.53	6.5	0.37	7.1
S:FA:C 1:1:1	4.78	6.4	0.32	4.9	6.12	6.3	0.21	6.6
CD *	0.44	0.3	0.06	1.0	NS	0.3	0.06	1.0
**	NS	NS	0.08	1.4	NS	0.4	0.08	1.4

S-soil; TS-tank silt; FA-fly ash; C-compost

2.3 Rainwater management

2.3.1 Evaluation of various soil and rainwater conservation practices in Alfisols

Bunding, land configurations and mulching are some of the options for in situ soil and water conservation in arable areas. Of late, mulching cum manuring is being recommended as an Integrated Nutrient Management practice. This practice is gaining importance in view of the need for improving the organic matter content of the soil and also cost reduction through on-farm generated inputs. Past experience in working with the farmers have shown that they prefer field boundary bunds to contour or graded bunds. This study was therefore initiated to assess the effect of the various practices, singly or in combination, to provide a basis for recommending various options to the farmers. The results are as under:

- Despite severe drought, castor cv Kranthi gave fairly good mean yield of 762 kg ha⁻¹ with conservation treatments.
- Live bunds recorded significantly higher yield of 854 kg ha⁻¹ over graded (714 kg ha⁻¹) and boundary bunds (717 kg ha⁻¹).
- The treatment differences due to land configurations were not significant. Sowing flat and ridging later, conservation furrows and farmers practice recorded yield of 743, 735 and 806 kg ha⁻¹, respectively.
- Treatment differences due to fertilizers were significant. Productivity was 843 kg ha⁻¹ for chemical fertilizer, 791 for 50% N by compost, and 650 kg ha⁻¹ for 75% N through gliricidia.

The lower yield in gliricidia could be due to late application of mulch constrained by agricultural operations and consequent delay in decomposition and nutrient availability to the crop. In view of the variability of results during different years, a pooled analysis would be required to

arrive at some conclusions after concluding the experiment.

2.3.2 Watershed-based NRM strategies in Prakasam district (AP-Cess)

These collaborative experiments were initiated at CTRI regional station, Kandukur, Prakasam district, A.P. for resource conservation through live-bed system and for efficient utilisation of the S-W monsoon rains through cover cropping, water harvesting for supplemental irrigation to get higher yield and quality of Flue cured Virginia (FCV) tobacco. Pros and cons of these two interventions are summarized below:

Live-bed System

- Tobacco is remarkably sensitive to water logging and a mere 24 hour stagnation near the rhizosphere is lethal. This necessitates a safe disposal of rainwater. Hence, live-bed system on contour with mild gradient for disposal of excess rainfall and also for production of green leaf manure was mounted for long term studies.
- The quality of tobacco is influenced by organic matter content of the soil. *In-situ* generation of organic matter is possible by planting fast growing leguminous *Gliricidia* in paired rows. The prunings of *Gliricidia* are rich source of organic matter.
- The live-bed covering an area of 444 m² in an hectare will result in loss of productive crop area which is significant for a small farmer. The loss can be compensated by producing biomass of gliricidia and stylo. In the first year itself, stylo yielded 887 kg ha⁻¹ on fresh weight, and 301 kg ha⁻¹ on dry weight basis.
- The yield of tobacco was high under live-bed system compared to control (Table 2.12) even after considering the area lost due to live-beds. Similarly grade index and per cent bright leaf was high with live-bed system.

Table 2.12 Yield of FCV tobacco with and without live-bed system

Treatment	Yield (kg ha ⁻¹)			Grade Index	Bright Leaf%
	Green Leaf	Cured Leaf	Bright Leaf		
With live-bed	9012	1448	838	1257	57.88
Without live-bed	8031	1262	709	1086	56.18
Mean	8522	1356	773	1172	57.00

Cover Cropping

- Greengram, cowpea and sunnhemp as cover crops were raised during the monsoon. Fresh biomass from greengram, cowpea and sunnhemp was 3200, 4900 and 9500 kg ha⁻¹, respectively which is less due to prolonged dry spells.
- The highest green leaf, cured leaf, bright leaf yield,% bright leaf and grade index was recorded with incorporation of sunnhemp. The yield did not vary significantly with cover crops, while N-levels had significant influence. The highest yield was recorded with 50 kg N/ha (Table 2.13). The crop passed through severe moisture stress due to drought.

2.3.3 Evaluation of watershed treatment measures in Srikakulam district

The evaluation was conducted on three micro-watersheds: Geddakancharam (712 ha), Murapaka-1 (434 ha), and Lopenta (407 ha) of Srikakulam district, Andhra Pradesh. In all the three, major share of investment was on drainage line treatments.

As part of the evaluation, soil loss for the individual drainage lines was estimated using two models developed by Morgan & Finney, and Stehlik (Table 2.14). The observed and estimated soil loss values matched with few of the drainage lines, while the variation was much higher for the others causing doubts on the efficacy of the models. In

Table 2.13 Yield of FCV tobacco cv Henna as influenced by cover crops and nitrogen

Treatment	Yield (kg ha ⁻¹)			Percent bright leaf	Grade index
	Green Leaf	Cured Leaf	Bright Leaf		
Cover crops					
Green gram	9166	1458	810	55.6	1204
Cowpea	9591	1509	810	53.7	1238
Sunnhemp	9902	1570	876	55.8	1291
Fallow	9155	1456	809	55.6	1188
N-levels					
25.0 kg/ha N/ha	8422	1331	731	54.9	1082
37.5 kg/ha N/ha	9237	1483	844	56.9	1229
50.0 kg/ha N/ha	9988	1579	859	54.4	1300
62.5 kg/ha N/ha	1077	1600	871	54.4	1310
General mean	9454	1498	826	55.1	1230
CD at 5%					
Main plots	NS	NS	73.13		NS
Sub-plots	685.2	99.7	67.4		98.99
Interaction	NS	NS	NS		NS

Table 2.14 Observed and estimated sedimentation in 3 microwatersheds

Mircro-watershed	Name of drainage line	Observed sediment (t)	Estimated sediment (t)
GLWS (Geddakancharam)	PGDL-Pillalagedda	183	203
	MKTGDL	585	1288
	DVGDL-Devaragedda	2346	6533
	AYVGDL-Ayyavarigedda	1594	2944
	NYDGL-Nayannadoragedda	286	539
MPK-1 WS (Murapaka-1)	GBDL-Gollavanibathi	63	94
	SVGDL-Salivanigedda	118	911
	TCGDL-Tamminaiducheruvugedda	851	3557
	DSVBDL-Desavanibathi	401	665
LOPWS (Lopenta)	SDGDL-Suddagedda	571	1465
	YPGDL-Yatapetagedda	215	335
	RCGDL-Ramacheruvugedda	256	390
	VNCGDL-Vallannacheruvugedda	147	647

order to assess the relation between other morphometric parameters and soil loss, drainage density values for these drainage lines were plotted against ratio of observed to estimated sediment values (Fig 2.16). The estimated sediment loads were revised by considering the drainage density. The resultant estimated sediment loads were more closer to observed values than the initial model estimates. Based on the above research finding, the process for prioritization of watershed could be changed to the following:

Step 1. An initial estimate of soil loss by the above models could be made.

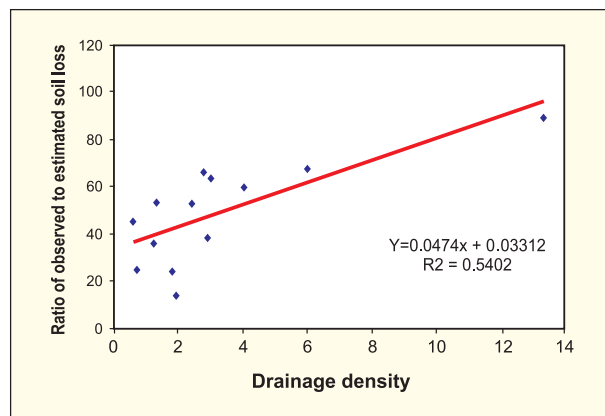


Fig.2.16 Relation between drainage density and ratio of observed to predicted soil loss

Step 2. This estimate be further revised by accounting for drainage density.

Step 3. Based on this revised soil loss estimates, the watersheds could be prioritized for treatment to reduce the resource losses.

2.3.4 Regional scale watershed plans for nutritious cereal production systems (NATP)

This is a collaborative project with NRSA to implement watershed development in a sorghum-based production system in drought-prone Nalgonda district of AP. This year the following activities were undertaken.

- Land development works like earthen check dam, gabion drops, loose boulder structures, sand bag checks, recharge pits, and diversion channels were completed.
- The hydrologic gauging stations with H-flumes were erected. The analysis of hydrologic data indicated the effectiveness of conservation measures in reducing resource losses. The treated hillocks having a series of depression storages in the diversion channel bed could reduce runoff by 90% compared to untreated watershed.



Sand bag structure as gully check



Gabion drop structure



Ground water monitoring



Display board in watershed area

- Continuing the preference for sorghum cv SPV-462 introduced last year, the farmers gained an additional 20% yield advantage over the local.

2.3.5 Impact of watershed management practices on sustainability (NATP)

In an effort to know the impact of ongoing watershed development programmes (WDPs) in the country, the present study was taken up. The main findings were:

- Of the 31 watersheds studied, only seven performed well, and 19 showed average performance. Significant differences were not detected when comparisons were made on soil or climate basis. Differences were mainly related to the agency that implemented the programme.
- Among the various indicators, farmers' participation in planning, execution, supervision, monitoring and evaluation declined gradually.
- There was a general increase in productivity of crops as well as livestock production
- The stakeholders evinced interest in the implementation of the WDP
- The SWOT analysis of the watersheds indicated that the success in WDP revolved around four issues.
 - i. Rainwater harvesting
 - ii. Development of proper vegetation
 - iii. A good training and capacity building to be imparted to farmers, besides viable CBOs, and
 - iv. Participatory development of action plan and execution
- On the other hand the failures were largely due to :

- i. Mismanagement of CPRs
- ii. Poor quality of work in water harvesting structures
- iii. Paying less attention to the demands of the primary stakeholders
- iv. Inaccessibility to loans, watershed funds, improved seeds, and
- v. Remoteness of the site

2.3.6 Indigenous moisture conservation and runoff management practices (NATP)

Experiments were taken up at Hyderabad, Jabalpur, Solapur and Bijapur involving moisture conservation practices. The following results were obtained:

- Hyderabad: There was an average increase of 10.6% (w/w) in soil moisture recorded in the plots with conservation furrows as compared to control plots (Fig. 2.17). These plots recorded an average increase of 10% in plant height, leaf, stem and racemes dry matter accumulation of castor. Castor yield was increased by 11% over control (343 kg ha^{-1}).
- Jabalpur: Plots with furrows recorded 12.3% more moisture than control plots. An yield increase of 15 - 23% in wheat, and 37 - 51% in lentil was recorded in these plots.
- Solapur: During *rabi* season, sorghum was sown in greengram biomass incorporated fields. The mean soil moisture content was 10 - 20%

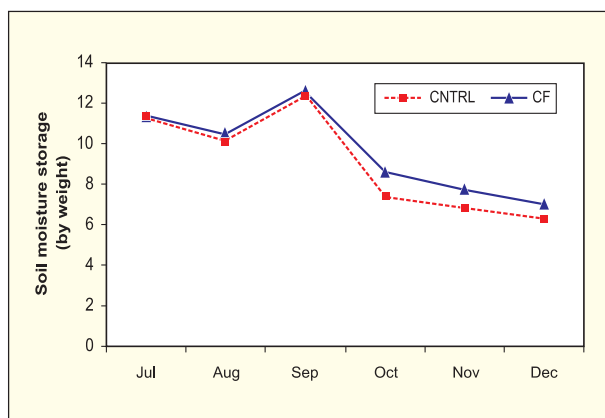


Fig.2.17 Soil moisture storage under conservation furrows



Conservation furrows at Hyderabad location

higher with cultivation of greengram in *kharif* for pod and cover incorporation + hoeing in *rabi* sorghum as compared to off season ploughing and 3 harrowings. This moisture increase translated to 23-48% increased *rabi* sorghum yield.

- Bijapur: The yield of *rabi* sorghum was significantly higher with *in-situ* incorporation of greengram residues (2968 kg ha^{-1}) followed by compartment bunding (2704 kg ha^{-1}) compared to farmers' practice (2477 kg ha^{-1}). The planting geometry also influenced yield and other characters significantly. The increase in grain yield with wider row spacing with frequent deep inter-cultivation was 85 and 25% over farmers' practice and paired row spacing.

2.4 Crops and Cropping Systems

2.4.1 Evaluation of maize for sustainable grain and fodder production

The study was taken up to quantify the growth and productivity parameters of maize under different types of fertilizer application along with harvesting techniques for enhanced production of grain and fodder. The maize cultivars (Harsha, DHM-105, African Tall, and Teosinte) were grown in three replications with varied fertilizer treatments consisting of inorganic (100%); Inorganic (50%) + FYM (50%), and FYM(100%). The inorganic treatment was

through recommended dose of 40N:30P₂O₅ as basal and 20N through urea as top dressing. In the other two treatments, the nutrients were supplemented through 50% FYM and 100% FYM respectively. The salient findings were :

- Under triple harvesting technique the fresh fodder weight and grain yield were highest in the crop grown with FYM, followed by inorganic +FYM, and inorganic treatments.
- Under triple harvesting technique, fresh fodder yield of cv Harsha was the best followed by cv African Tall.
- Grain yield in the triple harvesting technique was highest in hybrid DHM-105, followed by Harsha and African Tall.
- In the full plant harvest for fresh weight at tasselling stage, highest yield was recorded by cv African Tall followed by Teosinte. However in the full plant harvest for dry weight at maturity, Teosinte yielded highest followed by

African Tall. The grain yield at full plant final harvest was highest in cv DHM-105 following by cvs Harsha and African Tall (Table 2.15).

- cv Harsha was the earliest to flower with lowest Anthesis - Silking Interval (an index for tolerance to moisture stress), followed by cvs DHM- 105, African Tall and Teosinte.

2.4.2 Evaluation of sunflower cultivars under moisture and nutrient constraints (NATP)

- Sunflower cv KBSH 1 recorded >25%, higher yield over cvs MSFH 17, and Morden (580 kg ha⁻¹), respectively.
- cv KBSH1 performed well under nutrient and moisture constraints also.
- Moisture conservation practices and application of recommended dose of fertilizer recorded 40% higher net income than farmers' practice (Rs. 7413/ha).

Table 2.15 Seed and fodder yield of maize

Cultivars	Seed wt. FP (F)	Seed wt. (c) HP (F)	Fresh fodder wt.FP (T)	Fresh fodder wt.(a)HP(T)	Dry fodder wt. FP (T)	Dry fodder wt.(b) HP(F)
Inorganic						
Harsha	99.33	81.00	739.00	211.66	170.66	64.00
DHM-105	132.00	92.33	641.66	169.66	156.66	80.70
African Tall	54.33	33.66	978.33	180.00	181.00	109.30
Teosinte	44.00	-	750.00	-	265.00	-
Inorganic (50%) + FYM (50%)						
Harsha	90.33	75.00	1087.33	275.66	229.66	92.66
DHM-105	140.00	107.00	530.00	176.66	129.33	107.33
African Tall	62.66	46.33	1198.33	226.66	235.33	127.66
Teosinte	33.33	-	1102.66	-	372.33	-
FYM						
Harsha	131.33	103.00	789.00	271.00	172.33	78.33
DHM-105	148.66	114.00	597.00	174.00	132.00	88.66
African Tall	110.00	89.66	136.33	250.00	254.66	106.33
Teosinte	58.33	-	1134.33	-	333.33	-

FP = full plant, HP= half plant, T= tillering stage, F= final stage, a= harvest above cob, b=remaining part of plant after (a), c =seed weight from (b)

- Significant interaction was observed between fertilizer, cultivar and moisture conservation. KBSH 1 with moisture conservation and recommended fertilizer dose (60:30:30 kg ha⁻¹) recorded higher yield (1650 kg ha⁻¹).

2.4.3 Research gaps in intercropping systems (NATP)

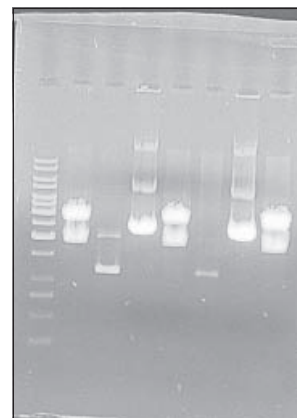
The project identified the critical gaps in intercropping systems (ICS) based on the survey conducted in 3207 farmers' fields in 32 districts covering marginal, small, medium and large farmers. Critical research gaps, researchable issues, recommendations for development agencies, extension network and farmers were identified. Domestic needs followed by lack of suitable implements for adopting different row proportions are the criteria for selection of crops by the farmers.

Critical review of research on ICS in rainfed regions during the last 30 years under different soil and climatic conditions was carried out. The predominant base crops have been identified as rice, sorghum, maize, pearl millet, pigeonpea, groundnut and soybean. Pigeonpea was the most preferred component crop followed by short duration pulses, groundnut and sunflower. Most of the work has been confined to crop combinations and row ratios only, leaving great scope for analysis on sustainability and economic considerations. The review findings were published in the form of a book entitled "Critical Review of research on Intercropping Systems in Rainfed Regions of India".

2.4.4 Enhancing tolerance of sorghum to abiotic stresses through genetic manipulation (AP-NL)

- Scanning Electron Microscopy (SEM) of 20 day old calli growing on MS with 2,4-D and kinetin was carried out at Ruska labs, ANGRAU. The studies indicated regeneration through somatic embryogenesis.

- Preparation of *mtlD* gene construct: PCR product of *mtlD* gene was cloned initially into TOPO TA cloning vector and subsequently into pRT101. It was then mobilized along with CaMV35S promoter and nos terminator into pCAMBIA 1305.1 and pCAMBIA 1300. These constructs namely pCB *mtlD* CRIDA1 (*mtlD* gene cloned in pCAMBIA 1305.1) and pCB *mtlD* CRIDA2 (*mtlD* gene cloned in pCAMBIA 1300) will thereafter to be used for transformation.



Construct preparation of *mtlD* gene

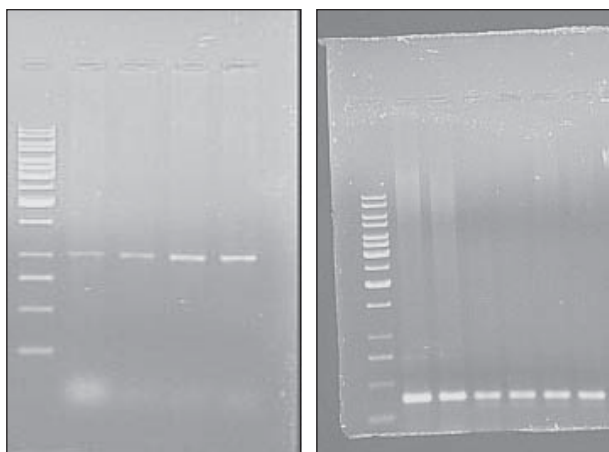
- To optimise the concentration of hygromycin for selecting the transformants, a kill curve was generated using 20 day old calli and different concentrations (3, 4, 5, 6, 8, 10, 12, 14 & 16 mg l⁻¹) of hygromycin and 6mg l⁻¹ was found optimal for selecting the transformed calli.
- The conditions for bombardment were standardised for using GENE PRO 2000 He



Plantlets regenerated from transformed (*pCAMBIA* vector 1305.1) calli grown on medium containing hygromycin

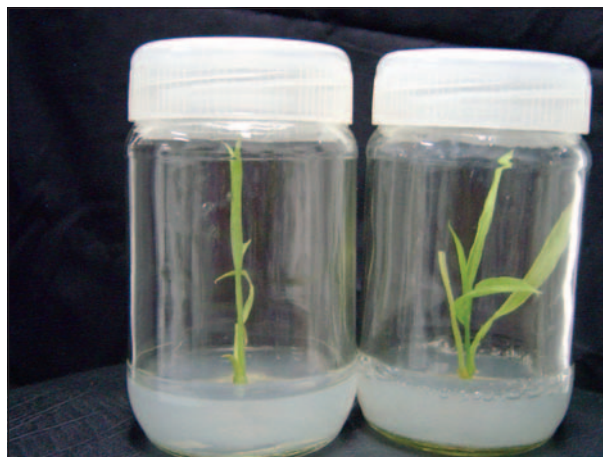
for achieving higher frequency of transformation. The stage of callus, distance of coated particle holder to target tissue and pressure were standardized to get the maximum frequency of transformation. Twenty-day-old shoot tip calli and *pCAMBIA 1305.1* binary vectors with *nptII* for bacterial selection, *hptII* for plant selection, and GUS as reporter gene were used in the above experiments. GUS assay was used to assess transformation frequency. Putative transformants were selected on media containing hygromycin.

- DNA isolated from the transformants generated using *pCAMBIA* vector 1305.1 growing on media containing hygromycin was used for PCR verification using *nptII* and *hptII* primers. Amplification of 1050 bp fragment for *nptII* and 350 bp fragments for *hptII* primers was observed in the vector-transformed plants. Eleven of the putative transgenic plantlets (using *pCAMBIA 1305.1*) were found to be PCR positive.



Get showing PCR amplified fragment in respect of
a) *nptII* primers b) *hptII* primers

- Shoot tip derived calli were bombarded with *pCB mtID CRIDA2* construct. Putative transgenics were selected and maintained on media containing hygromycin. PCR amplification using *hptII* and *nptII* primers, revealed the characteristic 350bp and 1050bp fragments, respectively.



Plantlets regenerated from transformed (with *mtID* gene in *pCAMBIA 1300*) calli growing on medium containing hygromycin

2.4.5 Drought tolerance in short duration pulses

The effect of water deficit on different physiological parameters, metabolites and grain yield was studied in greengram cvs ML-267 and WGG-37. Significant results are summarized:

- Water stress imposed at flowering and pod filling decreased leaf water potential, osmotic potential, relative water content, dry matter accumulation and seed yield in both the varieties.
- Proline accumulation under water stress was quite notable compared to accumulation of free amino acid and total soluble sugars.
- The reduction in seed yield was more via the reduction in pod number when stress was imposed at flowering, and via a reduction in seed filling when it was imposed at pod filling stage.
- cv WGG-37 yielded more than cv ML-267 under control and stressed conditions.

2.4.6 Studies on elevated carbon dioxide and water deficit (AP-Cess)

The germination rate of cereals (sorghum), pulses (blackgram) and oilseed (castor) crops at different time intervals was monitored under elevated CO_2 ($\text{Ch} + \text{CO}_2$) at 700 ppm and ambient (control)

conditions. In order to minimize the chamber effect the experiments were simultaneously carried out in the chamber with ambient CO_2 level and it served as chamber control (Ch- CO_2). The effect of elevated CO_2 during germination was monitored in terms of fresh weight gain and dry weight loss at 24 h interval and was calculated over the initial weight of the seeds. The following results were obtained:

- Elevated CO_2 levels enhanced the rate of germination especially at initial stages of germination (Fig. 2.18). There was a significant difference with elevated CO_2 at 48 h in sorghum, and upto 72 h in blackgram. In castor the difference was observed till the end of the study. Even though there was difference during initial germination in sorghum and blackgram, control also registered the same level of germination at the end of the trial. Castor behaved in a

different way in the rate and percentage of germination. At the end of the experiment, germination was significantly higher under elevated CO_2 when compared with the control.

- The increase in fresh weight of seeds during germination was more under elevated CO_2 in all the three crops (Fig. 2.19). The increment was significant after 48 h. Decrease in dry weight of seed was found more in sorghum and blackgram under elevated CO_2 condition over the control while it was significantly less in castor.

2.4.7 IPM modules for major pests of castor

Various integrated pest management components were tested individually and also as sequential sprays formulated into different modules against castor semilooper. Results indicated that sequential spray of *Bt* (0.2%) and Quinalphos (0.05%) was most effective in reducing semilooper population. Individual application of *Bt* (two sprays), sequential spray of Quinalphos (0.05%) and NSKE (5%), *GV* (250LE) and Quinalphos (0.05%) and two sprays of Quinalphos (0.05%) were the next best. Two sprays of *Bt* (0.2%) was on par with two sprays of Quinalphos (0.05%). Two sprays of *GV* was superior to NSKE in controlling the pest. Larval reduction was significantly higher in all the three IPM modules compared to their components when they were tested individually.

Studies on Economic Threshold Levels for castor semilooper revealed that estimated loss per insect was 3.5 and 2.26 kg when the crop was at 30 and 60 days, respectively. From the Gain Threshold values it was concluded that for the insecticide application to be profitable, at least 40.8 and 81.8 kg seed per ha need to be saved at 30 and 60 days after sowing, respectively. The initiation of pest control measures is recommended when the semilooper population per 10 plants is more than 8 and 25 at 30 and 60 days after sowing, respectively.

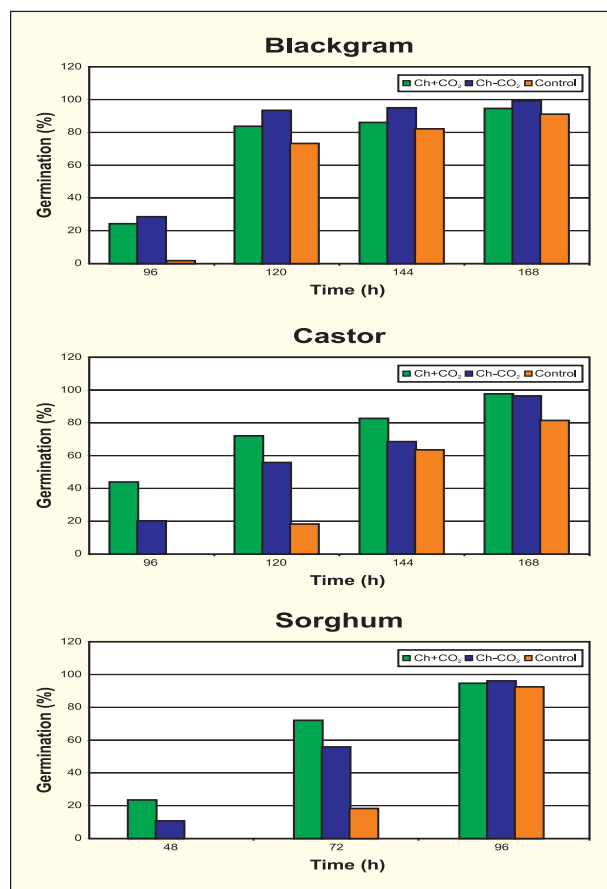


Fig.2.18 Germination at different time intervals under elevated CO_2

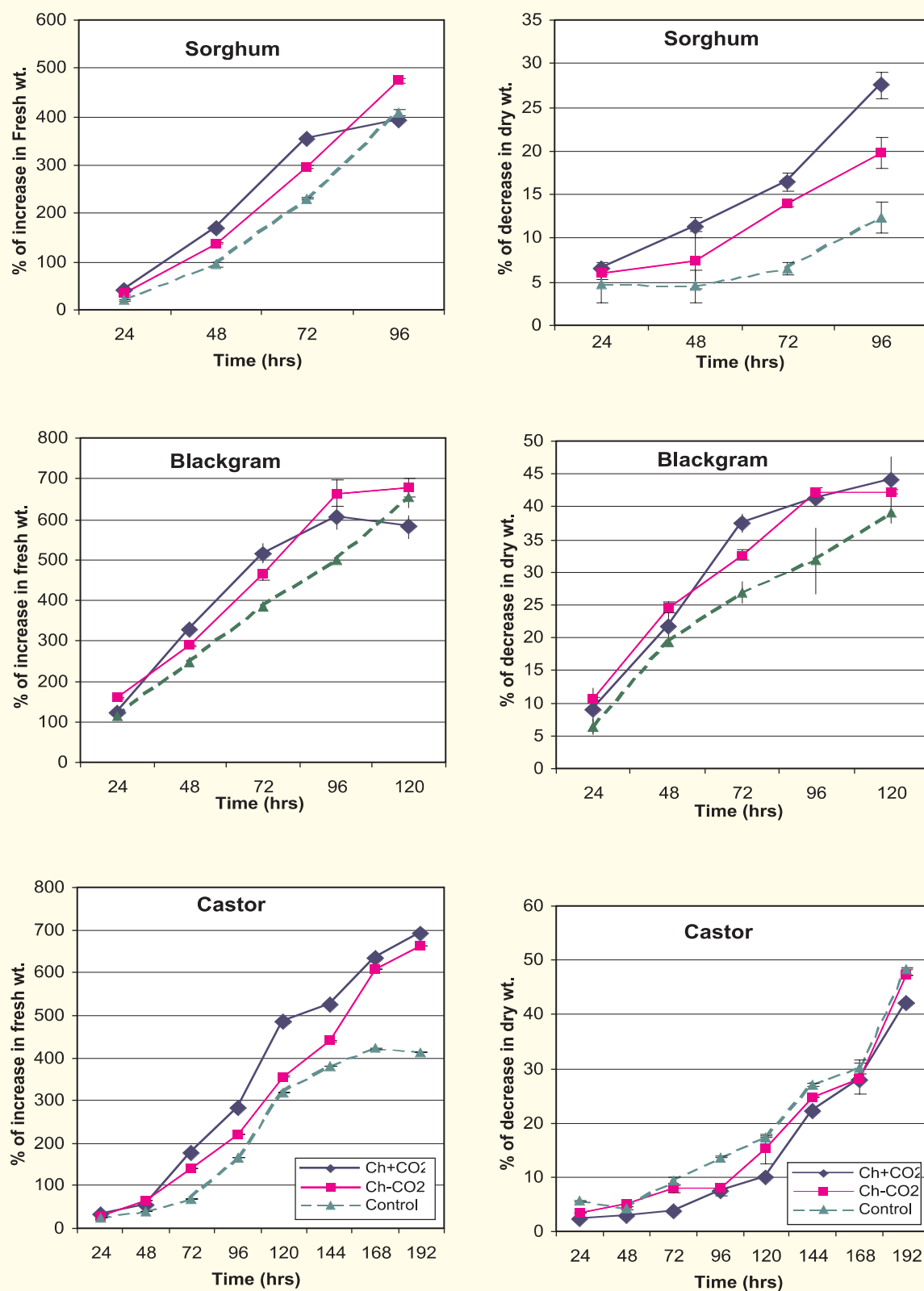


Fig.2.19 The changes in seedling fresh weight and dry weight at different time intervals during germination in sorghum, blackgram and castor

2.4.8 Crop-crop diversity and IPM (AP-Cess)

The survey results in on-farm trials conducted at two villages of Rangareddy district, and results obtained from on-station trials are given below:

- The most popular intercropping systems were sorghum + pigeonpea, castor + pigeonpea, maize + pigeonpea, and pigeonpea + cowpea.
- The matrix ranking for the adoption of various cropping systems revealed that castor + pigeonpea ranked higher with respect to profit and drought tolerance. Sorghum + pigeonpea system occupied next best rank for biotic and abiotic tolerance.
- Crop-crop diversity involving pigeonpea: pigeonpea (cv PRG-100)+ blackgram (cv T-9) (1:2), pigeonpea + castor (cv Kranthi) (1:1), pigeonpea + greengram (cv ML-267)' (1:2), pigeonpea + maize (cv Harsha) (1:2), pigeonpea + groundnut (cv JL-24)(1:2), pigeonpea + sunflower (cv Morden)(1:2), pigeonpea + sorghum (cv SPV-30)(1:2), pigeonpea+ soyabean (cv JS -335)(1:2), and pigeonpea sole.
- Crop - crop diversity involving castor: castor (cv Kranthi)+ blackgram (cv T-9)(1:2), castor + pigeonpea (cv PRG-100)(5:1), castor + greengram (cv ML-267) (1:2), castor + cowpea (cv C-152) (1:2), castor + groundnut (cv JL-24) (1:2), castor + sunflower (Morden)(1:2), castor + sorghum (cv SPV-462)(1:2), castor + clusterbean (cv Navbahar) (1:2), and Castor sole.
- Population of natural enemies viz., spiders and coccinellid beetles were found in significant number in majority of the cropping systems. The presence of parasitoid, *Microplitis maculipennis* on castor semi-looper was also recorded.
- Incidence of various pests of castor and pigeon pea varied among intercropping systems. Insect pest fluctuations were noticed and temporal variation was much evident. Castor sole crop recorded higher population of leafhopper (nymphs) followed by castor+soybean (Fig 2.20).



Sorghum + pigeonpea

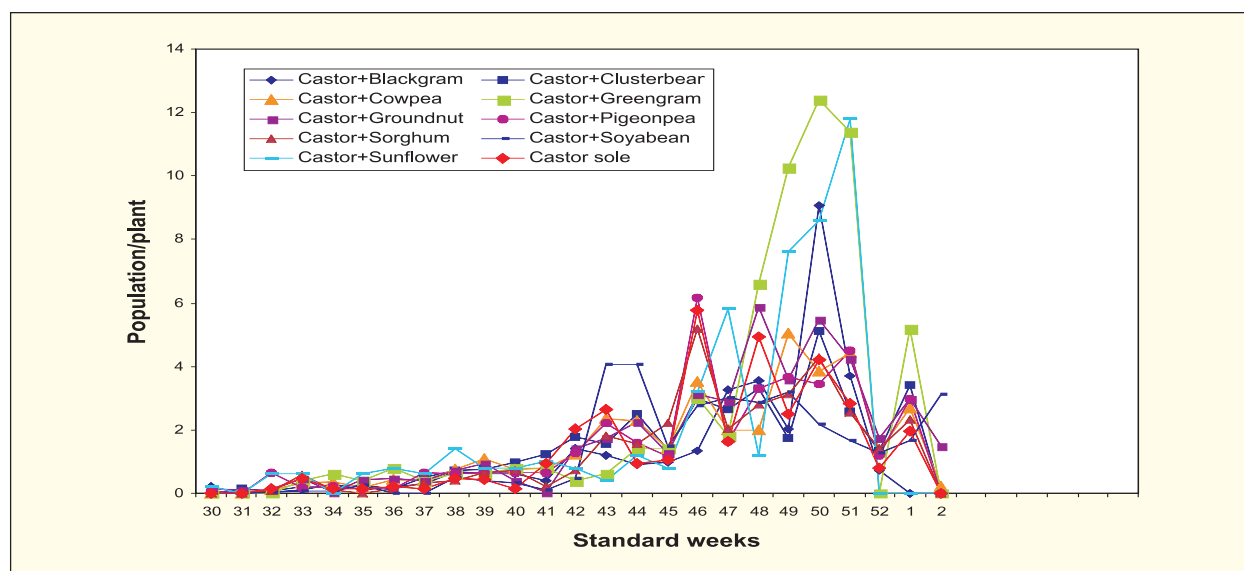


Fig.2.20 Incidence of pests in castor-based cropping systems

- Castor+clusterbean recorded less infestation of leafhopper and semilooper and more equivalent yields.
- The castor +sorghum system (1:2) was not good as castor was suppressed by sorghum.
- The castor + clusterbean and castor + cowpea systems nurtured higher natural enemy population and inturn recorded less pest incidence.
- Pigeonpea+sorghum recorded low incidence of insect pests.

2.4.9 Bio-intensive IPM (AP-NL)

Several IPM modules in castor and groundnut were evaluated in the farmers fields of Chityala and Nandimallagadda villages of Mahaboobnagar district after documentation of existing plant protection measures through focus group interaction and bench mark survey. The study covered 78 farmers from 4 villages. Bio-intensive IPM modules (Table 2.16) along with farmers' practice were planned in castor (135 acres), groundnut (26 acres) and redgram (8 acres sole and 36 acres intercropped redgram). The major results were:

- Semilooper incidence on castor was managed with treatments falling under 5 defined IPM modules comprising of two or more components: 1) Release of *Trichogramma* egg parasitoid 2) Neem oil spray 3) Granulosis virus spray 4) Bt spray 5) Combination of GV with half dose of Bt or insecticide 6) Insecticide spray

- Severe infestation of *Spodoptera* on castor was managed successfully through implementation of a simple technique: mechanical collection and destruction of infested leaves by farmers in about 100 acres of castor in 5 target villages. The practice saved one chemical spray in castor in farmers' fields. In about 5 acres of castor where farmers did not adopt mechanical collection, resorting to poison baiting technique controlled dispersed grown up larvae in about 4 days time.
- A severe incidence of leafminer on groundnut coupled with a low to moderate incidence of leaf spot disease was managed by sprays with insecticides and fungicides in the first week of September in about 15 acres of groundnut crop in four villages.
- Castor yields in Bio-intensive IPM modules and Farmers' practice fields were non-significant indicating that either both or one of the insecticide sprays practiced by farmers to control semilooper could be replaced with bio-intensive practices. C:B ratio was highest in IPM module 5 where in a prophylactic spray of neem oil was followed by two granulosis virus sprays combined with half dose of Bt or insecticide. This was closely followed by IPM module 2 where in releases of *Trichogramma* egg parasitoid were followed by one spray of Bt and one spray of granulosis virus spray (Table 2.16).

Table 2.16 Economics of Bio-intensive IPM in Castor

Treatment [#]	No. of fields	Mean yield (kg/ac)	Returns* (Rs)	Protection Costs (Rs)	Additional returns (Rs)	Additional cost (Rs)	C: B Ratio
IPM module 1	8	240.0	3600	265	214	115	1.86
IPM module 2	11	252.3	3784	339	398	189	2.11
IPM module 3	11	247.3	3710	339	324	189	1.71
IPM module 4	11	240.3	3605	376	219	226	0.97
IPM module 5	7	259.9	3898	376	512	226	2.27
Farmers' practice	7	225.7	3386	150	-	-	-

[#] Farmers' practice: Two sprays of Quinalphos; IPM 1=Neem oil-GV-Quinalphos; IPM 2=Tricho-GV-Bt; IPM 3=Tricho-Bt-GV; IPM 4=GV+1/2 Quinalphos-GV+1/2 Bt; IPM 5=GV+1/2 Bt - GV+1/2 q [§] One blanket spray of Chlorpyrifos against capsule borer *Sale price of castor beans @ Rs 1500 q⁻¹

- Studies on biology of the solitary ecto parasite of castor semilooper *Microplitis maculipennis* indicated that egg and larval stages were completed within the body of semilooper in 6.25 ± 0.96 days. The parasitic grub emerged from host larvae just before pupation. The infected larvae completely stopped feeding soon after the parasitic grub emerged out from its body. Cocoon and adult periods lasted for 5.08 ± 0.90 and 3.5 ± 1.02 days respectively. Total life cycle was completed in 16 ± 3.28 days
- Laboratory studies on damage potential of three species of caterpillars on castor revealed that red hairy caterpillar (*Amsacta albistriga*) was the most destructive species compared to semilooper (*Achaea janata*) and tobacco caterpillar (*Spodoptera litura*) and the leaf area consumed per larvae through out its life cycle was recorded as 439, 141 and 100 cm², respectively.

2.4.10 Development of weather-based forewarning systems for pests and diseases (NATP)

From the historical data on cotton and groundnut the following thumb rules or predictive equations were developed.

- Rain followed by dry spell of three weeks, maximum temperature between 32 - 36° C and minimum temperature of 21 - 23° C during dry spell will trigger aphid population in groundnut.
- Empirical models with good fit for prediction of bacterial leaf blight one week in advance in cotton was developed for Guntur (Fig. 2.21).

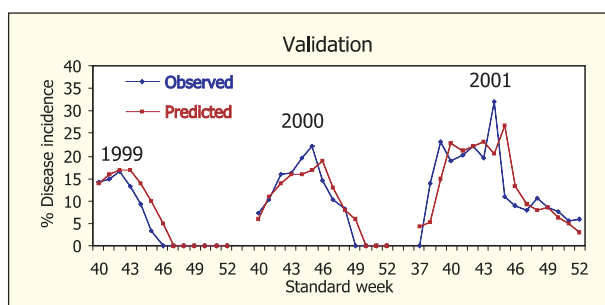


Fig.2.21 Prediction of bacterial leaf blight in cotton at Guntur (1982-94)

- Decision support model was developed for prediction of late leaf spot on groundnut. The risk values based on weather parameters were:

Weather Parameter	Risk value		
	Low	Moderate	High
Maximum temperature (°C)	31-33	28-30	25-27
Minimum temperature (°C)	14-16	17-19	20-24
Relative humidity 1	70-80	81-90	>90
Relative humidity 2	55-65	66-75	>75
Sunshine hours	5-6	3-5	<3
Rainy days	1	2	3

Criteria for the model were:

- Daily weather conditions were classified according to conduciveness for late leaf spot development from June to October.
- Three-day summation of risk values was assigned to each parameter.
- Based on accumulated risk values, three-day period was classified as low (16 - 28), moderate (29 - 43) and high (44 - 70) for disease development.

2.5 Alternate land use systems

2.5.1 Canopy management of leucaena

The present study was initiated during *kharif* 2000 to study the effect of pollarding on pasture production (*Cenchrus ciliaris* and *Stylosanthes hamata*), physico-chemical properties of the soil, and compare the performance of sheep maintained under established silvipasture vis-à-vis natural grassland. During this year, the following results were obtained:

- Light infiltration (% of PAR in open) was more in the centre of the alleys. Trees pollarded at 0.5m height from ground level allowed more than double the amount of light as compared to trees pollarded at 2m.

- Above ground dry biomass of the pasture species was maximum in open plots, where as under trees, pollarded plots registered more biomass than that under non-pollarded ones (Fig.2.22).

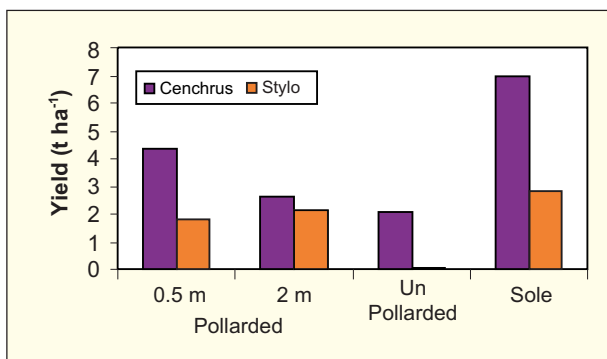


Fig.2.22 Effect of canopy management on yield of pasture

- The silvipastoral system supported the animals on itself, and no external supplementation of feed/concentrates was required. During the grazing period four lambings (average body weight of 3.20 kg) were registered.

2.5.2 Crop diversification for sustainability through dye yielding crops (AP-Cess)

The project was initiated this year to optimise organic and inorganic cultivation methods by utilization of biological waste materials from indigo / other crop residues through vermicomposting for obtaining higher yields and good quality produce of dye crop, and to devise value addition methods to enhance the quality and output of the dye.

Bixa

Results from the on-farm experiments conducted on 2, 3 and 4 - year old plantations of bixa in three villages of Rangareddy and Medak districts of Andhra Pradesh are summarized below:

- Different organic and inorganic sources of fertilizers influenced the yield and bixin content significantly. An yield increase of >60% over farmers practice was observed with vermicompost application in a 3-4 year old plantation.

- Micro-nutrient deficiencies were observed in fields under farmers' practice whereas they were absent in treated fields.

Indigo

Influence of organic N sources and phosphorus fertilizers on yield and dye content were studied.

- Higher yield and dye content were recorded with vermicomposting than with other organic sources.
- The dye content was influenced significantly by fertilizer application.
- Vermicompost made from indigo waste had higher nutrient content than that from other wastes.

Henna

On-farm experiment conducted on a 2-year-old henna plantation revealed that application of organic + inorganic fertilizer recorded 44, 39 and 20% yield increase over FYM, gliricidia and N alone.

2.5.3 Medicinal, dye and aromatic plants

The project was initiated in 1996 to identify remunerative species and to develop the agro techniques to make rainfed agriculture productive and profitable.

Lawsonia inermis, *Indigofera tinctoria*, *Bixa orellana* (dye yielding); *Withania somnifera*, *Cassia angustifolia*, *Aloe vera*, *Andrographis paniculata* (medicinal), and *Ocimum basilicum*, *Cymbopogon martini*, *Tagetes minuta* (aromatic plants) were found suitable alternate crops for the drylands.

Bixa orellana

This is a perennial bush, and yields an orange colored edible dye, bixin, from its seeds. The results obtained during this year on its agronomy are given below:

- The bixin content and yield varied among different trees in the plantation irrespective of pod size and color.
- Farm yard manure and inorganic fertilizers positively influenced the yield and bixin content.

Lawsonia inermis (henna)

During the year, effect of planting materials, microsite improvement/modification, and fertilizers was studied. The results were:

- Cuttings recorded higher yield, whereas seedlings recorded higher lawsone content.
- Microsite improvement is to be carried out yearly since this practice increased the yield and quality of produce even after 8 years of the treatment.
- Fertilizer application significantly influenced the yield and quality.
- 50% FYM + 50% inorganic fertilizers recorded higher yield than inorganics alone.
- Quality of *henna* was significantly influenced by sources of fertilizers.

Aromatic crops

An experiment was initiated with different organic and inorganic fertilizers on lemon grass cvs Krishna and Cauvery (FYM, Vermicompost, 50% FYM+ 50%NPK, 50% Vermicompost+ 50% inorganic fertilizers)

- FYM recorded higher yield followed by vermicompost, but oil recovery was very low from FYM treatment when compared to vermicompost and 50% vermicompost + 50% NPK.
- The total oil yield was highest from 50% vermicompost + 50% NPK treatment followed by vermicompost alone.
- cv Krishna recorded higher yield whereas Cauvery recorded higher oil content.

Medicinal plants

An experiment was conducted on different medicinal crops to study the influence of organic and inorganic sources of fertilizers. The following were the results:

- Germination of small seeded crops like *ashwagandha*, *Andrographis* and indigo increased with addition of organic fertilizers like FYM and vermicompost. However, *Senna* was not influenced by sources of fertilizers.
- Vermicompost made of indigo waste did not show any negative influence on indigo crop. Inorganic fertilizers + vermicompost recorded higher yield than with FYM. The quality of dye was influenced by fertilizer use.
- *Andrographis* and *senna* recorded higher yield with inorganic fertilizers, followed by indigo and other vermicomposts.
- Sennisoides and andrographalide content were also influenced by sources of fertilizer application.

Intercropping with alternate crops in neem

Different medicinal, aromatic and dye yielding crops were tested as intercrops under neem. The following observations were made:

- Germination of *Senna* was very poor under neem
- Germination and growth of *andrographis* and *Ashwagandha* was better under neem than as sole.
- Germination of indigo was on par both as an inter or as a sole crop.

2.5.4 Pruning and trenching in custard apple

Growth and yield

In the third year after pruning, no significant difference was detected in growth, height, and spread of the trees. However, fruit number and yield increased significantly over control in all the treatments. The highest number of fruits/plant (179.0) was

recorded in 45 cm pruning with trench, followed by (171.3) 25 cm pruning with trench. Similar trend was noticed in case of total yield.

Fruit characteristics

- 25 cm pruning with trench and 55 cm pruning with trench recorded significantly higher average fruit weight of 176.3g and 163.5g, respectively than control.
- Seed number increased significantly under 25 cm pruning with trench, 45 cm pruning without trench, and 45 cm pruning with trench. However, there was no significant increase in seed weight in any of the treatments indicating that though the seed number increased with fruit weight, the seed weight did not increase due to better practices of pruning and trenching.

In situ grafting

The custard apple hybrid Arka Sahan when *in situ* grafted on cv Balanagar, showed better scion growth than other varieties.

2.5.5 Guava-based horti-pasture system

In slightly slopy and marginal lands, fruit species like guava can be promoted with suitable agro techniques. Here, semi perennial/annual fodders like *Stylosanthes hamata* (semi perennial legume), *Cenchrus ciliaris* (semi perennial grass), and annuals like cowpea, horsegram and fodder sorghum can be encouraged for soil and water conservation besides generation of nutritious fodder for use during off-season. The fruit yield of guava is not influenced by fodder inter crop and hence these can be profitably grown in orchards. In a 10 year old orchard the following observations were made:

- The yield of guava was significantly influenced by irrigation treatments. Fruit yield recorded with 8 l day⁻¹ (36.8 kg tree⁻¹) and 16 l day⁻¹ (35.3 kg tree⁻¹) was significantly higher over rainfed control (21.3 kg tree⁻¹). Fruit number also significantly responded upto 8 l day⁻¹ irrigation level (82% increase) over no irrigation.

- Different nutrition levels influenced the guava yield significantly. Fruit yield recorded with 100% NPK, 100% + 50 kg FYM and 100% NPK + 25 kg FYM were significantly higher over control indicating the need for balanced nutrition preferably in INM mode (Fig.2.23).

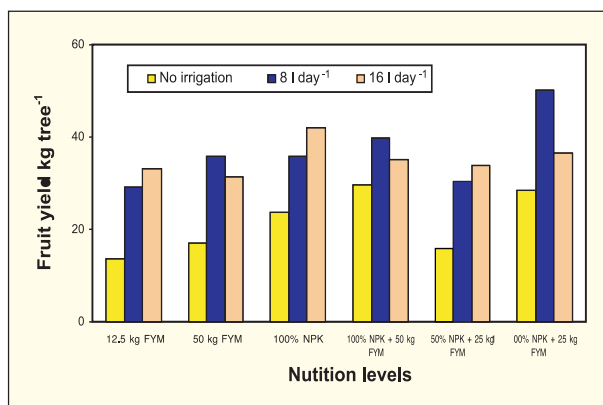


Fig.2.23 Effect of drip irrigation and nutrition levels on fruit number and yield of guava

Intercropping

An experiment having two spacings for guava (8 x 5 and 5 x 5 m) and two fodder crops (*Cenchrus ciliaris* and cowpea), and control was conducted. The results revealed the following:

- Yield reduction in both intercrops was 48% more under closely planted guava (5 x 5m) than under 8 x 5 m spacing (14%).

2.5.6 Mango-based agri-horti system

Intercropping and nutrition

Studies were continued on intercropping, nutrition and irrigation in the mango orchard (cv Kesar) established 10 years back. These led to the following conclusions:

- The yield of intercropped groundnut reduced by 29% in cv JL 24 and by 42% in cv K 134 over sole (768 and 776 kg ha⁻¹, respectively).
- All nutrient management treatments (100% NPK, 5 t FYM ha⁻¹, 100% NPK + 100% FYM ha⁻¹, 50% NPK + 50% FYM ha⁻¹) recorded



Guava with *Cenchrus*



Ten year old mango orchard with intercrop of groundnut

significantly higher pod yield (220 - 294%) than control (281 kg ha⁻¹).

- Conjunctive use of 100% NPK and 5 t FYM/ha produced significantly higher pod yield than all other nutrition levels.
- The oil content of cvs JL 24 and K 134 was unaffected by land use system but cv K 134 recorded higher oil content.
- Combined application of NPK and FYM at recommended quantities significantly improved the oil content over all other nutrient levels.

Drip irrigation

- Drip irrigation had significant and pronounced effect on mango yield over no irrigation. There was an yield increase of 86, 85 and 136% with drip at 0.25, 0.5 and 0.75 Ep, respectively over no irrigation (18.4 kg tree⁻¹).
- Under nutrient management maximum fruit yield was registered with 100% NPK+ 75 kg FYM per tree (55.2 kg tree⁻¹), which was significantly superior to all other treatments (FYM 75 kg tree⁻¹, 100% NPK, 50% NPK + 50% FYM, and control).

2.5.7 Development of agri-horti and agro forestry systems in *kharif* sorghum areas (NATP)

The productivity of sorghum and other nutritious cereals in rainfed regions is becoming

uncertain and unremunerative due to erratic rainfall. The area under *kharif* sorghum is declining year after year. Hence, there is an urgent need for alternative land use systems. The farmers are preferring to go for orchard crops as an alternative to sorghum and other nutritious cereals. In order to enhance the production in the orchards and to bring in sustainability to the production system the present project was taken up. In mango-based agri-horti-pastoral system, interventions like soil and water conservation measures, application of recommended doses of nutrients, and growing of intercrops like sorghum, cowpea, horsegram, and forage legume like *Stylosanthes hamata* and grass *Cenchrus ciliaris* were found highly suitable for sustainable production. Significant findings made this year are mentioned below:

- The surveys indicated a substantial shift towards cultivation of mango, custard apple, tamarind, sapota, ber, guava, pomegranate, aonla, vegetables, and timber yielding and multipurpose tree species in place of coarse cereals.
- Farmers preferred teak, neem, *Leucaena*, *Acacia*, *Dalbergia*, *Hardwickia* and *Gmelina arborea* on their farms, mainly on farm bunds.
- The orchard soils of Mahaboobnagar and Rangareddy districts were deficient in sulphur and boron although low levels of N, P, K, Fe and Zn were not uncommon.



Cowpea in a mango-based agri-horti system



Small ruminants in a mango-based horti-pastoral system

- In Mahabubnagar district, higher mango yield was realized ranging from 2.94-3.12 tons ha⁻¹ in 5-7 year old orchards, and 8.41-10.35 tons ha⁻¹ in older orchards by following *in situ* moisture conservation practices, preparation of crescent shaped tree basins, making ridges and furrows across the slope and mulching the tree basins, and use of recommended doses of nutrients, as against 0.71 tons ha⁻¹ in 5-7 year old orchards and 2.84 in older orchards in control fields.
- The B:C ratio in more than 10 year old orchards of Mahaboobnagar and Rangareddy districts rose from 2.38-2.55 (farmers' practice) to 7.71-8.53 (with scientific interventions).
- Inclusion of cowpea, horsegram and *Stylo* was found beneficial in mango-based production system.
- Inclusion of livestock component like small ruminants added extra income to the production system by making use of fodders generated in the orchards.

2.5.8 Field evaluation of micro-propagated teak and neem (AP-NL)

Elite clones of neem and teak were micro propagated at CRIDA and SAIRD, Gaddipally based on the technology developed by this

institute. During the year, on-farm trials were continued in 4 districts to evaluate the performance of micro propagated planting material and the farmers' planting stock (stumps) under different rainfall and soil conditions (Table 2.17).

The age of the plantations varied between 2-4 years and hence the mean annual increment in height and girth were compared at different locations. The analysis of data indicated no significant differences in height and girth up to 4 years between micro propagated plants and local stumps at most of the locations. However, if the stumps were directly planted the growth of such plants was inferior to the micro propagated plants. At all the locations, high degree of uniformity (up to 85%) was observed in micro propagated plants as compared to high variability in stumps. Mean annual rainfall also affected the growth increment. Plantations receiving annual rainfall of more than 900 mm have put up significantly higher girth increment rate. Those planted between 600-900 mm behaved similar while the performance of both TC and stumps in micro farming situation receiving less than 600 mm rainfall was quite poor. No significant differences were found between the two clones tried viz. *Teli* and *Nallamalai*. The data thus far indicated that micro propagated plants exhibit

Table 2.17 Details of on-farm trials conducted on micro propagated teak

District	Micro farming situation	No. of trials/ farmers	Area covered (ha.)	Purpose of the trial
Nalgonda	Alfisols, 600 mm MAR	25	12	- To evaluate the impact of rainfall and soil type on clone performance - To compare the performance of TC vs Stumps
Mahaboob-nagar	Alfisols, 655 mm MAR	8	5	To evaluate the impact of rainfall and soil type on clone performance
Medak	Vertisols, 800 mm MAR	4	2.5	To evaluate the impact of rainfall and soil type on clone performance
Rangareddy	Alfisols, 700 mm MAR	12	8	- To evaluate the impact of rainfall and soil type on clone performance. - To compare the performance of TC vs Stumps



A rural bio center established in Nalgonda district for macro propagation of teak
 (a) stumped TC orchard, (b) regrown healthy shoots being collected, (c) shade net unit
 (d) nodal cuttings raised in root trainers

high uniformity and field performance at par with the stumps.

In order to achieve wide diffusion of the improved planting material, a rural bio center was set up in Gaddipally village of Nalgonda district to mass propagate elite teak plants through clonal multiplication in a shade house. This is a simple technology which can be adopted by small farmers or educated youth. A typical bio center consists of a tissue cultured mother orchard, a shade net, rooting trays/media, chemicals and water. Plants in alternate rows from a two year old mother orchard are stumped to the ground to encourage profuse lateral shoots. The nodal cuttings from these lateral shoots are then rooted in root trainers filled with coco peat. Using this technology more than 10,000 plantlets were produced during the year at a considerably lower cost of Rs.5/plant.

2.5.9 Evaluation of high azadirachtin neem clone

Following an assessment of the variability for azadirachtin content in different neem clones, two plus-trees of neem were selected and multiplied through micropropagation. The field evaluation of this material is under progress from 2001-02. Data on the height and GBH of clone CRI-8/97 is presented in Fig.2.24. The plants attained an average height of 5.5 m and a GBH of 27 cm,

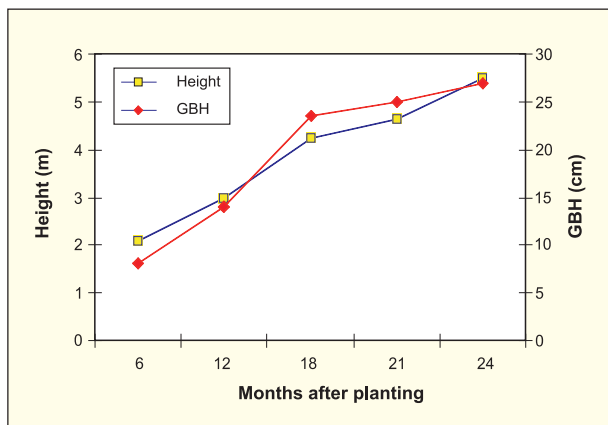


Fig.2.24 Growth of micro-propagated neem clone (CRI-8/97) selected for high azadirachtin

two years after planting under rainfed conditions. The first flowering was noticed after 24 months. However, yield data on seed production are to be collected to know the full agronomic potential of this clone.

Earlier, efforts were made at CRIDA to select neem eco types with high azadirachtin and produce planting material from such plus trees. Subsequently however high inter annual variability was found in the same trees for aza content. Therefore continuous monitoring for aza content has been done since 1997 on 5 eco types/clones. Data presented in Fig.2.25 revealed that more than 100% variation was noted in aza content between years. So far the variation could not be attributed to any of the environmental variables like rainfall, air temperature, relative humidity etc. But in general there was inverse relationship between aza content and yield. Interestingly though year to year variability was high in all the trees, the overall ranking remained unchanged. These results indicate that despite high variability, it is advantageous to select plus trees with high azadirachtin and produce planting material from such trees.

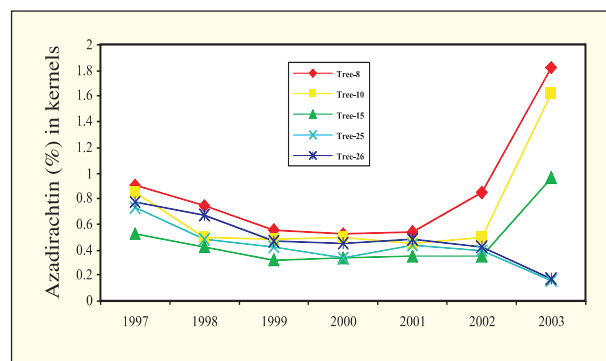


Fig.2.25 Annual variation in azadirachtin content in neem trees at the same location

2.5.10 Development of tree-borne oilseeds (NOVOD)

Under this development-oriented project, four useful tree species identified by NOVOD were planted in Rangareddy, Karimnagar and Nalgonda districts of A.P. The details are tabulated below:

Species	No. of seedlings raised	No. of seedlings out planted	Site
<i>Pongamia pinnata</i>	7500	2000	CRIDA Res.Farm, Hyderabad
		2400	Vangara, Karimnagar (AP)
		500	Thanugula, Karimnagar (AP)
		400	Jammikunta, Karimnagar (AP)
		1200	Malkapur, Nalgonda (AP)
<i>Jatropha curcas</i>	1300	1200	CRIDA Res.Farm, Hyderabad
<i>Simarouba glauca</i>	300	300	CRIDA Res.Farm, Hyderabad
<i>Bassia latifolia</i>	80	80	CRIDA Res.Farm, Hyderabad

2.5.11 Studies on Agroforestry in Nalgonda and Mahabubnagar districts of AP (AP-NL)

The project was in operation from December 1999 to July 2003 in six villages of Nalgonda and Mahabubnagar districts. In each village specific agroforestry module was taken up on 50 ha of land based on farmers preference. The main species planted were tamarind, mango, *amla*, custard apple, *Leucaena*, teak and the like. Predominant arable crops like groundnut, pulses, castor, and sorghum were sown as intercrops. Key findings to be adopted are:

- Integration of agroforestry in land management will contribute to improvement in environment and socio-economic status of the clientele.
- In the fragile, rainfed environments of Mahabubnagar and Nalgonda districts agroforestry alone cannot improve the degraded lands, and it has to be necessarily combined with soil and water conservation measures.
- Only willing NGOs and farmers have to be roped in for future programmes which have to be implemented for a minimum of 5 years. The project should first concentrate on better endowed areas having good rainfall and soil. The programme should begin with exposure visit. Plantation in

the first year may be done on boundaries/bunds, followed by main field plantation in the second year. *In situ* grafting should be tried.

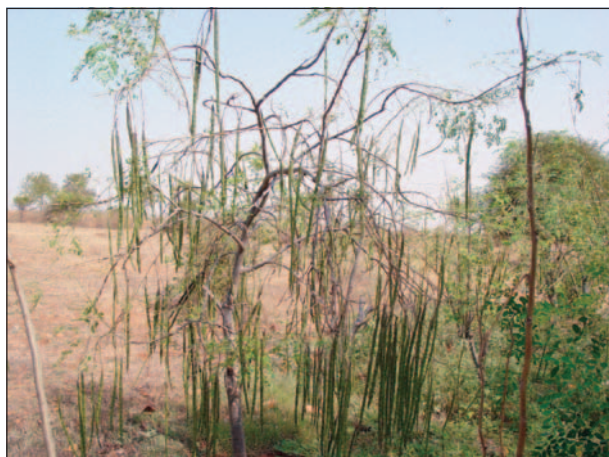
- Protection from cattle is essential for a successful impact.
- The farm size has to be such that it supports farmer and his family in the village so that there is no need for him to leave the village for off-season employment. Migration of the stake holder adversely affects the survival of the young plantation especially in the off-season when there is maximum damage by stray cattle.

2.5.12 Clonal propagation of high value horticultural and forest species (NATP)

- Five superior clones of Tamarind viz. APAPKD-1, APAPKD-11, APCWPU-12, APCWPU-13 and APCWPU-14 were identified from the selections made by BIOTRIM, Department of Forests, Tirupathi. These clones along with local controls were evaluated on-farm for establishment studies in four villages in Mahabubnagar and Nalgonda districts.
- Two high yielding Moringa cultivars along with a local one were evaluated in 10 villages of Nalgonda and Mahabubnagar districts. The results are tabulated below:

Performance of Moringa cv PKM-1

Location	Date of planting	No. of fruits /tree/year (2003)		
		cv local	cv PKM - 1	cv from TN
Five villages in Mahabubnagar	June 2001	Nil	250	200
Five villages in Nalgonda	June 2001	Nil	270	185



Drumstick cv PKM-1 for higher income

2.5.13 Developing alternate land use systems for industrial biomass production (NATP)

The project aimed at increasing biomass production from leucaena and eucalyptus - based agro forestry systems and identification of suitable combination of trees and crops for marginal and degraded areas of watersheds. Six farmers were selected from six villages viz. Bhadrachalam, Venkatareddypalle, Kollugudem, Amaravaram and Purushotta patnam distributed across Bhadrachalam and Kukkunuru mandals. The trees were planted during August, 2001. Observations recorded this year are given below:

- Tree height and collar girth in eucalyptus and leucaena were not influenced due to treatments. Highest tree height and maximum collar girth in eucalyptus were observed in 10 x 1.5 m and 3x2m spacing, respectively. In leucaena, maximum tree height was recorded in 1.3 x 1.3 m and highest collar girth in 3 x 2 m spacing.
- All the wider tree row spacings in eucalyptus recorded significantly higher sunhemp green biomass production over 3x2 m spacing (farmers' practice). Highest sunhemp green biomass yield was recorded with 10x1.5m triple rows treatment. Under leucaena significantly higher green biomass yield was recorded with 7x1m paired rows than with 3x0.75m.



Cowpea intercropped in eucalyptus spaced at 7.0x1.5m

- Sole groundnut and cowpea recorded significantly higher yield. These crops yielded moderately good under wider trees rows (Table 2.18).

Table 2.18. Yield of groundnut and cowpea in eucalyptus-based systems

Treatments	Yield (kg ha ⁻¹)	
	Groundnut	Cowpea
3x2 m (Farmers' practice)	261	309
6x1 m	482	443
7x1.5 m (Paired rows)	455	505
11x1m (Paired rows)	567	645
10x1.5m (Triple rows)	507	726
Control (crop without tree)	637	734
CD	132	180

2.5.14 Influence of agroforestry on soil fertility and resource conservation (NATP)

- Soil nutrient status under different agroforestry tree species like *amla*, tamarind, leucaena, teak and neem indicated medium availability as compared to low in control.
- Soils under tamarind recorded higher organic carbon as compared to other tree species.
- The increment in height and diameter at breast height (DBH) was higher with conjunctive use of organic and inorganics than inorganics alone.
- Higher fruit yield of *amla* was observed with vermicompost in combination with inorganics, followed by sunnhemp.

- Fruit drop was more with FYM, and least with *in-situ* introduction of earthworms in the basin.
- Castor yield varied significantly with tree species. Highest castor yield (68% of sole) was observed with tamarind, while lowest (40% of sole) was recorded with Acacia.
- Horsegram yield did not vary much with the tree species, yielding around 50% of sole. However, highest grain and fodder yield of horsegram were obtained with *amla* and the lowest with tamarind. Harvest index of horsegram was highest with Acacia and lowest with tamarind (Fig. 2.26).

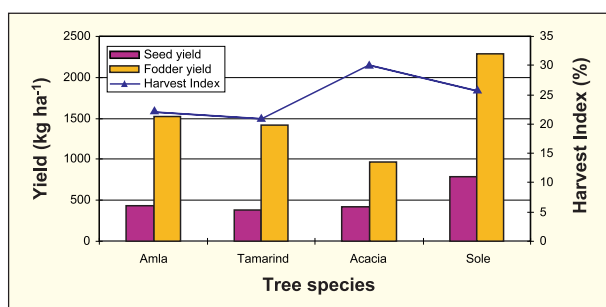


Fig.2.26 Effect of trees on intercrops

- There was no significant difference in growth parameters between true seedlings and tissue-cultured neem plantlets.

2.5.15 Storage of curry leaf essence

Traditionally, curry leaf has been used as a household culinary supplement in South India. Today it is widely used to flavour curries and chutneys. The availability of fresh curry leaf during summer is low leading to sharp increase in prices of the fresh leaves. As an alternative, the essence product can provide the aroma and would be of use to people living in big cities and abroad where fresh leaf material is not available or is very expensive. Leaf essence extract also finds good use as a flavoring agent in fast food products, pharmaceuticals and perfumeries.

As a basic pre-requisite to popularize the essence extraction technology, it is imperative to investigate variation in essence content among the

prevalent genotypes, extraction procedures, harvest times, processing gaps, and shelf life of essence. Based on literature survey it was found that Clevenger's distillation set was most widely used for extraction of volatiles and essence oils. The volatiles in the essence appear to be affected by heat. Hence the extraction assembly was modified in such a manner that leaf essence oils once volatilized were cooled down in the condenser and collected in a measuring stem over condensed water. The modified apparatus was tested for its performance using 2.0 kg leaf material and was used for extracting essence from fresh and overnight stored samples of cvs Suwasini, Bhuvneswari and Local.

cv Bhuvneswari was found superior for total essence yield followed by Local for both fresh as well as overnight stored leaf samples. The fresh and overnight stored leaf samples of cv Bhuvneswari contained higher moisture compared to cvs Local and Suwasini (Table 2.19).

Table 2.19 Moisture and essence in fresh and stored curry leaf foliage

Genotype	Moisture (%)	Essence oil content (%)
cv Local	63.72 (61.20)	0.149 (0.153)
cv Bhuvneswari	70.05 (65.66)	0.186 (0.195)
cv Suwasini	62.88 (62.30)	0.099 (0.080)

Figures in parentheses relate to stored foliage



Modified extraction assembly

2.5.16 Value addition

Custard apple: A simple technique was developed for manual extraction of custard apple pulp by rotatory motion of a round hair comb in a stainless steel sieve containing the raw material. This pulp used for manufacture of ice cream on a pilot scale in collaboration with a local ice cream factory.



Amla : A simple technique was developed for separation of segments of amla by steaming the fruit in a pressure cooker. These segments were used for preparation of amla pickle and murabba which had acceptable organoleptic properties.



Roselle : Attempts were made to utilize the calyces of Roselle (*Hibiscus subdariffa* L), a hardy vegetable which can be easily grown in the rainy and post-rainy season. Besides processing into different products, it can be a very good source for coloring fruit products which do not have attractive colour,

for example guava jelly. Guava-roselle in 85:15 ratio possessed good organoleptic properties (Table 2.20). Roselle sauce, made from the left over after extraction of colour, acids and pectin, was also found very acceptable.

2.5.17 Utilization of coarse cereal crop residues by strategic supplementation (NATP)

- Results from an experiment conducted to assess the effect of *Leucaena leucocephala*, *Stylosanthes hamata* hay and concentrate supplementation on live weight gain in local goats suggest that tree foliage or forage legume could play a major role to improve the productivity of goats reared on natural pasture.
- Leucaena and Stylo can be used as supplement to sorghum stover based diet for improving the feed intake and growth performance of sheep.

2.5.18 Top feeds as supplement to small ruminants

The effect of top feed / forage, directly, supplemented to natural grazing or stover or mixed with urea molasses mineral block was studied in a series of experiments on Deccani sheeps' feed intake and growth performance. The following results were obtained:

- Intake of Gliricidia fodder was quite low at the initial stage but improved after a week. DM intake was highest with Leucaena followed by wilted Gliricidia, and least with fresh gliricidia.

Table 2.20 Organoleptic evaluation of jellies prepared from guava-roselle blends

Treatment	Organoleptic score				
	Colour	Flavour	Taste	Consistency	Total
Guava jelly	8.1 *	8.1	7.8	7.6	31.6
Guava Roselle(85:15)	8.6	7.9	8.0	8.1	32.6
Guava-Roselle (80:20)	8.3	7.6	7.0	8.4	31.3
Roselle	7.3	7.2	7.4	7.7	29.6
CD (0.05)	0.72	0.63	NS	NS	1.91
S.E.	0.25		0.32	0.29	0.66

* Grade obtained on an ascending acceptability scale of 1 - 10

Wilting improved the DM intake of *Gliricidia* leaves significantly. The live weight gain of sheep fed on *Leucaena* or wilted *gliricidia* was significantly higher than those fed on fresh *gliricidia*. Similar trend was observed in DM digestibility, indicating their potential for improving sheep production.

- The highest gain in body weight of sheep was recorded due to *Leucaena* supplementation to grazing followed by *Gliricidia* and *Stylosanthes hamata* hay. The live weight gain of sheep supplemented with *Leucaena* or *Gliricidia* were significantly higher than those on *Stylo* hay. However, response to *Leucaena* and *Gliricidia* supplementation were similar. Results suggest that tree foliage or forage legume could play a major role as supplement to improve the productivity of sheep reared on natural pasture.
- Supplementation of urea molasses mineral block (UMMB) improved the intake of basal roughage significantly followed by *Leucaena* and *stylo* hay. However, the intake of *stylo* hay was more as compared to *Leucaena*. Significantly higher DM digestibility and live weight gain of sheep were recorded due to *Leucaena* and UMMB supplementation than that of *Stylo* hay.
- A study was conducted to evaluate the effect of supplementation of *Leucaena* and *Gliricidia* in comparison to concentrate on feed intake and live weight gain in sheep fed on sorghum stover basal diet. Results showed that DM intake of sorghum stover was highest with concentrate supplement, followed by *Leucaena* and least with *gliricidia*. However, the DM intake (kg/100 kg body wt.) was highest with *Leucaena* followed by concentrate and *Gliricidia*. Supplementation of *Leucaena* significantly improved the DM digestibility and live weight of sheep as compared to *Gliricidia* and concentrate, suggesting that tree foliage of *Leucaena* and *Gliricidia* can be used as supplement to sorghum stover-based diet for improving the feed intake and growth performance of sheep.

2.6 Farm Machinery and Power

2.6.1 Energy use in crop production and livestock management

A follow up study was undertaken to make an economic engineering study of existing farm machinery and power sources in 3 villages of three agro-climatic zones of Andhra Pradesh. Previously, studies were undertaken in 1990-91 in these three villages. Same villages were chosen now to act as a base to study and report the changes in agricultural scenario between 1990-91 and 2003-04. The findings in one village, Duppituru, Vishakhapatnam district are given below:

- Farm power availability increased by 28% and contributions from human and animal sources decreased by 34 and 68%. Tremendous increase in use of mechanical power was observed (Table 2.21).
- Use of improved, high capacity farm implements was observed in carrying-out tillage, plant protection and threshing operations. However, sowing is still carried out by traditional spiral sowing (pearl millet) and broadcast methods (pulses).
- Transformation in both priorities and practices in raising crops is taking place. Due to higher profitability and lesser cost on maintenance, 12.8% (27.6 ha) of land was brought under casuarina which is used for pulp and fuel. Similarly cashew crop is being raised in 4.5% of area (10 ha). Both these plantations were not at all seen in the village during 1990-91. Hence, conventional crops have lost 32.1% land to these trees.
- Reduction in draft animal population was to some extent compensated by rearing more milch animals. Milk production per animal increased almost two-fold. More attention in animal-rearing was observed in terms of feed, concentrates and health care in 2003-04 as compared to 1990-91.

Table 2.21. Trends in Farm Machinery and Farm Power use - a case study

Parameter	Farm Power (Kw ha ⁻¹)		Remarks
	1990-91	2003-04	
Human	0.23	0.15	34% decrease
Animal	0.56	0.18	68% decrease
Mechanical	0.10	0.83	730% increase
Total power density	0.90	1.15	28% increase

2.6.2 Improved tools for mechanization (NATP)

- Mechanization of tillage, sowing, interculture, harvest, and threshing operations for major dryland crops like castor, groundnut, soybean, cotton, maize, rabi sorghum, pearl millet, finger millet and rainfed rice was achieved in 641 ha area covering 104 farmers in 21 villages of 9 districts.
- Mechanization in drylands reduced 20-59% operation cost, saved 45-64% operation time, saved 31-38% seed and fertilizer and increased productivity by 18-53%.
- Seven industries, three in Maharashtra, two in A.P. and one each in M.P. and Rajasthan, signed MoU with CRIDA and adopted 11 designs of different CRIDA equipments for production and sale. Consultancy services were provided to

licensed industries for quality control and standardization of production technology for implements.

- A Custom hiring center (CHC) was opened at Kalwakurthy village in Mahboobnagar district, which benefited 100 farmers of all categories covering 350 ha area. These model CHCs demonstrated the economic feasibility of enterprise in rural clusters (Table 2.22). These industries and custom hiring centres generated an employment for about 40 skilled/unskilled rural youth.
- Technologies developed and facilitated: (a) plastic mulching machine, (b) castor sheller, (c) groundnut stripper, (d) vegetable preservator and (e) Iron tractor wheels were developed and 28 feasible technologies/designs were facilitated for adoption by farmers and industries.

Table 2.22 Performance of custom hiring centres

Implement	Village	Area covered (ha)	Utilization (h)	Hiring charges (Rs hr ⁻¹)	Total amount (Rs)	No. of beneficiaries
Rotavator	Byrapur, Palem, Kalvakurthy	30	30	75	2250	5
6-row CRIDA planter	Byrapur, Veldanda, Kalvakurthy, Palem	110	200	100	20000	40
CRIDA Weeder	Byrapur, Kalvakurthy	30	30	50	7500	5
Orchard sprayer	Veldanda, Kalvakurthy, Ongore	-	360	20	6400	30
Maize sheller	Tandra, Veldanda, Kalvakurthy	60	170	35	5850	
Castor sheller	Byrapur, Kalvakurthy	40	24	35	840	5
Groundnut stripper	Kalvakurthy, Veldanda, Ongore	80	80	10	800	15
Total (excluding tractor hiring charges)					43640	100

- A software christened 'DRYMECH' was developed for timeliness and precision indices. The model would be of use in selection of equipment for different dryland regions based on rain, soil, crops and power availability.
- The 1000 grain weight and bulk density ranged from 41.35 to 57.15g and 0.78 to 0.83g / cm³ respectively.
- Pitting + oil application @0.3% for 48h + 36h sun drying gave 75% *dal* recovery with 98% degree of de-husking for cv LBG-17.
- A low capacity (150 -200 kg h⁻¹) *dal* mill was developed with polisher and other components to enhance generation of income and employment in rural areas.

Research

- Decomposition of incorporated sorghum stubbles by MB Plough + rotavator was about 35% higher than that by MB plough alone. Disc plough+ rotavator gave 24% more decomposition than disc plough treatments. These results suggest that chopped stubbles obtained by rotavator were more responsive to decomposition than whole stubbles.
- A marker was added to the castor planter for better maneuverability. This helped the farmers to cover larger area within limited available time of moisture availability. The field capacity of the planter is 1.10 ha h⁻¹ as against 0.15 of the traditional method of sowing.
- A tractor drawn 3-row weeder was developed and was found very effective. The efficiency of the machine is 1.10 ha h⁻¹ vis-a-vis the more cumbersome manual operation which covers 0.15 ha h⁻¹.
- CRIDA Vegetable/fruit preserver's design was updated and fabricated with fibre reinforced plastic. The design was licensed for manufacture and sale. More than 50 preservers were supplied to the needy and the performance was found satisfactory.

2.6.3 Upgradation and evaluation of mini *dal* mills (NATP)

- Four blackgram cvs LBG - 402, T-9, LBG-623 and LBG - 17 were evaluated for milling characteristics in an abrasive roller mill

2.6.4 Frontline demonstration of improved agricultural machinery for pulse crop production (NATP)

- Field demonstrations of proven implements were conducted in selected villages.
- *Pingali danti* (an animal drawn, interculture implement), was modified to suite interculture operation in sole pigeonpea. The performance of the implement in on-farm demonstrations was found better, and saved 15 - 20% of time when compared to the conventional blade harrow.

A wheel hoe was fabricated and field demonstrated. The wheel hoe reduced drudgery when compared with Twin wheel / peg type weeder.

2.7 Socio-economic studies

2.7.1 Role of village institutions in watershed programmes

A study was conducted in 3 watershed villages of Medak and Rangareddy districts of A.P. The following conclusions were drawn:

- All the four mechanisms namely social, technological, financial and managerial were found important for community participation.
- DPAP watershed (Chinnacheuvu, Medak) was predominant with social and technological mechanisms. Another DPAP watershed Manchyal

(Malagudem village, Rangareddy) was dominant with technological mechanisms. Implementation of financial mechanism was not found to be satisfactory in Chinnacheruvu and Pomina watersheds.

- Awareness and capacity building of local institutions, prior to implementation of programmes was felt necessary to bring about complete participation in watershed programmes in A.P.

2.7.2 Women in agriculture (AP-Cess)

The study was carried out in Andhra Pradesh and Orissa during 2001-2003 to find out the role of women in agriculture. The main findings were:

- Women participation rates (WPRs) ranged between 83 to 100%. It was higher for farmers who were exposed to crop production technologies
- Agriculture occupied 50% of the total time spent for both men and women, but the time spent on overall activities indicated higher drudgery of women than men.
- Farmers who were exposed to crop production technologies fared better in on-farm activities. The share of female in total employment was as high as 65% in both the states.
- For women, inverse relationship was registered between total employment days per worker and size of farm. Hired farm employment days per worker in case of male and female workers recorded inverse relationship with the size of farm in both the states.
- The total annual earnings per worker were higher for men than women. These earnings were higher for landless than from the other categories.
- In Orissa, general disparities in wages were 20%. In Andhra Pradesh, wages for female workers were deplorably lower than those of males.
- Major decisions on cropping programme and dairying were taken by men and women jointly.

Major decisions on domestic issues were made by women only.

- The absorption and practising of improved crop production technologies was 55-80% in Andhra Pradesh and 60-100% in Orissa.

2.7.3 Empowerment of farm women (UNDP)

On farm demonstrations were conducted in Sangham lands of six villages: Goplapur and Masayapally, Mahabubnagar district; Mirjapur and Sultanpur, Medak district; and Regonda and Basavpur, Karimnagar district. The main implementing partners were Andhra Pradesh Mahila Samatha Society (APMSS), Centre for Environmental Concerns (CEC), and Society for Elimination of Rural Poverty (SERP). Survey activities and on-farm results obtained are summarized below:

- A baseline survey of the villages on demographic profile, CPRs, farm households, land use classification, farm machinery and also the cropping patterns was conducted.
- Inclusion of improved cultivars in the cropping systems led to tremendous increase in productivity over the locals: sorghum (75-300%), pigeonpea (25-300%), maize (150%) and bajra (75%).
- Epidemic diseases, calf mortality, low productivity and fodder scarcity were the problems identified in cattle. Vaccination against contagious diseases like the Haemorrhagic septicaemia, Black quarter, Foot and Mouth disease were carried out in all 6 villages. Management of calf mortality through de-worming and supplementation of mineral mixture, and reproductive management through supplementation of mineral mixture and hormonal treatment was also carried out in large ruminants. As a consequence there was substantial improvement in livestock health (Fig. 2.27).
- Among intercultural operations, manual weeding, heavy labour cost and no proper tool for top dressing were some of the gaps identified. Demonstration and distribution of dryland weeders, wheeled hoes and hand drawn top dressing

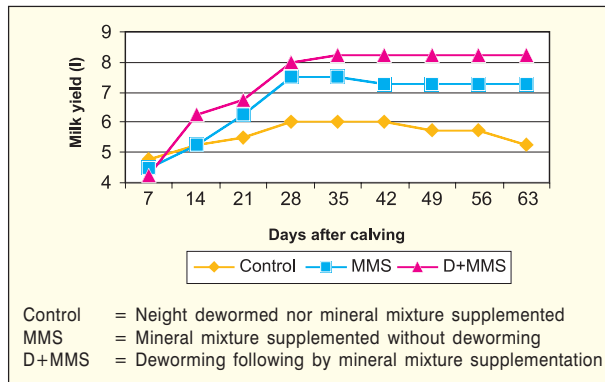


Fig.2.27 Effect of deworming followed by mineral mixture supplementation on milk yield in graded Murrah buffaloes

implements were carried out. Farm women observed that labour and time saving was reduced by 32 and 40%.



Women using improved intercultivation tools

- Under alternate land use system, curryleaf, gliricidia, subabul, tamarind, amla, stylo and jatropha were planted. Leased lands and misconception of shading on intercrops were the reasons for non acceptance of agro- forestry models. Farmers preferred boundary plantation.
- Contour bunding, diversion drains for excess runoff, and conservation furrows were some of the interventions carried out in the field.
- IPM practices were followed for pigeonpea sole and sorghum + pigeonpea intercropping system in all the villages. Pheromone traps for pest monitoring, neem seed kernel extract preparation, Bt and endosulphon sprays were the IPM modules

demonstrated. Sequential application of IPM modules was formulated and evaluated. This led to significant reduction in pest population.

- In *rabi*, demonstrations were conducted in Mungi village of Nyalkal mandal. Improved varieties of sorghum and chickpea, and chickpea + safflower intercropping was tested against local varieties and farmers practices of planting. Improved variety of chickpea (cv Annegere) recorded 131% higher yield over the local.
- Training cum exposure visits were conducted on agroforestry models, fodder production, soil and water conservation, cropping systems, farm machinery, and intergrated pest management.

2.7.4 Better livelihoods through improved NRM (DFID)

The project aimed at improvement of rural livelihoods through efficient management of natural resources and is being implemented by CRIDA in Andhra Pradesh (Mahabubnagar and Anantapur districts) and Karnataka (Tumkur district). Under this project an artificial insemination center for upgrading the livestock and increasing their productivity, custom hiring center by Farmers Youth Club, vermi-composting units, etc. were established for creating livelihoods for rural youth and farmers. Maize, lucerne, legume fodder and chickpea were introduced during *rabi* for the first time as an alternative to paddy-a high water requirement crop-as a means of crop diversification and better utilization of the small amount of available water. Farmers showed keen interest in soil and water conservation measures and with their co-operation check dams and farm ponds were constructed for maintaining ground water levels for improved water management.

The programme is executed by BAIF Institute of Rural Development (Karnataka) (BIRD-K) under the technical guidance of CRIDA and the State Agricultural University ANGRAU, Hyderabad and UAS, Bangalore.

2.7.5 Economics of castor seed multiplication

Castor is an important crop in the drylands. Keeping this and the scarcity of quality seed in view, CRIDA has considered multiplying quality and reliable castor seed in its research farm located at Gunegal so that the farmers in the neighboring villages are benefited. In order to work out the economics of seed production, an exercise was carried out in the 10 ha castor seed (cv Kranthi) multiplication plot during 2002-03. The following conclusions were drawn:

- There is a strong demand for quality seed of castor in the region
- The use of faithful seed from GRF enhanced crop yield and net returns from castor, which is the driving force for the high demand for castor seed supplied by GRF
- CRIDA incurred financial loss in multiplying and distributing quality seed. However, such a loss is due to the fact that the seed was made available to farmers at prices far lower than the market prices and cost of production and to the higher wages paid to the human labour
- The economic analysis from the society's point of view however justified the investment in seed multiplication as revealed by the substantial amount of net economic surplus generated
- Farmers were found to be willing to pay more for the seed. So, CRIDA may consider selling

the seed at a higher price in order to recover some more financial cost

2.7.6 Social Science Information Repository (NCAP)

The objective of the project, initiated in 2001, is to build up a panel database in all the seven agro-climatic zones of Andhra Pradesh that would generate key inputs to policy level decision-making. Under this project seven representative villages were selected. This year, among other things, the main emphasis was on the impact of drought which was quite severe.

In all the zones, excepting the Krishna-Godavari, a marked decrease in cultivated area was observed. The reduction in cropped area was highest in South Telangana Zone. This reduction was reflected in the fall in the area under major crops in each of the zone (Table 2.23). For example in the Scarce Rainfall Zone (SRF), the area sown to groundnut fell to 375 ha from the normal 870 ha. The observed fall under this crop was largely due to lack of rainfall and the non-availability of seed. Lack of adequate rainfall also resulted in decline in yield of most of the crops in all the zones. The impact on yield was more in case of groundnut in SRF. It was reported that some farmers could not get any thing. However, it was observed that the price of food grains and other crops experienced a rise in most of the cases.

Table 2.23 Change in area under major crops in different agro-climatic zones of Andhra Pradesh during 2002-03

Zone	Major crop	Normal year (ha)	Drought 2002-03 (ha)
Krishna - Godavari	Rice	613	620
North Coastal	Jute	44	27
Southern	Groundnut	365	300
North Telangana	Sugarcane	130	17
South Telangana	Castor	48	11
Scarce Rainfall	Groundnut	820	375
High Attitude and Tribal Area	Cassava	41	34

Considering that a majority of small and marginal farmers are net buyers of food grains, it is only obvious that these farmers might have suffered from the price rise. Fodder scarcity and increase in fodder prices, sale of livestock and reduction in demand for labour were other consequences

of drought. Dependence on wage employment through Food for Work Programme, increased dependence on public distribution systems, migration, increased borrowing and reduction in consumption spending were observed to be important ways of coping drought.

2.8 Transfer of Technology

2.8.1 Training courses organized under CET and TTC

A. Centre of Excellence for Training on Dryland Agriculture (CET)

Period	Programme	Participants
November 18-25, 2003	National Training Course on "Integrated Watershed Management" sponsored by DOE, New Delhi	Agricultural Officers, ADAs, DDAs, SMSs
February 24-26, 2004	National workshop cum seminar on "Extension Strategies for Fodder Production and Utilization"	DAs, JDAs, Training Organizers
March 9-11, 2004	National workshop cum seminar on "Information Technology and Agricultural Extension"	DAs, JDAs, SMSs, Training Organizers

B. Trainers Training Centre (TTC)

Period	Programme	Participants
April 22-26, 2003	Development of marginal and degraded lands through agroforestry	SMSs from SAUs, KVKs
May 27-31, 2003	Improved implements for dryland agriculture	SMSs from SAUs, KVKs, Development departments
June 17-21, 2003	Technology for improving the rainfed lands	ADAs, AOs, Training Associates
July 1-5, 2003	Integrated nutrient pest and disease management	ADAs, AOs, SMSs
August 5-14, 2003	Integrated watershed management for sustainable dryland agriculture	AOs, ADAs, SMSs
October 28 to November 1, 2003	Integration of livestock in watershed development	AOs, Training Officers, ADAs, Veterinary Officers

2.8.2 Training programmes organized by KVK

The Krishi Vigyan Kendra organized 85 need-based, skill oriented training programmes (14 on-campus and 71 off-campus) on various aspects of dryland agriculture. These were participated by 2189 clientele including practicing farmers, farm women, rural youth and field level extension functionaries.

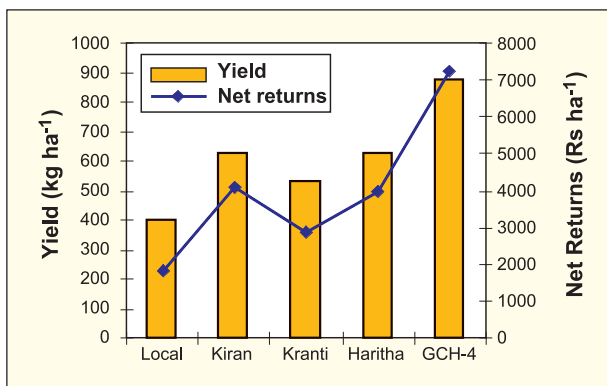
3 Technologies Assessed and Transferred

The TAR-IVLP programme was implemented in participatory mode in Nasdiksingaram, Manmarri, Antharam, Bodampahad and Kakkaluru villages of Yacharam and Shabad mandal of RR District. The main objective was to assess and refine the technologies in sorghum and maize - based production systems to achieve stability of production and profitability in both Vertisols and Alfisols. The theme areas covered under this programme include crops and cropping systems, integrated nutrient and pest management, rainfed horticulture and livestock options. The technological modules were assessed and refined in both vertisols and alfisols. Main results are described below:

3.1 Arable cropping

Vertisols

- Castor cvs Kiran and Haritha recorded higher seed yield ($625-630 \text{ kg ha}^{-1}$) and net returns (Rs.4030 ha^{-1}). These cultivars on an average registered 124% higher net income as compared to the local (Rs.1800 ha^{-1}).



- Soybean cv MAC-15 gave 17% higher seed yield leading to additional income of Rs.3050 ha^{-1} over cv JS-335 (Rs.3620 ha^{-1}).
- Chickpea cvs KAK-2 and ICCV-2 gave 110% higher seed yield over local (430 kg ha^{-1}). These

on an average exhibited BC ratio of 3.03-3.26 as against 1.72 of the local.

- CRIDA planter improved the plant stand by 20% in maize + pigeonpea system compared to the traditional method of seeding with a country plough, saved time by 300%, and labour cost by 40%.



CRIDA planter for timely sowing of maize in Vertisols

- Maize cvs Kargil and DHM-107 recorded higher BC ratio (5.32-5.36) followed by cv Sri Tulasi (4.75) in a pigeonpea intercropping system. However, maize cv Ganga-2 with local pigeonpea (3:1) gave additional returns of Rs.41512 ha^{-1} , which was on par with cv Bioseed.
- Pigeonpea cv PRG-100 was found best for yield and net returns over local in maize + pigeonpea system (3:1).
- Application of 35-75-75 NPK ha^{-1} was found economically optimum in maize + pigeonpea. This practice recorded BC ratio of 4.18 as against the farmers practice of 35-75-0 NPK ha^{-1} and recommended dose of 110-75-75 NPK ha^{-1} .
- The integrated pest management module in cotton (seed treatment with Imidachloprid @ 8 g kg^{-1} , sowing of castor and marigold in

Treatments	Yield (kg ha ⁻¹) (maize + pigeonpea)		Cost of production (Rs. ha ⁻¹)	Gross income (Rs. ha ⁻¹)	Net returns (Rs. ha ⁻¹)	B:C ratio
	Grain	Fodder				
FP (35-75-0) PK ha ⁻¹ basal	9723+360	14182+ 734	13000	43212	30212	3.32
FS + 75 K ₂ O ha ⁻¹ basal	13133+496	20451+ 808	14000	58484	44484	4.18
FS + 56 kg N ha ⁻¹ as TD	14298+588	17578+1192	14800	64088	49288	4.33
FS (35-75-75) NPK ha ⁻¹ as basal + 56 kg N ha ⁻¹ as TD	16449+680	24452+1432	15800	73946	58146	4.68

the border rows to trap *spodoptera* and *Helicoverpa*; bird perches @ 10 ac⁻¹, nipping terminal shoots at 90 days after sowing to remove eggs of *Helicoverpa*; monitoring the activity of boll worms through pheromone traps; spray of HaNPV @ 200 LE/ac; release of *Trichogramma chilonis* egg parasitoid @ three cards ac⁻¹; spray of 5% neem seed kernal extract and need - based application of selective chemical insecticides) was evaluated against the farmers' practice of using chemical insecticides. The results showed that there is considerable reduction in use of chemical pesticides in IPM plots. The activity of beneficial insects was high in IPM plots. *Nomuraea rileyi* was recorded in many farmers fields. The dead cadavers of *H.armigera* were found all around the field on plant parts and on soil and it played a key role in natural mortality of *H.armigera*.

- In the Bt cotton cv MECH 162, the bollworm damage was less as compared cv Bunny. In spite of delayed sowing and intermittent

drought, Bt cotton performed well. The major advantage of Bt cotton as perceived by farmers is that it is early maturing, tolerant to drought, heavy boll forming and having low bollworm infestation. The total number of pesticide sprays given to Bt cotton was 7 as compared to 18 on cv Bunny.

Alfisols

- Improved cultivars of sorghum (SPV-462/CSV-15) and pigeonpea (PRG-100) in 3:1 enhanced the gross income (Rs.5128 ha⁻¹) as compared to the local. Farmers preferred to have improved cultivars of sorghum and pigeonpea for meeting domestic and fodder requirements.
- Formation of conservation furrows, irrespective of the rainfall distribution, for every 3 rows in sorghum + pigeonpea system and in alternate rows of castor after 30 DAS, improved the productivity and profitability by 20% over no conservation furrows. Uniform application of 10:30:0 NPK ha⁻¹ for sorghum and pigeonpea



Helicoverpa damage on cotton



Detopping in cotton



Dead cadaver of *Helicoverpa* affected by *Nomuraea rileyi*

with 20 kg N ha⁻¹ as top dressing after 30 DAS was found optimum in sorghum + pigeonpea.

- Horsegram (cv Palem-2) and cowpea (cv C-152) were more efficient as compared to castor under delayed sowing conditions. These crops on an average recorded BC ratio of 1.75 as against 1.2 of castor.
- Tomato seed treatment with Thiram @ 3 g kg⁻¹ of seed and sowing on raised bed nursery improved productivity by 39% as compared to flat bed nursery. The raised nursery reduced the incidence of damping off.

3.2 Rainfed horticulture

- Growing of cenchrus in the interspaces of tamarind enhanced profitability by Rs.1000 ha⁻¹ as compared to tamarind + castor (Rs.3000 ha⁻¹). Pitcher system served as a better water management technique to improve the survival of tamarind than the basin system.
- Use of FYM @ 5 kg plant⁻¹ and 0.5 kg of DAP during early July enhanced mango fruit yield

by 4.5 times and net returns by 2.3 times compared to the farmers' practice.

3.3 Farming systems module

The project characterized the traditional farming systems in the vertisols of Manmarri under different categories of farmers and quantified the benefits of the technology:

- A marginal farmer having 0.8 ha land and growing cotton and maize + pigeonpea recorded B:C ratios of 3.47 and 4.43 respectively. One milch animal on an average gave net benefit of Rs.380 year⁻¹. Thus this farmer could get a net return of Rs.33520 with an investment of Rs.14600.
- A small farmer having 1.2 ha, growing cotton and maize + pigeonpea, and having two milch animals could realize a profit of Rs.17190 ha⁻¹ with a total investment of Rs.20840.
- A medium farmer having two milch animals and 2 bullocks could realize a net gain of Rs.44944 with an investment of Rs.48280.

4 Education and Training

4.1 Vocational course on Dryland Agriculture

B.Sc. vocational course on Dryland Agriculture conducted in collaboration with P.G. College of Science, Osmania University is in its fourth year. This year on job training for hands on experience was imparted to second and third year students. The first batch of students inducted in 2000-01 has successfully completed the course in April, 2003. Many of them have joined P.G. courses and some were suitably placed. Presently 13 students in the third and 18 in the second year are on rolls.



Students undergoing practical training

4.2 Education

4.2.1 Post graduate research

The following scientists are guiding post-graduate research

Scientist	Student	Discipline	Institute/University
K.L. Sharma	G. Ramesh	Soil Science and Agricultural Chemistry	ANGRAU, Hyderabad
	J. Kusuma Grace	Environmental Sciences	JNTU, Hyderabad
P.K. Mishra	Ch. Vasudeva Reddy	Soil and Water	UAS, Dharwad
	Conservation Engineering		
V.M. Mayande	Ch. Srinivas	Master of Computer Application (MCA)	Osmania University, Hyderabad
	P. Chandra Kiran		
K. V. Rao	H. Kurma Rao	Agricultural Engineering	IGAU, Raipur
J.V.Rao	Ms. S.Sujatha	Agronomy	ANGRAU, Hyderabad
K.P.R.Vittal	C.R.Thyagaraj	Water Resource	JNTU, Hyderabad
Kausalya Ramachandran	Thummala Dhananjaya	M.Sc. Photogrammetry and Geoinformatics	FHS Stuttgart, Germany
M. Srinivasa Rao	N. Srinivas	M.Sc.(Ag.) Entomology	ANGRAU, Hyderabad
B. Venkateswarlu	A. Nagamani	Microbiology	Periyar University, Tamil Nadu

4.2.2 Higher studies

The following scientists have been deputed for pursuing Ph.D. studies

Scientists	Institute / University
C.R.Thyagaraj	JNTU, Hyderabad
K.Ravi Shankar	ANGRAU, Hyderabad
Sreedevi Shankar	ANGRAU, Hyderabad
I. Srinivas	JNTU, Hyderabad
D.B.V.Ramana	ANGRAU, Hyderabad

4.2.3 Ph.D. awarded

K. Srinivas	ANGRAU, Hyderabad
M.V.Padmanabhan	JNTU, Hyderabad

4.3 Training

The following personnel obtained need-based training in their fields of specialization

India

Name	Topic	Venue	Period
Sreenath Dixit	Sabbatic	ICRISAT, Patancheru	22 November, 2002 to 31 October, 2003
B. Sanjeeva Reddy G.Pratibha K.V.Rao K.Srinivas K.Nagasree N. Jyoti Lakshmi	Drought Management (Summer School)	CRIDA, Hyderabad	6-26 May, 2003
A.Sambraijyam	Training Needs Assessment of ICAR employees	NAARM, Hyderabad	6 June, 2003
A.K.Mishra	Management of Livestock Enterprises under Swarna Jayanthi Grama Swarozgar Yojna	NIRD, Hyderabad	2-7 June, 2003
S.K.C.Bose G.Lakshminarayana	Improving Administrative Efficiency and Financial Management	NAARAM, Hyderabad	17-24 June, 2003
Ashish Roy	Training programme on Managing stress at workplace	ASCI, Hyderabad	23-26 June, 2003
N. Babjee Rao	Reforms in Agriculture trade in the context of globalization	MANAGE, Hyderabad	24-28 June, 2003
K.V.Subrahmanyam G.R.Korwar K.L.Sharma P.K.Mishra Md. Osman	Training of state level officers and trainers associated with restructured NWDPA funded by Ministry of Agriculture, Govt. of India for capacity building in light of new guidelines of watershed	MANAGE, Hyderabad	7-11 July, 2003
A.Malla Reddy	The Cyberary: a platform for information	MANAGE, Hyderabad	11-14 August, 2003
A.Malla Reddy	Networking and E-Resource Management	INFLIBNET, Ahmedabad	1-12 September, 2003
N.Babjee Rao	Watershed Development in Rainfed Areas (Winter School)	CRIDA, Hyderabad	1-30 September, 2003
M.Prabhakar	Introduction to Arc GIS	ESRI, India NIIT, Hyderabad	15-19 September, 2003
A.Girija	REPSA (Refresher Programme on Statistical Applications)	NIRD, Rajendranagar	15-17 September, 2003

Name	Topic	Venue	Period
A.Sambraiyam A.Vidyadhari	Rural Programmes	NRCWA, Bhubaneswar	3-8 October, 2003
M.Vanaja	Protection of Intellectual Property and Agricultural Research	NAARM, Hyderabad	14-17 October, 2003
A.Vidyadhari	Winter School on Visual preparation techniques in interior designing	ANGRAU, Hyderabad	3-21 November, 2003
S.K.Yadav	Orientation course on Biosafety considerations for evaluation of transgenic crops	NBPGR, New Delhi	10-18 November, 2003
G.Nirmala	Women empowerment	NRCWA, Bhubaneswar	November, 2003
G.Nirmala K.Sreedevi Shankar N.N.Reddy	Internet based information systems in agriculture	NAARM, Hyderabad	11-20 November, 2003
A.Malla Reddy	Development of National Agricultural Database (NARD)	ICAR, New Delhi	20-21 November, 2003
S.S.Balloli	Sabbatic	ICRISAT, Patancheru	24 November, 2003 to 23 November, 2004
A.Sambraiyam A.Vidyadhari	Techniques of improving extension services for farm women	NRCWA, Bhubaneswar	27-30 November, 2003
M.C.Swamy R.D.R.Reddy	National Training Course on Integrated Pest Management in pulses and oilseeds for resource personnel	NCIPM, New Delhi	1-6 December, 2003
R.Dasaradharami Reddy M.Chidambara Swamy	Integrated Pest Management in Pulse and Oil seed crops	NCIPM, New Delhi	1-6 December, 2003
M.Vanaja N.Jyothi Lakshmi improvement	Application of stable isotopes to study physiological processes for crop	UAS, Bangalore	2-22 December, 2003
V.Renu	Windows - Office productivity tools	NIC, Hyderabad	15-19 December, 2003
M.Osman	Short course on Data Analysis using SPSS	CPCRI, Kasargod	8-12 December, 2003
R.Joseph	Hybrid seed production in tropical vegetable crops	IIHR, Bangalore	16-23 February, 2004
P.R.Singh	Hi-tech Floriculture	IIHR, Bangalore	3-10 March, 2004

Abroad

Name	Topic	Venue	Period
J.V.N.S. Prasad	International conference on rural livelihoods, forests and bio diversity	Bonn, Germany	19-23 May, 2003
Y.G.Prasad	i) Plant biotechnology and biosafety ii) Role of pesticides in IPM	IAC, Wageningen	9 June to 4 July, 2003

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Name	Topic	Venue	Period
A.K.Mishra	Recent Advances in Animal Nutrition	The Macaulay Land Use Research Institute, Aberdeen, Scotland	16 June to 6 July, 2003
G.R.Korwar	Fourth Asia - Africa Forum of UNCCD on Combating Desertification	Cotonou, Benin	24-27 June, 2003
G.Pratibha	Dynamic cropping systems with reference to Oilseeds	North Dakota, USA	27 July to 9 August 2003
Ch. Srinivasa Rao	Nutritional constraints and management in different soil types	Institute of Natural Resources, Massey University, New Zealand	8-19 September, 2003
V.Ramesh	Carbon sequestration under different land uses	Oregon State University, Corvallis, USA	22 October to 5 November, 2003
U.K.Mandal	Planning for Sustainable Land Resource Management	The Ohio State University, Columbus, Ohio, USA	26 October to 8 November, 2003
G. R. Korwar	IPLAC International Symposium on Sustainable Dryland Agriculture Systems	Niamey, Niger	2-5 December, 2003
K.V. Subrahmanyam	Study tour - under DFID-NRSP-R8192 project "Enabling Rural Poor for Better Livelihood in SAT India"	Kenya and Tanzania	18-30 January, 2004
Y.G. Prasad	Development and dissemination of forecasts for pest insects of outdoor crops	Horticulture Research International, Warwick, U.K.	29 March to 9 April, 2004

5 Women in Agriculture

CRIDA has a fair representation of women in all sections. There are 10 women in the Scientific, 11 in the technical, 14 in administrative and 19 in supporting staff categories. They are actively involved in research projects and other institution building activities. Women scientists have both

institute and externally funded projects (Table 5.1). They have also been instrumental in attracting funds from several funding agencies. Besides carrying out the research activities they are also active in institute committees like IMC, RAC and IJSC.

Table 5.1 Projects handled by women scientists

Project title	Handled by
Institute Projects	
1. Evaluation and exploitation of plant species for alternate value added products in marginal lands	Dr. G.Pratibha (PI) Dr. M.Vanaja (Assoc.)
2. Low till farming strategies and integrated plant nutrient supply for rainfed SAT	Dr. K.Neelaveni (Assoc.) Dr. V.Maruthi (Assoc.)
3. Spectral characterization of rainfed <i>kharif</i> sorghum	Dr. M.Vanaja (Assoc.)
4. Evaluation of dual purpose cereals	Dr. M.Vanaja (Assoc.)
5. Managing abiotic stress tolerance in Drylands: physiological and molecular approaches	Dr. M.Maheswari (PI) Dr. M.Vanaja (Assoc.) Dr. N.Jyothi Lakshmi (Assoc.)
6. Studies in extraction and storage of curry leaf essence.	Dr. M.Vanaja (Assoc.)
7. Life table analysis, economic threshold levels and IPM modules for major pests of castor	Dr. K.Nagasree (Assoc.)
8. Sustainable land use through agri-horti and horti-pasture system - rainfed Alfisol watershed	Dr. N.Jyothi Lakshmi (Assoc.)
9. A study on role of village institutions on management of programmes on area development on watershed basis in southern Telangana of AP	Dr. G.Nirmala (PI)
10. Zero energy cool chamber storage studies on dryland fruits and vegetable	Dr. K. Sreedevi Shanker (PI)
11. Impact assessment of IVLP project	Dr. K.Nagasree (PI)
NATP	
12. Evaluation of cultivars of major oilseed crops for moisture and nutrient constraints in different soil type	Dr. G.Pratibha (CCPI)
13. Development of sustainable alternate landuse systems for industrial biomass production from dryland	Dr. G.Pratibha (Assoc.)
14. Landuse planning and management of agricultural resources in rainfed agriculture	Dr. Kausalya Ramachandran (Assoc.) Dr. G.Pratibha (Assoc.) Dr. G.Nirmala (Assoc.) Mrs. A. Vidhyadhari (Assoc.)
15. Identifying systems for carbon sequestration and increased productivity in semi-arid tropical environment	Dr. M.Vanaja (Assoc.)
16. Influence of different agroforestry models on soil fertility and resource conservation under conditions in SAT	Dr. G.Pratibha (CoPI)

Project title	Handled by
Externally funded	
17. Enhancing tolerance of sorghum to abiotic stress a through genetic manipulate (AP-NL)	Dr. M.Maheshwari (PI) Dr. M.Vanaja (Assoc.) Dr. N.Jyothi Lakshmi (Assoc)
18. Network project on agroforestry in A.P. (AP-NL)	Dr. G.Pratibha (Assoc.)
19. Interaction of elevated CO ₂ and moisture stress on seal viability, seed germination and initial plant estimate of different dryland crops (AP-Cess)	Dr. M.Vanaja (PI) Dr. M.Maheshwari (Assoc.)
20. Crop diversification for sustainability of drylands through dye yielding crops (AP-Cess)	Dr. G.Pratibha (PI)
21. Enabling rural poor for better livelihood through improved natural resource management in SAT India (DFID)	Dr. K.Nagasree (Assoc.) Dr. V.Maruthi (Assoc.)
22. Biointensive integrated pest management (AP-NL)	Dr. G.Nirmala (Assoc.) Dr. V.Maruthi (Assoc.)
23. Crop-crop diversity as a key IPM management (AP-Cess)	Dr. G.Pratibha (Assoc.) Dr. V.Maruthi (Assoc.)
24. Empowerment of women through participatory dryland technology interventions (UNDP)	Dr. V.Maruthi (PI) Dr. G.Pratibha (Assoc.) Dr. K.Nirmala (Assoc.)

Women's Cell

There is an active Women's Cell in the Institute with the following members:

- Dr. G.Pratibha (Scientific)
- Mrs. V.Savitri (Technical)
- Mrs. Manikyam (Administration)
- Mrs. Rajmani (Supporting)

Farmwomen club

Under the NABARD scheme of technology transfer, a club was formed for farmwomen at Saireddyguda village recently. (Sai Mahila Podupu Sangham - with 15 active members). The scheme will be financed by NABARD.

Research

There are two ongoing research projects related to women viz., Empowerment of women through participatory dryland technological interventions and Studies on women in agriculture in India with special emphasis on crop production technologies (NCAP)

In the UNDP funded project on empowerment of women in Agriculture, on-farm demonstrations on various activities like crop production, agroforestry, integrated pest management were taken up to improve the yields and reduce drudgery of the women farmers. The trials were conducted in 6 villages in three districts.

International Women's Day

The CRIDA Women's Cell conducted International Women's Day on 8 March 2004. Dr. Poornima Nagraj (Psychiatrist) was the chief guest who advised the working women on ways and means of coping with stress at work and home.



Women in Agriculture Day

Women in Agriculture Day was celebrated on 4 December 2003 in Saireddyguda village of R.R.District which was participated by 60 farmwomen. The role of women in agriculture production was recognised as crucial factor for family food and nutritional security.

Women Empowerment

KVK under CRIDA conducted many activities for empowerment of farmwomen. They included training programmes for skill development and exposure visits.

Training Programmes

A total of 1723 farm women were provided with need based skill oriented training in various aspects of agriculture developed, and farm and home improvement with emphasis on crop production, use of improved implements, preparation of vermicompost, IPM, soil and water conservation in integrated watershed management, sericulture and food and nutrition etc.

The clientele for the KVK training included rural women, women farmers, members of watershed committees, members of watershed groups and self-help groups, extension functionaries and others concerned with rural development and women



Farmwomen on a field visit

empowerment. Special emphasis was given on extending training to women in the areas like garment making, candle making, vegetable preservation, preparation of washing power and phenyl, backyard poultry, bakery and rural crafts.

Exposure visits

Sixty women members from various organizations like APMSS, YFA(NGO) and FTC visited the KVK farm and got acquainted with various latest agriculture technologies.

ICAR Sport meet

A good contingent of women participated in the ICAR sports meet conducted at NAARM, Hyderabad. They brought laurels by winning medals individually and in team events.

6 Awards and Recognitions

- CRIDA was awarded "Rajrishi Tandan Rajbhasha Puraskar" for the year 2002-03 by the Indian Council of Agricultural Research (ICAR), New Delhi for the best implementation of the Official Language policy of the Govt. of India amongst the ICAR Institute's situated in Southern Region.



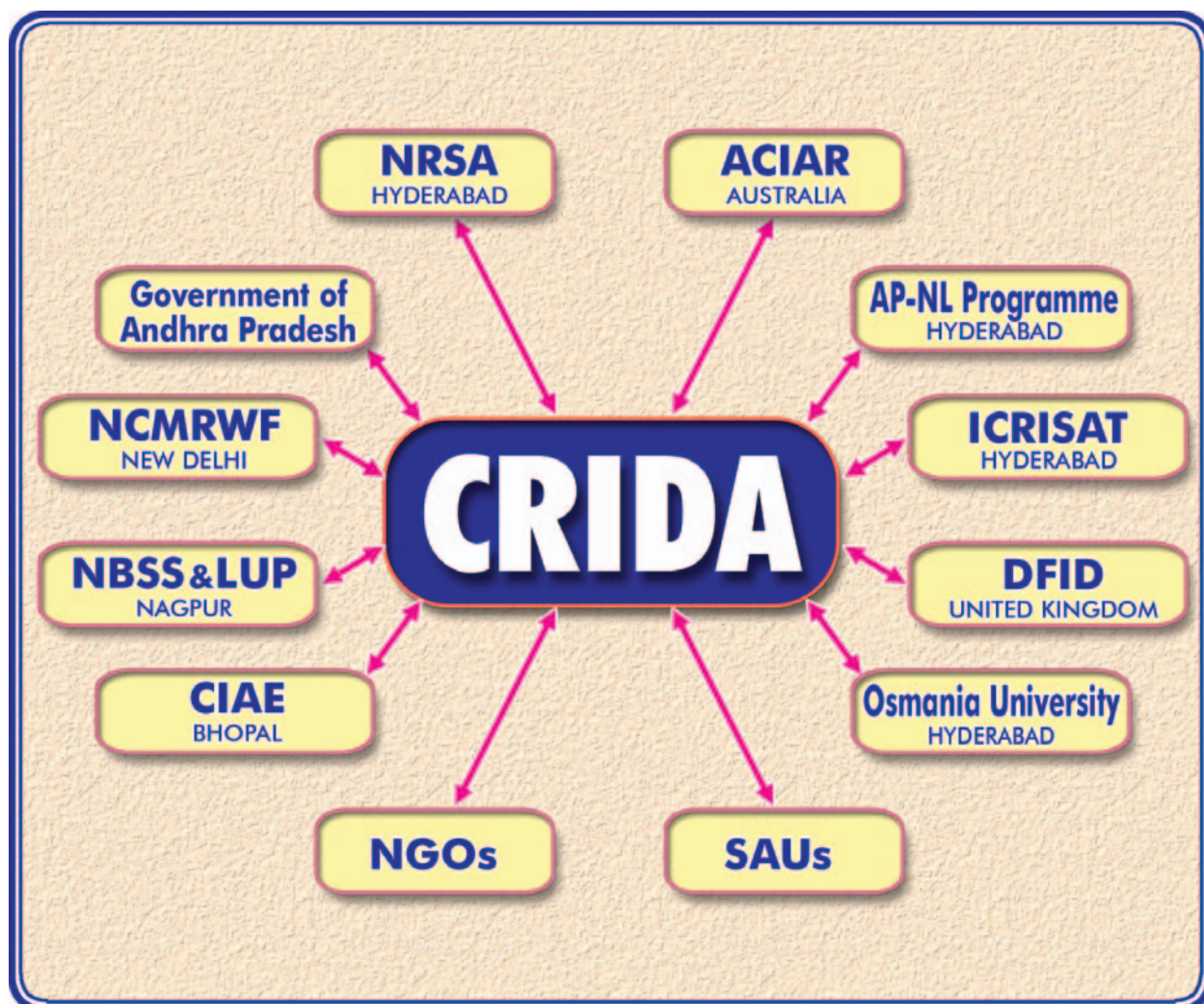
- Dr. Y.S.Ramakrishna, Director, was honoured by Shri Sompal, Member, Planning Commission for his outstanding contributions to Agricultural Meteorology.
- Dr. Y.S.Ramakrishna was appointed as a Member on the Board of Governors of Agri-business Incubator, ICRISAT.
- Dr. Y.S.Ramakrishna was nominated as Country Coordinator of the Asia Development Bank Project.
- Dr. Y.S.Ramakrishna has been appointed as a Member on the Steering Committee of the programme on Virtual Academy for Semi-Arid Tropics of ICRISAT which is working on drought management in which CRIDA is a partner.
- Dr. B.Venkateswarlu, Principal Scientist, was admitted as Fellow of Indian Society of Oilseeds Research, Hyderabad and member of All India Biotech Association, New Delhi.
- Dr. G.Subba Reddy, Principal Scientist, was admitted as Fellow of Indian Society of Oilseeds Research, Hyderabad.
- Dr. K.Srinivas, Scientist (Sr. Scale) was awarded gold medal for his Ph.D. thesis on "Regulating mineralization from plant residue by manipulation of quality". He was also conferred with the Best Doctoral Research Presentation Award - 2003 by the Indian



Society of Soil Science, New Delhi.

- Dr. Md. Osman, Sr. Scientist, was appointed as a Member of Advisory Committee of "Ecological Concerns" (Agroforestry and Bio-diversity), Centre For People's Forestry, Hyderabad.
- Dr. Ch. Srinivasa Rao, Sr. Scientist, was admitted as a Fellow of the Indian Society of Pulse Research and Development, Kanpur.

7 Linkages and Collaborations



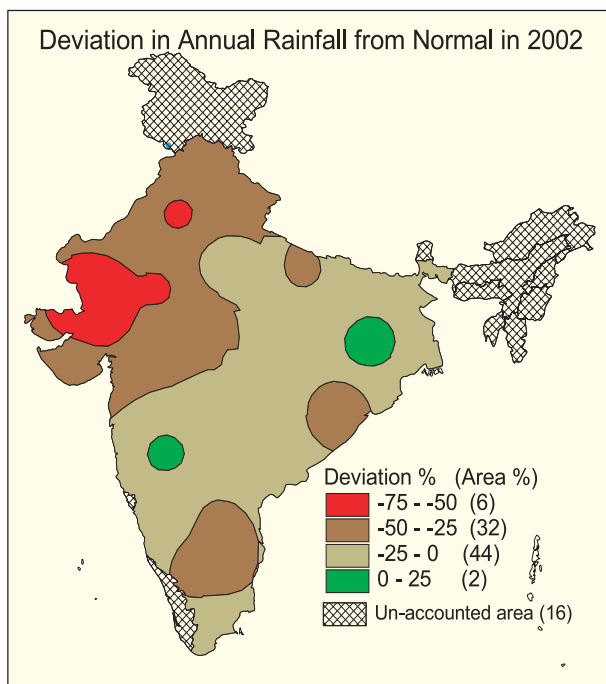
8 AICRP/Coordination Units/NATP

8.1 All India Coordinated Research Project for Dryland Agriculture

The weather played havoc with the dryland agriculture. The crops experienced unprecedented

agricultural drought in the country. In general, the rainfall was erratic. Consequently both *kharif* and *rabi* production suffered. In view of the peculiar weather situation, an analysis on yield deficiencies of cropping systems was made in AICRPDA network comprising centers from seventeen State Agricultural Universities, two Technical Universities and three ICAR institutes. Results of research work are presented in eight crop based production system matrix. The description consists of on-station and on-farm work with some focus on sustainable practices.

On-station results: On-station field experiments, 247 in number, were conducted at 21 centers located under rice, *rabi* sorghum, maize, pearl millet, cotton, groundnut, soybean, finger millet and *kharif* sorghum production systems on different research themes: integrated nutrient management (28%), crop improvement (28%), soil and water conservation (21%), cropping systems (17%), energy management (2%), pest/weed management (2%) and alternate land use systems (3%). The important findings from each of the production system are described here under:



Upland rice-based

Centre	Research theme	Salient findings
Ranchi	Cropping system	Rice + okra (1: 2) Pigeonpea (60 x 30 cm) + 2 rows of okra
Faizabad	Cropping system	Line sowing (30 cm apart) and ZnSO_4 @ 40 kg ha ⁻¹ for chickpea
Varanasi	Cropping system	Flat planting with a density of 0.67 lakhs ha ⁻¹ and 20 kg N + 40 kg P + 20 kg K + 3 kg Zinc + 20 kg ha ⁻¹ of sulphur for pigeonpea
Faizabad	Integrated nutrient management	100% recommended N (inorganic) for maize + pigeonpea intercropping ZnSO_4 @ 30 kg ha ⁻¹ for pigeonpea
Ranchi	Integrated nutrient management	Inorganic for rice
Phulbani	Integrated nutrient management	30 kg N (FYM) + 20 kg P + 20 kg K ha ⁻¹ for rice 15 kg N (FYM) + 20 kg N (inorganic) for rice equivalent yield 20 kg N (gliricidia) for maize

Centre	Research theme	Salient findings
		FYM @ 6 t ha⁻¹ + rest N (inorganic) for pigeonpea and rice equivalent yield under pigeonpea + rice 45 kg N/ha for rice under pigeonpea + rice 80 kg N + 60 kg P + 80 kg K ha⁻¹ (100% recommended dose) for yam and yam equivalent yield under yam + maize 50% N recommended dose + 50% N (FYM) for maize under yam + maize (50% recommended dose) 30 kg N + 15 kg P + 45 kg K ha⁻¹ + calcium hydroxide (0.25 lime requirement + FYM @ 20 t ha⁻¹ for turmeric
Ranchi	Integrated nutrient management	15 kg N (compost) + 20 kg N ha⁻¹ (inorganic) for rice under rice - blackgram rotation 15 kg N (compost) + 10 kg N (green leaf) for blackgram under rice - blackgram rotation Farm yard manure @ 10 t ha⁻¹ for rice under rice - linseed system
Varanasi	Integrated nutrient management	100% recommended dose of fertilizer for rice (cv NDR-97) 100% recommended dose of fertilizer for rice and greengram under rice + greengram -lentil system
Phulbani	Mulches	Mimosa green leaf manure @ 5 t ha⁻¹ for maize equivalent yield under maize + pigeonpea Maize stover mulch @ 5 t ha⁻¹ for pigeonpea Gliricidia green leaf mulch @ 5 t ha⁻¹ for maize
Varanasi	Mulches	Straw mulch for rice 2% urea spray to mitigate drought for rice
Phulbani	Tillage and nutrient management	Low tillage + interculture + herbicide for rice
Faizabad	Tillage and nutrient management	Conventional tillage + interculture twice for rice - lentil sequence
Ranchi	Tillage and nutrient management	Low tillage + weedicide + hand weeding once for rice 50% through organic + 50% through inorganic for rice Ploughing once by mold board plough + ploughing once by Birsa ridger plough + planking + seeding by country plough for rice
Varanasi	Tillage and nutrient management	Conventional tillage for rice - barley sequence 100% recommended dose (80 kg N + 40 kg N + 20 kg K ha⁻¹) for rice - barley sequence Conventional tillage (disc harrowing + cultivator once) for rice 100% recommended dose through organic source for rice

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Centre	Research theme	Salient findings
Faizabad	Varieties	Rice (cvs Vandana and Brown gora) Niger cvs GA-10 and Otakamund with 60 kg N ha ⁻¹ Chickpea cv K -850, Lentil cv NDL-1, Mustard cv NDR-1 for maximum chickpea equivalent yield
Phulbani	Varieties	Rice cv RR-166-645 and cv RR-348-6; Blackgram B-3-8-8 and OBG-23; Pigeonpea cv V-41
Ranchi	Varieties	Rice cv Anjali and cv RR-347-1; Rice cv RR-347-166; Rice cv BAU-255-76 and cv Birsa gora -102; Sesame cv CST-93 and cv RT-328; Groundnut cv BAU-20 and cv BAU-18
Varanasi	Varieties	Rice cv CR-876-6; Rice cv HUR-1029; Pigeonpea (cv Bahar) + rice (cv NDR-97)
Faizabad	Weed management	Sprouted seed of cv NDB-2 of barley

Groundnut-based

Centre	Research theme	Salient findings
Anantapur	Alternate land use systems	Soapnut (6x6 m) for maximum plant height and girth with drip or without drip irrigation situations
Rajkot	Cropping system	Pearlmillet - pearlmillet with integrated nutrient management for maximum yield
Anantapur	Cropping system	Early sowing (8 June) for maximum net returns of sole pigeonpea and castor + pigeonpea Normal sowing (1 August) for maximum net returns of sole groundnut, groundnut + pigeonpea and groundnut + castor Shrivelled small seed of groundnut for maximum net returns Intercropping of groundnut with pulses (cowpea, horsegram and pigeonpea) in 1: 1 ratio for maximum pod yield
	Drought management	Spray of zinc sulphate @ 0.5 at 35 and 65 days after sowing for groundnut
	Implements	AERC seed drill for groundnut
Rajkot	Integrated nutrient management	25% N (compost) + 75% N (inorganic) for groundnut under groundnut monocropping 50% N (glyricidia) + 50% N (inorganic) for castor under castor monocropping 50 5 N (compost) + 50% N (inorganic) for castor under groundnut - castor rotation 20 kg N + 40 kg P + 40 kg K ha ⁻¹ + groundnut shells @ 4 t/ha for groundnut under treated plots and no fertilizer under depleted plots

Centre	Research theme	Salient findings
	Mulches & fertilizers	15 kg N (compost) + 10 kg N (inorganic) for pearl millet under permanent strip 15 kg N (green leaf) + 20 kg N (inorganic) for pearl millet under rotational strip 100% recommended N (inorganic) for groundnut under permanent or rotational strips. Recommended dose of fertilizer (12.5 kg N + 25 kg P) for maximum pod yield and compost enriched with SSP @ 5 t/ha for maximum fodder yield of groundnut Farm yard manure @ 10 t ha⁻¹ for groundnut pod yield Farm yard manure @ 6 t ha⁻¹ for sorghum (fodder) and soybean 50% recommended dose of fertilizer + vermi compost @ 0.5 t/ha for maize, cowpea and Blackgram Soil mulch and 100% recommended farm yard manure (70 kg tree⁻¹) for maximum plant height and stem girth of <i>aml</i>
Anantapur	Tillage & nutrient management	Low tillage + herbicide and 100% recommended dose of fertilizer through organic source (20 kg N + 40 kg P + 40 kg K ha ⁻¹) for groundnut
Rajkot	Tillage & nutrient management	Deep tillage upto 30 cm and 100% recommended fertilizer (organic) for groundnut Deep ploughing every year for groundnut
Anantapur	Varieties	Groundnut cvs JAL-46, TMV-2 and CD-60
Rajkot	Varieties	Groundnut cvs JSP-37, M-13 and GG-11; Groundnut JSSP-19, GG-20 and JSSP-20 of virginia bunch; Sesame cvs AT-79, AT-92, AT-81 and G.Til-1; Sorghum cvs CSH-14, SPH-1376, CSH-9 and CSH-16; Greengram cvs GM-9926, GM-9705, GM-9710 and GM-9925
Anantapur	Water harvesting	15 mm supplemental irrigation for groundnut + pigeonpea
	Weed management	Hand weeding at 20 and 40 days after sowing + pendimethalin @ 0.5 kg ai ha ⁻¹ with sand at 50 days after sowing for managing <i>Celosia</i> weed in groundnut

Soybean-based

Centre	Research theme	Salient findings
Indore	Cropping system	Drumstick + pigeonpea for maximum soybean equivalent yield and gross monetary returns Sunflower + pigeonpea (4: 2) for maximum soybean equivalent yield (sown on 24 June)

Centre	Research theme	Salient findings
Rewa	Cropping system	Soybean + pigeonpea (4: 2) for maximum soybean equivalent yield (sown on either 4 or 14 July) Groundnut for maximum yield and net profit Soybean (cv JS-335) + pigeonpea (cv JA-4) under shallow, medium and deep soils for maximum soybean equivalent yield and returns Pigeonpea (cv NPWR-15) + soybean (cv JS-335) for maximum pigeonpea equivalent yield Soybean - coriander sequence for maximum net returns Rice - chickpea for maximum net returns and B : C ratio
Indore	Implements Integrated nutrient management	Sowing with Tifan for soybean 25 kg N (compost) + 15 kg N ha⁻¹ (urea as top dress) for soybean 50% recommended N for maize 15 kg N (compost) + 20 kg N (urea as top dress) for maximum soybean equivalent yield from soybean + maize (4 : 4) system FYM @ 6 t ha⁻¹ + 20 kg N + 13 kg P ha⁻¹ for soybean (FYM in rainy season only) 60 kg P (Jabua Rock Phosphate) + farm yard manure @ 5 t/ha + 10 g phosphorus solubilizing microbes kg⁻¹ seed treatment + 3 kg phosphorus solubilizing microbes blended with 50 kg farm yard manure ha⁻¹ for soybean
Rewa	Integrated nutrient management	100% N through compost for maximum chickpea equivalent yield from rice - wheat, blackgram - chickpea sequences
Indore	Soil & water conservation	Sowing across the slope + mechanical bund for maximum soybean yield, minimum runoff and soil loss
Rewa	Soil filters	Vetiver filters + trench for maximum blackgram yield and soil deposition
Indore	Tillage	Conventional tillage + recommended dose of fertilizer+ off season tillage + hand weeding for soybean
Rewa	Tillage & nutrient management	Low tillage + weedicide + interculture and 50% organic + 50% inorganic fertilizer for soybean
Indore	Varieties	Pigeonpea cvs JIA-62 and JIA-33; Maize cvs Navjot, JM-12 and Chandan-3; Earthing at 30 days for maize; Soybean cvs JS-335, Samrat, JS-71-05 and NRC-12
Rewa	Varieties	Blackgram cvs JU-26, JU-23 and JU-2; Chickpea cvs RWG-12 and JG-315; Lentil cvs RWL-12 and RWL-4

Centre	Research theme	Salient findings
Weed management	Varieties	Hand weeding at 30 and 40 days after sowing for soybean
Alternate land use system	Varieties	<i>Pongamia pinnata</i> + barley (cv AK-560)

Fingermillet-based

Centre	Research theme	Salient findings
Bangalore	Implements	Tractor drawn CRIDA seed drill for groundnut and fodder maize
	Integrated nutrient management	Recommended N (green leaf manure) for fingermillet 50% N (green leaf manure + FYM) + 50% NPK for groundnut Lime to 40% calcium saturation + 150% of K for groundnut Farm yard manure @ 10 t ha ⁻¹ (FYM) and maize residue @ 5 t ha ⁻¹ + 100% recommended NPK for groundnut (maize residue series) under groundnut - fingermillet rotation FYM @ 10 t ha ⁻¹ + 100% NPK (FYM) and maize residue @ 5 t ha ⁻¹ + 100% recommended NPK for fingermillet under fingermillet - fingermillet monocropping system
	Soil & water conservation	Natural vegetation (control) for minimum runoff and soil loss
	Tillage & nutrient management	Conventional tillage and 100% recommended N (inorganic) for fingermillet
	Varieties	Cowpea cvs P-4, P-3, P-1, P-9 and C-15 Sesame (cvs KP local, Magadi local and Bhadhuri) for sesame - greengram (cv PS-16) double cropping Greengram (cvs KGG-1, PS-16, PDM-5 and NM-92) for greengram - cowpea double cropping Sunhemp for green leaf manure and maximum fingermillet yield Long duration fingermillet cvs L-15-1 and L-5; Medium duration fingermillet cvs HR-911 and cvs GPU-28; Short duration fingermillet cv GPU-26
	Vegetative barriers	Nase live barrier for maximum horsegram yield and minimum runoff
	Cropping system	Cowpea (cv TVX-945-02E) for maximum green biomass yield and green manuring

Maize-based

Centre	Research theme	Salient findings
Arjia	Alternate land use system	<i>Cinararia</i> + <i>C.setigartities</i> for class IV and V soils
Rakh Dhiansar	Alternate land use system	<i>Amla</i> + green fodder for maximum fodder yield <i>subabul</i> + <i>gobi sarson</i> for maximum green leaf, fuel wood and green grass
Arjia	Cropping system	Maize - cowpea (fodder) for maximum biomass
Ballowal Saunkhri	Cropping system	Maize (60 x 22.5 cm) for maximum maize equivalent yield Maize + greengram with 80 kg N + 40 kg P ha ⁻¹ for maximum maize equivalent yield
Rakh Dhiansar	Cropping system	Wheat (cv RSP-423) sown on 14 November for maximum grain yield
Arjia	Drought management	Sorghum + cowpea fodder under delayed onset of monsoon for maximum biomass
	Integrated nutrient management	15 kg N (compost) + 10 kg N (inorganic) for maize and blackgram stover yield 150% recommended fertilizer dose for maximum biological yield of maize
Ballowal Saunkhri	Integrated nutrient management	15 kg N (compost) + 10 kg N (inorganic) for maize and 15 kg N (green leaf manure) + 20 kg N (inorganic) for greengram 15 kg N (compost) + 10 kg N (inorganic) for wheat and 15 kg N (green leaf manure) + 20 kg N (inorganic) for lentil 125 kg N + 30 kg P ha ⁻¹ for innovated seed of lentil
Rakh Dhiansar	Integrated nutrient management	100% recommended N (inorganic) for maize equivalent yield under cereal + legume 100% recommended dose of fertilizer (60 kg N + 40 kg P + 20 kg K ha ⁻¹) + ZnSO ₄ @ 20 kg/ha for maize FYM @ 10 t ha ⁻¹ + 40 kg N ha ⁻¹ + recommended P and K for maize under maize - wheat rotation 40 kg P ha ⁻¹ + lime @ 1500 kg ha ⁻¹ for blackgram 90 kg N/ha for maximum oat seed yield and dry <i>bhusa</i> yield 60 kg P ha ⁻¹ and zinc sulphate @ 5 kg ha ⁻¹ for maximum chickpea yield FYM @ 10 t ha ⁻¹ to maize in <i>kharif</i> for maximum residual effect of chickpea and mustard in <i>rabi</i> and maximum sarson equivalent yield
Ballowal Saunkhri	Seed rate & row spacing	30 kg ha ⁻¹ of seed rate and 22.5 cm of row spacing for lentil

Centre	Research theme	Salient findings
Arjia	Soil & water conservation	<i>Cenchrus ciliaris</i> for maximum grass yield, sorghum fodder for maximum maize equivalent yield and compartmental bunding (5 m interval) for <i>cenchrus</i> and sorghum fodder
	Tillage & nutrient management	Conventional tillage + hand weeding twice and 50% inorganic + 50% organic fertilizer for maize
Ballawal Saunkhri	Tillage & nutrient management	Low tillage + interculture + weedicide + 100% recommended fertilizer (inorganic) for maize Conventional tillage + interculture + 100% recommended fertilizer (organic) for wheat under maize - wheat sequence
Rakh Dhiansar	Tillage & nutrient management	Conventional tillage + interculture and 100% N (inorganic) for maize
Arjia	Varieties	Horsegram cvs AK-42, AK-1 and AK-44; Maize cvs Mahi Kanchan, Aravali makka-1, PEHM-2 and EC-3108; Sesame cv SPRT-23; Sorghum cv CSV-15; Groundnut cv JL-24; Sesame cv RT-125; Blackgram cv T-9; Greengram cv K-851; Cluster bean cv RGC-986; Horsegram cv AK-21
Ballawal Saunkhri	Varieties	Bread wheat cvs PBW-175, C-306, PBW-396 and UP-2596 and Durum wheat cvs D-1840, D-1913, C-306 and PBW-175
	Varieties & fertilizers	Greengram cv SML-668 with 125 kg N + 40 kg P ha ⁻¹
	Weed management	Trifluralin @ 0.5 l ha ⁻¹ for greengram

Cotton-based

Centre	Research theme	Salient findings
Kovilpatti	Alternate land use systems	Tamarind cv PFM + blackgram cv CO-5 for cotton equivalent yield
	Hybrids	Sunflower (RAH-0212 and RAH-0214) (Advanced hybrid trial) Sunflower (RIH-02466 and RIH-02464) (Initial hybrid trial)
Akola	Integrated nutrient management	Organic manure @ 4 t ha ⁻¹ and 100 kg N + 50 kg P + 50 kg K ha ⁻¹ for maize (popcorn) 25 kg N + 25 kg P + 25 kg N (FYM) for maximum cotton and greengram yield under cotton + greengram (1 : 1) 100% recommended N for maximum grain and fodder yield under sole sorghum + 15 kg N through green leaf + 20 kg N through inorganic fertilizer for maximum grain yield and 100% recommended N for maximum fodder yield under strip sorghum
Kovilpatti	Integrated nutrient management	50% N (FYM) + 50% N (urea) + 10 kg P ha ⁻¹ for pearl millet 20 kg N/ha as energetic farm yard manure for seed cotton yield

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Centre	Research theme	Salient findings
		20 kg N (green leaf manure) + 20 kg N ha⁻¹ (urea) for sorghum 20 kg N (urea) + 20 kg N (FYM) + 20 kg P ha⁻¹ (SSP) for cotton + blackgram Energetic farm yard manure + 75% N + <i>Azospirillum</i> + phosphobacteria for seed cotton yield under cotton - sorghum sequence 15 kg N (compost) + 20 kg N (inorganic) for maximum net returns from sorghum + cowpea
Akola	Soil & water conservation	Vetivar key lines at 1 m vertical interval for soybean Soil mulch with application of 20 kg K ha⁻¹ and crop residue mulch for cotton Soil mulch with application of 20 kg K ha⁻¹ and furrow opening for soybean and sorghum
Kovilpatti	Soil & water conservation	Compartmental bunding for sorghum
Akola	Tillage & nutrient management	Conventional tillage (ploughing + off season tillage + interculture + hand weeding) and 100% inorganic fertilizer for cotton
Kovilpatti	Tillage & nutrient management	Conventional tillage + interculture and 50% (organic) + 50% (inorganic) for sunflower
	Varieties	Blackgram (COBG-632 and VBN-3) (multi location trial) Blackgram (X-5, VBG-29, KBG-96007 and AKV-10) (Advanced varietal trial) Blackgram (VBG-23 and KBg-98008) (Preliminary evaluation trial) Greengram (COGG-913 and VRMGG-1) (Multi location trial) Greengram (cvs Pusa-9072 and VGG-7) (Advanced varietal trial) Greengram (VGG-8 and PDM-54) (Initial evaluation trial) Greengram (LGG-470 and Pusa -9671) (preliminary yield trial)
	Water harvesting	Amla for maximum grain yield with farmer pond water utilization
Akola	Cropping system for maximum gross monetary returns	Soybean (cv JS-335) - chickpea (cv PKV-Kab-2)

Rabi sorghum-based

Centre	Research theme	Salient findings
Solapur	Cropping system	Castor (cv DCH-32) with spacing of 60 x 45 cm and 50 kg N + 25 kg P ha⁻¹ Sunflower + pigeonpea (2:1) for maximum gross returns 45 x 20 cm spacing and 75 kg N + 37.5 kg P ha⁻¹ for maximum <i>rabi</i> sorghum grain and fodder yield <i>Rabi</i> sorghum (cv Phule mouli) with 45 x 20 cm spacing for maximum grain yield

Centre	Research theme	Salient findings
Bijapur	Cropping system	Chilli + onion (2:4) under poultry manure + residue incorporation for maximum chilli fruit yield Castor 60 x 15 cm + sunflower 60 x 20 cm in 2: 4 ratio for maximum net returns
Bellary	Hybrids	Sorghum cvs CSH-19R, SPH-1077 and CSH-15R
Solapur	Hybrids	Castor (cvs AHT-8, AHT-9, AHT-5 and AHT-3) with ridges and furrows for moisture conservation
Bellary	Integrated nutrient management	15 kg N (compost) + 10 kg N (green leaf manure) for sorghum, chickpea and sorghum + chickpea different blocks
Bijapur	Integrated nutrient management	50% N through farm yard manure + 50% recommended dose of fertilizer for maximum grain and fodder yield of <i>rabi</i> sorghum 15 kg N through compost + 20 kg N through inorganic source for maximum grain and fodder yield of <i>rabi</i> sorghum 15 kg N through compost + 20 kg N through inorganic source for maximum grain yield of chickpea 15 kg N through compost + 20 kg N through inorganic source for sorghum (cv M-35-1) + chickpea (cv A-1) 100% recommended N for maximum seed and stalk yield under sunhemp - sunflower - sunhemp- <i>rabi</i> sorghum and sunflower - <i>rabi</i> sorghum sequences FYM @ 5 t ha ⁻¹ for maximum yield of <i>rabi</i> sorghum (cv M-35-1) and lowest runoff and soil loss FYM @ 5 t ha ⁻¹ for sorghum under sunflower - <i>rabi</i> sorghum sequence and lowest runoff and soil loss
Solapur	Integrated nutrient management	25 kg N through crop residue + 25 kg ha ⁻¹ through luaceana loppings for maximum grain yield of <i>rabi</i> sorghum 50 kg N ha ⁻¹ for maximum grain and stover yield of <i>rabi</i> sorghum under sole plot. 15 kg N through compost and residue + 20 kg N ha ⁻¹ through urea for maximum grain yield of <i>rabi</i> sorghum under strip cultivation 50% recommended N for chickpea in sole plot. 15 kg N through leuceana + 20 kg N ha ⁻¹ through urea for chickpea under strip cultivation
	Soil & water conservation	Ridges and furrows (45x30 cm) for sunflower sown on 9 th July (28 th standard metrological week) and 60 kg N + 30 kg P/ha Mechanical bunds for pearl millet + mothbean (2: 1) for minimum runoff and soil loss Stone bund for maximum grain and fodder yield of <i>rabi</i> sorghum and lowest runoff and soil loss

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Centre	Research theme	Salient findings
Bijapur	Soil & water conservation	Sand mulch at 15 cm depth for maximum greengram and sorghum yield under greengram - sorghum sequences and lowest runoff and soil loss
Bellary	Tillage & nutrient management	Conventional tillage (ploughing once + harrowing twice + hoeing twice + hand weeding once) and 100% N through organic (50% farm yard manure + 50% green leaf manure) for sorghum
Solapur	Tillage & nutrient management	Conventional tillage and 100% inorganic fertilizer for pearl millet
Bellary	Varieties	Sorghum cvs RSLG-262, SPV-1591 and SPV-1546
Bijapur	Varieties	Sunflower cvs MLSH-8, RSFH-318, MLSH-6 and MLSH-10; Mulberry cvs S-1635, S-13, TR-10 and DD; Proso millet cvs PMLT-9, PMLT-7, PMLT-2 and PMLT-4; Spreading groundnut cvs GPM-31, GPM-84, GPM-29 and GPM-6; Horsegram cvs GPM-40, GPM-6 and IC 100938; Spanish bunch variety of Groundnut cvs DH-106 and DH-107; Little millet cvs LMLT-5 and LMLT-4; Foxtail millet cvs FMLT-6 and FMLT-7
Solapur	Varieties	Castor (cvs AVT-2, AVT-10 and AVT-6) and ridges and furrows for moisture conservation
Weed management	Varieties	Pendimethalin @ 1 kg ai ha ⁻¹ (Preemergence) + 1 hoeing at 45 days after sowing for pigeonpea

Pearlmillet-based

Centre	Research theme	Salient findings
SK Nagar	Alternate land use system	Amla + stylo for dry fodder grass yield <i>Cenchrus ciliaris</i> for pearl millet equivalent yield
Agra	Cropping system	Sowing between 11 - 20 October and 100% of the recommended plant population (1.48 lakh ha ⁻¹) for mustard Palmarosa for maximum plant height and <i>sada bahar</i> for maximum survival
SK Nagar	Cropping system	25% N as basal and remaining 75% N at 20-25 days after sowing for pearl millet equivalent yield Karingdo in 3 rd row of pearl millet for pearl millet equivalent yield
	Drought management	Kaolinite/bentonite spray (5% solution) for pearl millet equivalent yield for early and late season drought with normal seeding at onset of monsoon
Agra	Integrated nutrient management	<i>Dhaincha</i> (<i>Sesbania aculeate</i>) (green leaf manure) and 60 kg N ha ⁻¹ for mustard
SK Nagar	Integrated nutrient management	50% N (inorganic) + 50% N (farm yard manure) for castor

Centre	Research theme	Salient findings
Hisar	Integrated nutrient management	40 kg N + 30 kg P ha ⁻¹ for maximum fodder yield of pearl millet + cowpea 45 kg N + 22.5 P ha ⁻¹ for maximum barley (cv BH-8) yield with <i>dhaincha</i> green manure or without green manure
Agra	Soil & water conservation	Raised bunds (20 cm high) with rectangular belts (6 x 2.7 m) across the slope for pearl millet Row catchment method (with 6% slope) for higher survival% of amla plants
SK Nagar	Soil & water conservation	Ridges and furrows and farm yard manure @ 10 t ha ⁻¹ for castor (cv GCH-5) Compartmental bunding (3.6 x 6 m) for castor Dust mulch (soil mulch) and kaolin @ 5% for castor Kaolin 6% for castor
Agra	Tillage & nutrient management	Low tillage + weedicide + interculture and 100% recommended dose through organic source for pearl millet
SK Nagar	Tillage & nutrient management	Low tillage + farm yard manure @ 4 t/ha + hand weeding for sorghum fodder Low tillage + weedicide + interculture and 100% through inorganic (urea) for pearl millet
Agra	Varieties	Cluster bean cvs RGC-1025 and HGS-345 with 60 kg/ha of sulphur and 60 kg/ha of P
	Water harvesting	4 cm irrigation at pre sowing and 4 cm irrigation at puddling and 90 kg N/ha for mustard

ORP Results: Fifty eight on-farm trials on integrated nutrient management, soil and water conservation, cropping system, crop improvement, alternate land use system, pest/weed management and package of practices were conducted at seven Operational Research Project (ORP) centers. Number of trials could not be conducted at Hisar due to low and erratic rainfall. Out of 58 trials, 19 were on cropping system, 12 on crop improvement, 11 on package of practices, 7 on integrated nutrient management, 4 each on soil and water conservation and pest/weed management, and 1 on alternate land use. Ballawal - Saunkhri had maximum number of on-farm trials (19) while Anantapur had the lowest (1). The salient results from ORP trials conducted at different locations are tabulated below:

Centre	Research theme	Salient findings
Ranchi	Cropping system	Pigeonpea + groundnut (1: 2)
	Weed management	Hand weeding at 30 days after sowing for rice
	Integrated nutrient management	20 kg N + 20 kg P ha ⁻¹ as basal for rice
Anantapur	Package of practices	Complete package of practices for groundnut
Indore	Integrated nutrient management	Recommended dose of fertilizer + sulphur @ 20 kg ha ⁻¹ for soybean

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Centre	Research theme	Salient findings
Bangalore	Weed management	Recommended dose of fertilizer (30 kg N + 60 kg P ha ⁻¹) for soybean Weedicide + interculture for soybean
	Soil and water conservation	Deep ploughing + land smoothing + contour cultivation for fingermillet and groundnut Paired rows and intercultural operations twice + conservation furrow for fingermillet Coirpith mulch for mango grafts of 5 years age
	Integrated nutrient management	Tank silt @ 15 t ha ⁻¹ + recommended NPK for fingermillet + pigeonpea 50% NPK (inorganic) + 50% N (FYM) for fingermillet (cv MR-1)
	Alternate land use system	Vertical ditch for 5 years age maximum survival of silver oak
	Varieties	Groundnut JL-24; Soybean Macs-450; Cowpea KBC-2; Horsegram PHG-9; Finger millet MR-1 and GPU-28
	Package of practices	Recommended management + recommended dose of fertilizer for fingermillet
	Pest management	Spraying twice + dusting once + bird resting + use of pheromone trap for pigeonpea (cv Hy-3C)
	Cropping systems	Sowing in May for pigeonpea (cv Hy-3c) for maximum vegetative pod yield and net returns Groundnut + pigeonpea (8:2) for maximum yield and net returns Finger millet (cv GPU-28), groundnut (cv JL-24) and pigeonpea under watershed area
Arjia	Varieties	Sesame cv RT-46; Maize cv Navjot; Groundnut cv JL-24; Blackgram RBU-38; Greengram cv RMG-62; Horsegram cv AK-42
Ballawal Saunkhri	Varieties	Maize cv JH - 3459; Greengram SML - 668; Wheat PBW - 175
	Cropping systems	Maize + greengram (cv SML-668)
	Crops	Blackgram
	Package of practices	Improved practices for maize, greengram, blackgram, wheat, mustard, chickpea, lentil, taramira
	Seed treatment	Treated seed of wheat
	Weed management	Application of 2, 4 - D for wheat
Solapur	Soil and water conservation	3 supplemental irrigations for wheat (cv PBW-175) Post sowing one irrigation for wheat
	Cropping system	Pigeonpea + cluster bean and pigeonpea + sunflower Greengram - sorghum for double cropping
	Crops and varieties	Maize cv MPQ-13; Pigeonpea cv ICP-8863; Pearl millet cv Shradha; Sunflower cv MSFH-17; Maize cv African tall; Barseem cv Wardhan under irrigated condition for maximum fodder

Centre	Research theme	Salient findings
Bijapur	Demonstrations	Sorghum, chickpea and safflower
	Integrated nutrient management	Recommended dose of fertilizer application for <i>rabi</i> sorghum
	Varieties	<i>Rabi</i> sorghum cv Yashoda
	Water management	Protective irrigation for chickpea
	Soil and water conservation	Deep ploughing + residue incorporation + conservation furrow for pigeonpea + groundnut (2 : 4 ratio) for maximum net returns Off season tillage + repeated harrowing + compartmental bunding + incorporation of greengram residue for sunflower with paired row planting of 45 cm - 135 cm row spacing with frequent inter cultivation for maximum seed yield

Training imparted

With the funding from NATP, 67 technical officers from various production systems were trained at CRIDA in 2 batches for one week each during November, 2003 on the recent trends in dryland agriculture research scenario. The programme included discussions with CRIDA and other ICAR institutes, ICRISAT, ANGRAU and the like.

8.2 All India Coordinated Research Project on Agro-meteorology

Research activities on Agroclimatology, Crop-Weather Relationships, Crop Growth Modelling, Effect of Weather on Pests and Diseases, and Agro-advisories were carried out at all the 25 centres of AICRPAM. The salient findings are as follows:

Agroclimatology

- Agroclimatic analysis using long-term weather data for Midnapur (West) district of West Bengal showed that rainfall was most assured from 23 SMW (04 - 10 June) to 39 (24 - 30 September). Based on this analysis, farmers can be advised to take up transplanting of *kharif* rice under rainfed conditions after 23 SMW week by choosing suitable cultivars that could complete grain filling by 39 MSW.
- Water balance studies at the same location showed that length of growing period (LGP) varied from 203 days in sandy loam soil to 261 days in clay soil. In sandy loam soils having LGP of 203 to 230 days upland rice cultivars of 100 days followed by a second crop of mustard (cultivars maturing in 100 days) can be grown. In clay loam and clay soils transplanted rice followed by mustard/lentil/ gram/linseed can be grown under rainfed conditions.
- Agroclimatic characterization studies showed that minimum and maximum temperature at various locations in Madhya Pradesh did not show any persistent increasing or decreasing trend. First week of January was identified as the most vulnerable period for frost.
- Long term rainfall analysis of eastern dry zone of Karnataka brought out that the rainfall during July decreased from 114 to 73 mm while rainfall during August increased from 109 to 179 mm. Peak rainfall, which was observed to be in September, has now shifted to October. This analysis indicates that sowing of crops could be taken up during August while rainfall during June and July could be used for land preparation.
- Using the water balance model of FAO, optimum number of mango saplings for eastern dry

Season	Normal Rainfall	Percentage contribution to annual	Standard Deviation	CV (%)
Monsoon (June - September)	1925	68	373	19.4
Post - Monsoon (October - November)	441	16	140	31.6
Winter (December - February)	65	2	47	72.4
Summer (Marrrc - May)	391	14	160	41.0
Annual	2822	100	408	14.5

zone of Karnataka was worked out to be 46 to 48 ha⁻¹.

- The long term (1871 to 2002) analysis of rainfall of Kerala showed that 68% of annual rainfall was received during the monsoon, 16 in post - monsoon, 14 in summer, and 2 in winter. The seasonal rainfall during monsoon was dependable (CV 19.4%) while that of winter non-dependable (CV 72.4%). The analysis indicated that wetland paddy could be grown under rainfed conditions during virippu (*kharif*) while wet paddy can be grown in mundakan (winter) only under assured irrigation. Many of the plantation crops require irrigation from December to May, particularly in northern districts of Kerala, where predominantly uni-model rainfall situation is noticed.

Crop weather relationships

Finger millet:

- At Bangalore, higher rainfall, evapotranspiration and temperature during the reproductive phase were found favorable for higher grain yield under early sowing than under late conditions. However, these weather conditions during the vegetative phase of late sown crop favoured higher straw yield.

Vegetables:

- At Thrissur, a multiple regression equation was developed between the yield of vegetable crops and weather parameters like minimum temperature during vegetative phase, maximum temperature during reproductive phase and bright sunshine

hours, and rainfall during 4 - 6 weeks after sowing. The equation explained 76% variability in productivity.

Cotton:

- At Kovilpatti, number of sunshine hours showed positive correlation with yield attributes like plant height, leaf area index and dry matter production irrespective of date of sowing.
- At Parbhani, rainfall, number of rainy days, maximum and mean temperature during flowering to boll setting and boll bursting to first picking had significant relationship with seed cotton yield.

Rabi sorghum:

- SMW 39 to 41 were the optimum sowing time for *rabi* sorghum in Marathwada region of Maharashtra.
- At Solapur, cumulative moisture use during the crop growing period had significant positive relationship with grain yield.

$$Y = 2.7 X - 0.5 R^2 = 0.80$$

Rabi sunflower:

- At Solapur, seed yield showed significant positive relationship with cumulative moisture use.

$$Y = -1.3 + 3.0 X R^2 = 0.98$$

Safflower:

- Seed yield at Solapur showed significant positive relationship with cumulative moisture.

$$Y = -7.2 + 4.5 X R^2 = 0.96$$

Soybean:

- At Akola, grain yield of cv MACS-450 had significant negative relationship with minimum temperature.

$$Y = 3.7 - 0.7 T_{\min} \quad R^2 = 0.25^{**}$$

- At Jabalpur cardinal temperature and photoperiod limits of soybean crop were worked out. This information will be useful for identifying optimum sowing dates and areas.

Groundnut:

- at Anand, heat units accounted for 89 to 99% variation in biomass of 2 cultivars grown under normal and delayed sowing conditions.

Wheat:

- At Raipur, eight cultivars were evaluated for their thermal stress tolerance using a thermal sensitivity index (TSI). cvs Kanchan, Sujata and Arpan were found suitable for normal sowing whereas cv LOK-1 was found suitable for late sowings, as it is more stable and yields well even under moderate thermal stress.
- At Kanpur, yield was adversely affected by increase in temperature during the reproductive period (Fig. 8.1). The rate of fall in productivity was approximately 2.0 q ha^{-1} for every $^{\circ}\text{C}$ increase.

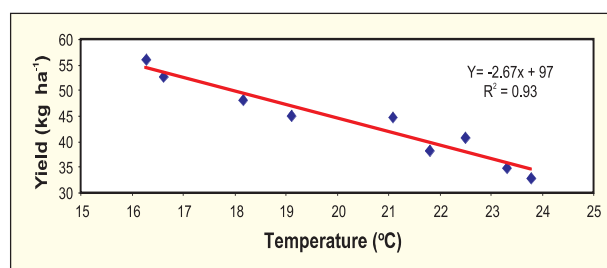


Fig.8.1 Relation between yield of wheat and temperature during reproductive period

Rice:

- At Bhubaneswar, low sunshine hours from tillering to panicle initiation were responsible for 26% yield reduction under delayed planting conditions compared to early planting.

Mustard:

- At Jorhat, accumulated growing degree-days and accumulated photothermal units during vegetative period showed significant positive relationship with seed yield.

Crop growth modeling**Rice:**

- The following predictive models for estimating grain yield based on accumulated agroclimatic indices like ACTU (accumulated cloud thermal units) and ARFL (accumulated rainfall) were developed at Jorhat.

$$Y = 1309.2 + 0.24 \text{ ACTU} \quad R^2 = 0.68$$

$$Y = 1983.9 + 2.56 \text{ ARFL} \quad R^2 = 0.69$$

Variation between predicted and actual grain yield was lower ($< 10\%$) showing the efficacy of the models in estimating yield ahead of harvest.

Mustard:

- At Anand, *Brassica* model was used to simulate LAI, dry matter production and seed yield under normal weather and management practices.
- Testing and validation of *Brassica* model was carried out at Hisar. In general, the model over estimated the seed yield and harvest index.

Wheat:

- At Anand, CERES model was tested. Large differences in actual and simulated grain weight were observed. Model underestimated both biomass and grain yield in most of the years. Genetic coefficients need to be modified further to account for these variations.

Weather Effects on Pests and Diseases**Rabi Sorghum:**

- At Bijapur, the following forecasting model was developed to predict incidence of shoot fly one week in advance

$$Y = 221.1 - 4.2 T_{\max}(3) - 0.65 \text{ RH}(1) \quad R^2 = 0.89$$

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Where Y = Percent dead hearts caused by shoot fly;
 T_{max} = Maximum temperature; RH = Afternoon relative humidity; Numbers in brackets indicate weeks prior to forecast period.

Ber:

- An equation for powdery mildew incidence was developed at Bijapur which can predict the incidence 2 weeks in advance.

$$Y = -34.5 + 3.1 RH_1(3) + 4.4 RH_2(3) - 0.89 RH_1(2) - 1.3 RH_2(4) - 3.7 TR(4) - 4.5 MINT(4)$$

Where RH_1 = Morning relative humidity; RH_2 = Afternoon relative humidity; TR = Temperature range; MINT = Minimum temperature; figures in brackets indicate weeks prior to the forecast period

Safflower:

- At Akola, minimum temperature and afternoon relative humidity positively influenced aphid population:

$$Y = -7.5 + 2.1 T_{min} + 3.5 RH \quad R^2 = 0.91^{**}$$

Rice:

- At Bhubaneswar, a multiple linear regression model with cumulative rainfall (15 days prior to prediction date), afternoon humidity (14 days prior) and maximum temperature (7 days prior), and stage of the crop as independent variable was successfully developed to predict bacterial leaf blight (BLB) incidence ($R^2 > 0.90$).
- At Bhubaneswar, leaf folder could be successfully predicted ($R^2=0.81$) based on bright sunshine hours and average temperature accumulated over past 15 days prior to the incidence of the pest.
- Best-fit equation between rice blast and weather parameters indicated that maximum and minimum temperature, and morning cloud cover were negatively related with disease incidence at Palampur.

Groundnut:

- At Anantapur, a model for predicting red hairy caterpillar was developed based on rainfall

received during June through September. The model will help in forecasting the occurrence and taking precautionary measures.

Raya:

- At Ludhiana, critical period of pests occurrence in raya was from the end of December to middle of February. An inverse parabolic relationship between peak aphid population and humidity: temperature ratio (HTR) was observed.

Mustard:

- At Mohanpur, appearance of aphids showed significant correlation with minimum temperature and growing degree days (GDD) accumulated upto 1 to 3 weeks before the appearance of aphids from the date of emergence of crop. Simple regression models were developed to predict the appearance of aphids, 1 to 3 weeks in advance.

Wheat:

- At Faizabad, the infection rate of rust decreased with increase in temperature and decrease in relative humidity.

Cumulative disease infection rate ($\times 10^{-2}$)	Minimum Temperature ($^{\circ}$ C)	Maximum Temperature ($^{\circ}$ C)	Relative Humidity
2.2	8.8	22.0	77
1.8	9.8	24.8	73
1.6	14.2	30.9	54
1.5	18.3	35.2	52

Agromet Advisories

A website www.cropweatheroutlook.org was launched to provide agromet information generated under AICRPAM and its cooperating centres. This website was inaugurated by Honourable Union minister of Agriculture Sri Rajnath Singh on 30 July, 2003. This web site is operating from the Central Research Institute for Dryland Agriculture (CRIDA), Hyderabad where AICRPAM is located, and is linked to the ICAR website for a wider use

by the planners, researchers, farming community and other users. The website contains (i) Weekly report on crop-weather conditions, (ii) Current weather data, and (iii) Agro advisories. Beside providing information on research activities of agromet centres, it also provides linkages to other associated websites containing information of agrometeorological relevance. The contents of weekly report, current weather data and agro advisories are as follows:



- Weekly report on crop-weather conditions: Contains daily rainfall of the station, general rainfall situation and crop condition in the region; information on incidence of pest/diseases; unfavourable weather conditions experienced during the last week and contingency measures to be taken.
- Current weather data: Displays the daily weather data along with normal such as minimum and maximum temperature; rainfall; relative humidity; wind speed; evaporation; sunshine and soil temperature recorded at the centre during the last week.
- Agro advisory information consists of weather-based advisory, which is issued based on the models developed at the centre and the weather forecast issued by National Centre for Medium Range Weather Forecast, New Delhi. It also provides information on sub-divisional rainfall and its departure maps of the country, monsoon status and its progress, updation of satellite picture at six hourly interval, and the weather outlook for next 10 days.

Meetings / Workshops

- One day meeting on “Value additions to the agro meteorological information in agro advisory services” chaired by the Honorable Director General ICAR was conducted on 3 May, 2003.
- Working group meeting of AICRPAM for finalizing the technical program for 2004-2005 was held at Kerala Agricultural University, Thrissur during May 16-18, 2003.

8.3 NATP

8.3.1 Significant highlights from NATP PSR research

Arboreum cottons - a new ray of hope for dryland farmers

Cultivation of cotton hybrids is posing major challenges in rainfed areas due to drought and intense pest and disease incidence. The farmers are losing on their investment many a times under unfavorable weather conditions. In order to overcome these problems, an effort was made to identify *desi* cottons with superior yield and quality, by strengthening the on going breeding efforts and extensive on-farm participatory varietal evaluation. Trials in Maharashtra, A.P., Karnataka and M.P. resulted in developing three promising *arboreum* varieties. These varieties bring down the cost of cultivation significantly and are better adapted to rainfed conditions where farmers can not invest much on expensive inputs like pesticides.

The most promising *arboreum* varieties identified were cvs PA 402 and PA 255 for Maharashtra, cv MDL 2463 for A.P. and cv DLSA 17 for Karnataka. During the last six months, efforts were made to evaluate the quality of the seed cotton. For example, cv DLSA 17 has a micronaire of 4.5 comparable to the popular *hirsutum* cv CPD-431. The cost of cultivation was Rs.7,020 ha⁻¹ with cv DLSA-17 as against Rs.10,300 with cv CPD-431. The net profit and BC ratios were Rs.24,840 and 1:3.5 for cv DLSA-17 as against Rs.15,950 and 1:1.5 for cv CPD-431. The higher profits earned by a large

number of farmers in Maharashtra and Karnataka demonstrated the importance of quality arboreums for rainfed areas. The fibre quality evaluation is planned in collaboration with M/s. Maral Overseas, a leading textile exporter in the country. The quality acceptance by the Industry will result in fetching good price for the arboreum cotton, which leads to their increased adoption. If pursued in a well orchestrated manner, this can bring a key social change among cotton growers of the country who are in a debt trap due to high cost of cultivation and frequent crop failures.

Crop diversification in tribal areas

- In tribal areas of Orissa, Jharkhand and Chhattisgarh, only single cropping of *kharif* rice is practised by farmers through subsistence farming which does not give them enough income. In 4 districts (Koraput, Jagdalpur, Ambikapur and Ranchi) of these states, crop diversification in uplands by introduction of agri horticultural system resulted in significant gains in income. After a 3 - year period of project implementation between 2000 to 2003, the income of the tribal farmers increased by 75-90% through the production of vegetables and fruits. This was achieved by demonstrating appropriate land use depending on the land capability and recommended fruit/vegetable species along with package of practices. The success story of Pitambar Majhi of Gopalput village in Koraput district who could double his income from 5 acres of rainfed upland through crop diversification attracted the attention of district administration. The technological interventions tried under NATP projects are likely to be implemented on large scale in tribal blocks to improve livelihood and provide employment during the lean season. Similar efforts are in progress in other states to use the success stories as a platform for linking up with the developmental programmes.
- In low rainfall areas of Maharashtra, Gujarat and Karnataka also the income stabilizing potential of agri horticulture and horti pastoral systems were demonstrated during drought years which

became models for district administration for further extension.

Alcohol production from sorghum

- Studies during the last two years gave encouraging results regarding the potential of sweet sorghum as raw material for production of alcohol. During 2003, a pilot study in collaboration with Renuka Sugars, Belgaum was successfully conducted for the assessment of techno-economic feasibility of ethanol production from sweet sorghum cv SSV-84. Juice was extracted from 100 tonnes of stalks through rollers. It was fermented and distilled to obtain 9% alcohol (95%). Bagasse was successfully used for the cogeneration of electricity (approx. 2086 net calories of energy per tonne). The economic feasibility of ethanol production from sweet sorghum was evaluated based on 60 farmers which showed that farmers could earn a net income of Rs. 2000 acre⁻¹ from stalks alone in one season. The cost of ethanol produced from sweet sorghum is Rs. 0.56 l⁻¹ higher than using molasses, but considering the positive socio-economic (poor farmers) and environmental (no pollution) implications, there is an urgent need to promote sweet sorghum as raw material for alcohol production.

Achievements from North Eastern states

Improving the productivity of eri silk in north east India :

- Eri silk production provides income to thousands of tribal farmers in Assam and Manipur. Farmers use local, poor yielding varieties of castor as silk worm feed. Under a comprehensive project under NATP, improved castor cvs like 48-1 and DCH-177 were introduced with recommended package of practices to maximize the crop yield with improved nutritional quality. The cocoon and shell yield were highest with cv 48-1. Even with local red castor variety, the cocoon yield could be significantly enhanced by appropriate agronomic practices like optimum plant geometry, nipping and flower bud removal, and balanced fertilization. The project also demonstrated the possibility of taking up castor cultivation on the

hill slopes of north east India which can contribute to significantly higher eri silk production.

Indigenous Cotton Germplasm from NEH Region:

Since long, number of indigenous cotton cultivars of *G.arboreum* and *G.barbadens* are grown by local farmers on hill slopes in northeastern states. These possess certain unique properties of stress tolerance, high ginning percentage and non shedding of *kappas* after boll burst. However in the recent past, cotton cultivation has been going down due to poor marketing leading to loss of valuable germplasm. At AAU, Dipu an effort was made to collect and characterize indigenous cotton germplasm of NEH regions. Thirty five indigenous cotton germplasm were collected from various cotton growing areas of NE region. Out of these, twenty four were *arboreum* cottons and eleven were *barbadense* cottons. Eighteen *arboreum* lines were evaluated during *Kharif* 2002-03 for quantitative traits like days to flower, plant height, number of bolls per plant, boll weight and seed cotton yield. The maximum plant height was recorded in cvs Garo Kil-1 (204.7cm) and Phelo Chapong (191.7 cm). Number of bolls/plant was maximum in cv Phelosaw-1 (17.0 bolls). Maximum boll weight was recorded in cv Phelopisa (3.33g) followed by cv Garo-1 (3.30g). Seed cotton yield was maximum in cv Karbi (646.7 kg ha⁻¹).

Significant differences were recorded among *barbadense* cultivars also for the traits studied. Cv Phelopi-1 showed maximum plant height (239cm) where as maximum number of bolls per plant was recorded in cv Phelopi-1 (57.67/plant). Cv Felopi-2 exhibited the highest seed cotton yield of 1342 kg ha⁻¹ and ginning percentage was maximum in cv Karbi-Phelo-2 (32.46%).

In indigenous *arboreum* cotton germplasm, leaf roller infestation was lowest in cv Karbi. Minimum white fly population was recorded in cvs Karbi and Garo-1 at 40 days. Minimum infestation of spotted boll worm was recorded in cv Karbi (8.40 and 6.90 on 80 and 100 DAS). The overall insect pest incidence was less in cvs Karbi and Garo-1. Among *barbadense* germplasm,

minimum leaf roller infestation was recorded in cv Felopi-2 (6.60%).

Salient achievements under TAR - IVLP

The technology assessment and refinement (TAR) through Institute Village Linkage Programme is in vogue in 24 centers under different micro farming situations in rainfed rice, oilseed, cotton, nutritive cereals and pulses covering 521 interventions. The project involved 10266 farmers and covered an area of 4106 ha during 2003-04. The major themes covered were crops and cropping systems, natural resource management, integrated nutrient management, integrated pest management, post harvest technology, value addition and gender issues. Important achievements under different production systems are summarized below:

Upland rice-based

- At Ranchi, improved rice cv IR-36 with balanced dose of nutrients (80:40:20NPK ha⁻¹) gave highest grain yield (3825 kg ha⁻¹) and additional returns (Rs.10910 ha⁻¹)
- Line sowing at Ranchi contributed to higher productivity by 643 and 223 kg ha⁻¹ and profitability of Rs.994 and Rs.1625 ha⁻¹ with improved and local respectively than broadcasting. Similarly at Cuttack line sowing of upland rice cv Vandana behind the country plough gave 71% increased yield over broadcasting method (5050 kg ha⁻¹).
- Rice-field pea and rice-horsegram systems were found 47% more profitable than that of rice-fallows.
- The improved varieties of finger millet (cv A-404) and Deenanath grass with improved nutrient management practices (50:30:20 NPK ha⁻¹) enhanced productivity by 45-50% over locals in upland conditions.
- Kalinga III and Vandana gave enhanced net returns of Rs.1900 and Rs.2600 ha⁻¹ compared to the farmers' variety at Ranchi. Improved cultivation practices with cv Savithri helped to get 42% higher yield and net returns (Rs.17000 ha⁻¹) than the farmers practice of broadcasting and traditional beaushening (3450 kg ha⁻¹).

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- At Cuttack, bunding round the upland rice field (50 x 25 cm) increased grain yield (900 kg ha⁻¹) and B:C ratio (0.32) over no bunded field. Balanced fertilizer supply recorded higher grain yield by 74, 40 and 53% over farmers method in upland, medium land and lowland conditions, respectively.
- Improved production technology (cv Vandana, line seeding at 20 cm spacing, 40:20:20 NPK ha⁻¹), mechanical weeding with finger weeder in between crop rows along with manual weeding, and need - based plant protection gave 122% higher yield in rice as compared to the farmers variety and management (1455 kg ha⁻¹).
- Backyard poultry with improved strain of Kalinga Brown and Barberi cross of goat were found profitable as homestead farming activities in small farmers production system at Cuttack.
- At Hassan, a maize composite NAC-604 recorded additional yield of 600 kg ha⁻¹ as compared to cv Deccan-101 (1600 kg/ha) besides showing higher tolerance to downy mildew.
- Improved maize cv Giant double African yellow gave net returns of Rs.6000 ha⁻¹ as compared to local at Korapur.

Oilseed-based

- Improved soybean cvs NRC-2 and NRC-37 gave higher yield by 30 and 62% compared to local varieties at Indore.
- Use of 20:40:20:20 NPKZn ha⁻¹ gave 30% higher yield in soybean compared to the farmers practice of N & P @ 16 and 20 kg ha⁻¹ (904 kg ha⁻¹) at Jabalpur.
- Sowing soybean across the slope increased productivity by 350 kg ha⁻¹ compared to the farmers method (450 kg ha⁻¹).
- Soybean cv JS-90-41 was adopted by 20% of the farm families by replacing existing cv JS-335 at Bhopal.

- Seed treatment modules involving Carbendazim @ 2 g kg⁻¹, 2% neem oil, @ 62.5 kg ha⁻¹, castor as a trap crop, pheromone traps, and *Trichoderma* enhanced groundnut productivity by 16% compared to the farmers practice at Junagadh.
- Supplementation of mineral mixture @ 50 g animal⁻¹ in combination with grazing, improved the body weight and milk productivity by 14% in cows and buffaloes at Jabalpur.

Cotton-based

- Cotton cv PKV-Rajat at Akola, Desi cotton cv AKA-7 at Nagpur and Narasimha at Warangal were found profitable than other hybrids.
- Cotton cv AKH-84635 has become quite popular at Nagpur.
- Agri-sheep system @ 10 lambs unit⁻¹ maize + cowpea, fodder sorghum and cowpea gave additional net income of Rs.15000 ha⁻¹ unit⁻¹ compared to the arable cropping of cotton alone (Rs.18000 ha⁻¹) at Warangal.

Nutritious cereals-based

- Improved castor cvs Kiran, Haritha and Kranthi recorded 25% additional bean yield compared to the local (200 kg ha⁻¹) at Hyderabad.
- Conservation furrows in alternate rows of maize in Vertisols enhanced productivity by 12% compared to the farmers' practice (2200 ha⁻¹).
- Simple *in-situ* moisture conservation furrows in alternative rows of cotton cv Narasimha helped to drain out excess water (3%) in Vertisols of Mandamarri of Ranga Reddy district in Andhra Pradesh.
- Planting maize with 6 tyned tractor drawn planter developed by CRIDA helped to improve plant stand by 20% and reduced the cost of production (Rs.150 ha⁻¹) as compared to the farmers' practice of sowing with country plough.
- At Dharwad, improved littlemillet cv TNAU-63 gave 45% higher yield as compared to the local (550 kg/ha) even in severe dry spells.

- Application of 50:25:0 kg NPK ha⁻¹ along with Azatobacter enhanced the productivity of sorghum as compared to the farmers practice at Nagpur.
 - At Bangalore, spraying of 2% neem oil gave 20% higher yield in okra over farmers practice and non-application of pesticides (600 kg ha⁻¹).
 - At Jhansi, cv ICBS-44 (groundnut), cv PK-1042 (soybean), cv Budhel Guar-1 (cluster bean), cv CSV15 (sorghum) and cv DVR-2 (tomato) produced 30-50% higher than the locals. Planting of hybrid Napier and guinea grass on field boundaries produced 5.1 and 1.2 t of green fodder in 3-5 cuttings in a year.
 - Use of mineral mixture @ 50g animal⁻¹ day⁻¹ gave 5.2-6.2 l milk yield day⁻¹ animal⁻¹ up to 3rd week after feeding. But the milk yield declined by 1.2 l day⁻¹ animal⁻¹ from 4th week onward.
- Pulse-based**
- Pendimethalin @ 3.3 l ha⁻¹ reduced 70% of the weed population in pigeonpea at Kanpur.
 - Among short duration pulses cv IPU 94-1 (urdbean), cv PDM-139 (mungbean), and cv TKG-22 (sesamum) gave 30% additional yield over locals. Mungbean cv Samrat was found tolerant to yellow mosaic virus.
 - Incorporation of 15-20 kg oat as green fodder with wheat straw enhanced feed intake and milk yield of cow and buffalo by 30 - 40% compared to feeding of wheat straw alone.

List of technologies developed under PSR projects which need to be assessed/refined through TAR-IVLP

Sl. No.	Technology	Region
Rainfed rice-based production system		
1.	Sequence cropping of vegetables and oilseeds in rice fallows	Chhattisgarh, M.P., Orissa
2.	Intercropping of upland rice + pigeonpea	Uplands in Chhattisgarh, Jharkhand and Orissa
3.	Pigeonpea + groundnut intercropping	Uplands in Chhattisgarh, Jharkhand and Orissa
4.	Rainwater harvesting and recycling through <i>dabris</i>	Chhattisgarh, Orissa and Jharkhand
5.	Utilisation of excess rainwater in medium and low lands for second crop and fish culture	Orissa and Jharkhand
6.	Mango + upland rice agri horticulture	Red soils of Koraput district, Orissa
7.	Mango + ginger/turmeric agri horticulture	Red soils of Koraput and Phulbani districts, Orissa
8.	Rice-fish-duck farming	Tribal areas of Jharkhand
9.	Rice-fish-pig-farming	Tribal districts of West Bengal
10.	Improved upland rice varieties for aberrant weather	Orissa, Chhattisgarh and Jharkhand
11.	Integrated nutrient management with incorporation of legume intercrop in rainfed rice	Orissa and Jharkhand
12.	Management of parasitic diseases (nematodes and trematodes) in buffaloes	Orissa, Chhattisgarh and Jharkhand
13.	Improved methods of upland vegetable cultivation (ginger/turmeric/onion) with emphasis on nursery technologies	Orissa and Jharkhand

Sl. No.	Technology	Region
14.	Use of bullock drawn puddler 99 for improved yield of rainfed rice in low lands	Orissa, Chhattisgarh and Jharkhand
15.	Integrated weed management in upland rice	Chhattisgarh and Jharkhand
16.	Integrated pest management in rainfed rice	Assam, Manipur, Orissa and West Bengal
17.	Water management technique for increasing cropping intensity through utilization of abandoned village ponds	Bhadrak and Balasore districts Orissa
18.	Improved <i>biasi</i> method of cultivation	Chhattisgarh
19.	Storage of paddy in RCC ring bin	Assam, Manipur and Orissa
20.	Improved method of drying paddy through rack drying	Orissa, Assam and Manipur
21.	Inter row crop seeder for rice and green manure crop	Orissa and Assam
22.	Sprouted rice seeder	Orissa and Chhattisgarh
Oilseeds-based production system		
23.	Cultivation of non spiny varieties of safflower	Maharashtra and Karnataka
24.	Use of safflower (multicrop) harvester	Karnataka and Maharashtra
25.	Low cost technology (mud plastered bamboo baskets/ vacuumised metallic bags) for storing soybean seeds for seed purpose	Madhya Pradesh and Maharashtra
26.	Improved technology for production of eri silkworm	Assam and Manipur
27.	Feeding livestock with sunflower head - based complete feed	Maharashtra, Karnataka and A.P.
28.	IPM modules for sunflower, safflower, mustard and groundnut	Relevant states
29.	INM in oilseed - based cropping systems	M.P. and Maharashtra
30.	<i>In situ</i> moisture conservation technology in castor and groundnut	A.P. and Maharashtra
31.	Production technology for castor, groundnut, safflower and linseed for saline and sodic soils	A.P., Maharashtra, Gujarat and U.P.
32.	Integrated management of groundnut stem necrosis	Anantapur and Kurnool districts of A.P.
33.	Liquid rhizobium inoculant for pulses	Relevant states growing chickpea, pigeonpea and soybean
34.	Non pesticidal control of soil nematodes	U.P.
35.	Management of MYMV in mungbean and urdbean	A.P., Tamilnadu and U.P.
36.	Use of improved mini dal mill	All relevant states growing pigeonpea, chickpea and lentil
37.	Pitfall trap for monitoring and control of pulse beetle	All states
38.	Integrated crop management technology for pigeonpea - based intercropping systems	Maharashtra, M.P. and A.P.
39.	Bio intensive IPM modules for pigeonpea and chickpea	All relevant states

Sl. No.	Technology	Region
Cotton-based production system		
40.	Rainwater management in cotton on toposequences in a watershed	Maharashtra, Karnataka and A.P.
41.	Cultivation of quality <i>arboreum</i> cvs MDL 2463, DLSA-17 and PA-402	A.P., Karnataka and Maharashtra
42.	Land treatments for moisture conservation and INM in cotton - based cropping system	Maharashtra, Tamilnadu, A.P. and M.P.
Nutritious cereals-based production system		
43.	Popularisation of value added health foods from pearl millet and finger millet	Karnataka, Haryana and Maharashtra
44.	Establishment and management of live fences around the crop fields	Maharashtra, A.P. and U.P.
45.	Integrated management of blast disease in finger millet	Karnataka and Tamilnadu
46.	Finger millet - based intercropping systems with legumes for improved returns	A.P., Karnataka and Tamilnadu
47.	Cultivation of dual purpose sorghum variety CSV-15	All relevant states
48.	Improved production technology for <i>rabi</i> sorghum	Maharashtra and Karnataka
49.	Rain water management technology in maize - based cropping system	Rajasthan and Gujarat
50.	Establishment of improved silvi pasture systems for small ruminants	U.P., Gujarat and A.P.
51.	Moisture conservation and nutrient management technology for pearl millet	All relevant states
52.	Feeding of poultry with substitute rations to reduce the cost of production	U.P. and A.P.
53.	Improved utilization of coarse cereal crop residuals by nutrient supplementation	All relevant states
54.	Management technologies for mango - based agri horticultural systems	Gujarat and Karnataka
55.	Technology of physiological harvesting and grain drying in <i>kharif</i> sorghum	A.P. and Maharashtra
56.	Cultivation of high yielding sweet sorghum genotypes	A.P., Karnataka, Maharashtra and Tamilnadu
57.	Preparation of value added products like syrup, jaggery and cake from sweet sorghum	All relevant states

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Progress on Scale up and Commercialisation of Promising Technologies/Products/ Processes

Technology	Collaborators
Alcohol from sweet sorghum	M/s.Renuka Sugars, Belgaum M/s.Praj Industries, Pune M/s.G.M.R.Vasavi Industries, Hyderabad M/s.Mohan Breweries, Chennai
Yellow dye from safflower petals	M/s.BEC Foods, Raipur
Herbal tea from safflower	M/s.Eco Save Systems, Mumbai
Cardboards from safflower stalks	M/s.Amar Plantations, Mumbai
Detoxification technology for castor cake	M/s.Jayanth Oil Mills, Vadodara M/s.Vetcare India, Mumbai
Pit fall probes for insect trapping	M/s.K.S.N.M. Marketing, Coimbatore
Mill tests on fiber quality of arboreums	M/s.Maral Overseas, Indore M/s.Gadag Cooperative Spinning Mills, Hulkoti, Karnataka
Diabetic health foods from finger millet	NRDC, New Delhi M/s.Godrej Plant Biotech, Mumbai
Grain drying technology for <i>kharif</i> sorghum	M/s. J.K. Seeds, Maharashtra
Bullock drawn puddler 99	Implements Factory, Govt. of Orissa and Agricultural Engineering Department
Foot operated vacuum packing machine	CEDMAP, Bhopal

9 Publications

9.1 Research Papers

- Babjee Rao, N. and Venkata Ramaiah, P. 2003. Awareness-knowledge and attitude of teachers and parents and awareness-knowledge of students of operation Black Board programme. J. Res. ANGRAU 31:58-61.
- Ganeshamurthy, A.N., Ali, M., Srinivasa Rao, Ch. and Mathur, R.S. 2003. Nutrient mining in central plain zone of Uttar Pradesh. Fertilizer News 48 (11):51-58.
- Hemalatha, B., Prashanth, V.R.N. and Reddy, Y.V.R. 2003. Economics of milk production of different breeds of bovines in Ahmednagar district of Maharashtra. Indian Dairyman 55(10):41-44.
- Hemalatha, B. and Reddy, Y.V.R. 2003. Present status and prospects of agriculture in India. Agric. Situation India LIX (10):629-634.
- Kausalya Ramachandran. 2003. Agricultural sustainability through strategic land use planning in rainfed regions of AP, India. GIS India 12(10):24.
- Kausalya Ramachandran and Govil, P.K. 2003. Environment audit and remediation for industrial contamination - a case study of Hyderabad and its surrounding areas. GIS India 12(11):10.
- Kausalya Ramachandran, Sai Kiran, D., Kalpana, M. and Purnendu, M. 2003. Contamination of urban India environment by hazardous industries www.gisdevelopment.net/application/environment/conservation/envm0009pf.html:1-7.
- Mandal, Uttam Kumar, Gurcharan Singh, Victor, U.S. and Sharma, K.L. 2003. Green manuring: its effect on soil properties and crop growth under rice-wheat cropping system. European J. Agron. 19(2):225-237.
- Mishra, P.K., Rao, K. V., Sivaprasad, S., Maheswar Babu, B., Sharma, S. and Padmanabhan, M. V. 2003. Development of a programmable rainfall simulator for soil hydrological studies. Indian J. Dryland Agric. Res. Development 18(2): 143-148.
- Nirmala, G., Maruthi Sankar, G.R., Babjee Rao, N., Prasad, M.S. and Rama Rao, C.A. 2003. Participatory watershed management programmes of southern Telangana region of Andhra Pradesh, India. Indian J. Dryland Agric. Res. Development 18(2):118-125.
- Prabhakar, M., Srinivasa Rao, M. and Prasad Y.G. 2003. Evaluation of bio-intensive integrated pest management modules for castor semilooper, *Achaea janata* L. Indian J. Plant Protection 31(1):56-58.
- Rama Rao, C.A., Chowdry, K.R., Reddy, Y.V.R. and Krishna Rao, G.V. 2003. Measuring and explaining technical efficiency in crop production in Andhra Pradesh. Indian J. Agric. Economics 58(4):768-780.
- Ramesh, V. and Varghese, S. S. 2003. Effect of fertilizer levels of N,P and K on the yield and juice quality of sugarcane. Indian Sugar LIII(3): 175-178.
- Ramesh, V. and Varghese, S.S. 2003. Influence of varying fertilizer N, P and K levels on nutrient uptake of sugarcane. Indian Sugar LIII(2):99-102.
- Raghuram Reddy, P., Maruthi Sankar, G.R. and Das, N.D. 2004. Genotype X Environment interaction in *rabi* sorghum (*Sorghum bicolor*). J. Maharashtra Agric. Univ. 29(1):21-24.
- Reddy, Y.V.R., Om Prakash, Sastry, G. and Singh, H.P. 2002. Evaluation of watershed programme and strategies for development of natural resources. Agric. Situation India LIX (9):565-570.

- Reddy, Y.V.R., Om Prakash, Sastry, G. and Singh, H.P. 2002. Watershed programme in India. Agric. Situation India LIX (8):487-492.
- Samantha, A.K., Singh, K.K., Verma, N.C., Misra, A.K. and Das, M.M. 2003. Silage quality of different forages ensiled in plastic bag. Range Management and Agroforestry 24 (1) :42-44.
- Sanjeeva Reddy, B, Lal, R.R., Adake, Ravikanth, V. and Verma, Prasoon. 2003. Effect of pre-milling treatments and milling mechanisms on dehulling of blackgram. Indian J. Dryland Agric. Res. Development 18(1):61-64.
- Sastry, G., Reddy, Y.V.R., Om Prakash and Singh, H.P. 2002. Impact of watershed development programme on biophysical and economic factors in India. J. Soil Water Conserv. India 1 (4):296-303.
- Sastry, G., Reddy, Y.V.R., Om Prakash, Rama Rao, C.A. and Singh, H.P. 2003. Evaluation of watershed development programmes in India- SWOT analysis. Agric. Situation India LX (4):173-184.
- Satyanshu Kumar, Singh, A. K., Kumar, M., Yadav, S. K., Chauhan, J. S. and Kumar, P. R. 2003. Standardization of Near Infrared Reflectance Spectroscopy (NIRS) for determination of seed oil and protein contents in rapeseed-mustard. J. Food Sci. Technol. 40(3):306-309.
- Sharma, K. L., Srinivas, K., Mandal, U. K., Vittal, K. P. R., Grace, J. K. and Sankar, G. R. M. 2004. Integrated nutrient management strategies for sorghum and greengram in semi-arid tropical Alfisol. Indian J. Dryland Agric. Res. Development 19:13-23.
- Singh, H.P., Sharma, K.D. and Korwar, G.R. 2003. Sustainable dryland agriculture development. Financing Agriculture 35:38-43.
- Singh, S.V., Luthra, S.K., Khan, I.A. and Pandey, S.K. 2003. Performance of Kufri Anand in North - Western and Western - Central plains of India. J. Indian Potato Assoc. 30(1-2):11-12.
- Sridevi, S., Katyal, J.C., Srinivas, K. and Sharma, K.L. 2003. Carbon mineralization and microbial biomass dynamics in soil amended with plant residues and residue fraction. J. Indian Soc. Soil Sci. 51(2):133-139.
- Srinivasa Rao, Ch., Ali, Masood, Ganeshamurthy, A.N. and Singh, R.N. 2003. Potassium availability, releasing power and uptake by chickpea and rajmash in different soil types of pulse growing regions of India. Indian J. Pulses Res. 16(2): 128-132.
- Srinivasa Rao, Ch., Ganeshamurthy, A.N., Ali, M., Singh, R.N. and Singh, 2003. Potassium supplying power of different soil types of pulse growing regions of India. J. Indian Soc. Soil Sci. 51(3):312-315.
- Srinivasa Rao, Ch., Prasad, J.V.N.S., Vittal, K.P.R., Venkateswarlu, B. and Sharma, K.L. 2003. Role of optimum nutrition in drought management. Fertilizer News 48 (12):105-112.
- Srinivasa Rao, M. 2003. Yield infestation relationships in short duration pigeonpea. Indian J. Dryland Agric. Res. Development 18(2):187-191.
- Srinivasa Rao, M., Dharma Reddy, K., Singh, T.V.K. and Subba Reddy, G. 2002. Crop-Crop diversity as a key component of IPM. Agric. Rev. 23(4): 272-280.
- Srinivasa Rao, M. and Dharma Reddy, K. 2003. IPM of pod borers in long duration pigeonpea. Annals Plant Protection Sci. 11(1):26-30.
- Srinivasa Rao, M., Dharma Reddy, K. and Singh, T.V.K. 2003. Impact of intercropping on predators of insect pests of pigeonpea in rainy and post rainy season. Indian J. Entomol. 65(2):245-251.
- Srinivasa Rao, M., Dharma Reddy, K. Singh, T.V.K. and Subba Reddy, G. 2003. Effect of duration of pigeonpea cultivars and intercropping on pod borers. Annals Plant Protection Sci. 11 (2): 232-236.

- Venkateswarlu, J., Reddy, Y.V.R. and Sastry, G. 2003. Access to the harvested rainwater. LEISA India 5(3):10.
- Victor, U.S., Das, N.D., Srinivasa Rao, M., Vijayakumar, P., Srivastava, N.N., Vittal K.P.R. and Ramana Rao, B.V. 2003. Risk management options using weather forecasts in insect pests and diseases management for some dryland crops. J. Agrometeorol. 5(1):12-24
- Vimala Devi, P.S. and Prasad, Y.G. 2003. Influence of different temperatures on the efficacy of *Nomuraea rileyi* (F) Samson against *Spodoptera litura* (F.). J. Oilseeds Res. 20 (1): 162-164.
- Vimala Devi, P.S., Prasad, Y.G., Anitha Chowdary, D., Mallikarjuna Rao, L. and Balakrishna, K. 2003. Identification of virulent isolates of the entomopathogenic fungus *Nomuraea rileyi* (F.) Samson for the management of *Helicoverpa armigera* and *Spodoptera litura*. Mycopathologia 156: 365-373.
- ## 9.2 Books / reports
- Indra Kumar, N., Shankar, M.A., Mayande, V.M., Sreenatha, A. and Umesh, M.R. 2003. Adoption of Improved Tools for Fingermillet-based Cropping System in Eastern Dry Zone of Karnataka. Technical Bulletin No. NATP/MMPDM/CRIDA/TB-05/03. UAS, Bangalore. p.12.
- Pacharne, D.T., Pharanade, A.L., Sanglikar, R.V. and V.M. Mayande. 2003. 'V' Harrow. Technical Bulletin No. NATP/MMPDM/CRIDA/TB-01/03. MPKV, Sholapur. p.8.
- Prasad, M.S., Rama Rao, C.A., Nirmala, G., Ramakrishna, Y.S. and Reddy, Y.V.R. (Eds.) 2003. Technologies for Farm and Household Development in Rangareddy District (A.P.). CRIDA, Hyderabad. p.158.
- Rama Rao, C.A., Srinivasa Rao, M., Ramakrishna, Y.S. and Reddy, Y.V.R. 2003. Economic Analysis of Castor Seed Multiplication at Gunegal Research Farm. Research Bulletin. CRIDA, Hyderabad. p.16.
- Rama Rao, C.A., Srinivasa Rao, M., Ramakrishna, Y.S., Vittal, K.P.R. and Reddy, Y.V.R. 2003. Economics of Some Dryland Agricultural Technologies. Research Bulletin. CRIDA, Hyderabad. p.22.
- Ranade, D.H., Chaurasia, M.C., Sharma, R.A and V.M. Mayande. 2003. Natural Resource Management Through Land Development Process with Heavy Farm Machinery. Technical Bulletin No. NATP/MMPDM/CRIDA/TB-06/03. JNKV, Indore. p.15.
- Rao, J.V. 2003. Compendium of Lecture Notes of Winter School on "Wasteland Development in Rainfed Areas", Central Research Institute for Dryland Agriculture, Hyderabad, A.P., p.300.
- Rao, J.V., Khan, I.A. and Sujatha, S. (Eds.) 2004. Critical Review of Research on Intercropping Systems in Rainfed Regions of India. NATP, CRIDA, Hyderabad. p.100.
- Samra, J.S., Singh, G. and Ramakrishna, Y.S. 2003. Coldwave of 2002-2003: Impact on agriculture. ICAR, New Delhi. p.49.
- Sastry, G., Reddy, Y.V.R., Om Prakash. 2003. Review Report on Impact of Watershed Management Practices on Sustainability of Land Productivity and Socio-Economic Status (ROPS-14 & 14A). p.116.
- Sastry, G., Reddy, Y.V.R., Om Prakash, Mishra, P.K. and Rama Rao, C.A. 2003. Preliminary Survey Report on Impact of Watershed Management Practices on Sustainability of Land Productivity and Socio-Economic Status (ROPS-14 & 14A). p.154.
- Sidhpuria, M.S., Milakh Raj., Ashwin, K., Singh, Sube and Mayande, V.M. 2003. A Manual on Ridger Seeder. Technical Bulletin No. NATP/MMPDM/CRIDA/TB 02/03. CCSHAU, Hisar. p.12.
- Srinivasa Rao, Ch., Ganeshamurthy, A.N. and Ali, M. 2003. Nutritional Constraints in Pulse Production. Indian Institute of Pulses Research, Kanpur. p.34.

Subba Reddy, G., Venkateswarlu, B., Dixit, S., Srinivas Rao, Ch., Prabhakar, M. and Maruthi, V. (Eds.). 2003. TAR-IVLP Success Stories, NATP-CRIDA, Hyderabad. p.32.

Subba Reddy, G., Venkateswarlu, B., Srinivasa Rao, Ch. and Ramesh, G. 2004. Achievements at a Glance of TAR-IVLP. NATP-CRIDA, Hyderabad. p.8.

Vittal, K.P.R., Singh, H.P., Rao, K.V., Sharma, K.L., Victor, U.S., Chary, G.R., Sankar, G.R.M., Samra, J.S. and Gurubachan Singh. 2003. Guidelines on Drought Coping Plans for Rainfed Production Systems-An AICRPDA contribution. CRIDA, Hyderabad. p.39.

Vittal, K.P.R., Singh, H.P., Ravindra Chary, G., Maruthi Sanker, G.R., Prasad, Y.G., Srinivasa Rao, M., Samra, J.S. and Gurbachan Singh. 2003. Improved Agronomic Practices for Dryland Crops in India. CRIDA, Hyderabad. p.210.

9.3 Book Chapters

Mayande, V.M. 2004. Improved farm implements for rainfed region. *In* Land Use Diversification for Sustainable Rainfed Agriculture (eds. K.D. Sharma and B. Soni). National Institute of Hydrology, Roorkee, pp.428-438.

Mayande, V.M. 2004. Negotiating drought through engineering interventions in agriculture. *In* Drought Management (eds. K.D. Sharma and K.S. Ramasastri). National Institute of Hydrology, Roorkee, pp.130-138.

Mishra P.K. 2003. Analysis of some indigenous methods of soil moisture conservation by soil amendment and mulching. *In* Watershed Management (eds. V. P. Singh and R. N. Yadav). Allied Publishers Pvt. Ltd., New Delhi, pp.413-421.

Osman, M. 2003. Alternate land use systems for sustainable production in rainfed areas. *In* Agroforestry : Potentials and Opportunities (eds.

P.S.Pathak and Ram Newaj). Agrobios (India) Jodhpur, pp.171-182.

Rai, P. and Misra, A.K. 2003. Agroforestry systems for sustainable livestock production in India. *In* Agroforestry: Potentials and Opportunities. (Eds. P.S. Pathak and Ram Newaj). Agrobios (India) Jodhpur, pp. 281-303.

Ramakrishna, Y.S., Sharma, K.D. and Mishra, P.K. 2003. Integrated watershed management in dryland tracts. *In* Land use / Land Cover and Management Practices in India (eds. N.C.Gautam and V.Raghavswamy). BS Publications, Hyderabad, pp. 233-252.

Yadav, Sant Ram and Sharma, K.L. 2003. Krishi anusandhan mein Hindi ka siksha prasar ke kshetron mein Hindi ka yogdan- samasyaein avam nidan. *In* Rajbhasha Alok. Indian Council of Agricultural Research, New Delhi, pp. 29-32.

9.4 Papers presented in symposia, seminars, workshops

Jayachandra Reddy, M., Hemalatha, B., Raja Reddy, K. and Reddy, Y.V.R. 2004. Performance of agriculture development pre and post liberalization : evidence of Andhra Pradesh. National Workshop on Impact of Liberalization on Agriculture and Rural Poor. NIRD, Hyderabad, 19-21 January, 2004.

Jayachandra Reddy, M., Hemalatha, B., Saidulu, R., Raja Reddy, K. and Reddy, Y.V.R. 2004. The role of watershed management programme to control forest degradation in India. Workshop on Devolution and Community Based Forest Management, NIRD, Hyderabad, 1-3 March, 2004.

Korwar, G.R. and Pratibha, G. 2003. Existing and improved agroforestry systems in low rainfall areas of India. International Symposium on Sustainable Dryland Agriculture Systems, Niamey, Niger, 2-5 December, 2003.

Korwar, G.R. and Pratibha, G. 2003. Influence of different factors on quality of henna. National

- Seminar on New Perspectives in Spices, Medicinal and Aromatic Plants, Goa, 27-29 November, 2003.
- Korwar, G.R. and Pratibha, G. 2003. Optimization of spacing for curry leaf in rainfed regions of semiarid tropics. National Seminar on New Perspectives in Spices, Medicinal and Aromatic Plants, Goa, 27-29 November, 2003.
- Korwar, G.R. and Pratibha, G. 2004. Diversity in henna accessions. National Seminar on Research and Development in Production, Protection, Quality, Processing and Marketing of Medicinal and Aromatic Plants, Hisar, 27-29 February, 2004.
- Korwar, G.R. and Singh, H.P. 2003. Biomass energy production through agro forestry in dry lands. UNCCD's Fourth Asia-Africa Forum on Combating Desertification on Agroforestry and Soil Conservation, Cotonou, Benin, 24-27 June, 2003.
- Luthra, S.K., Khan, I.A. and Jai Gopal. 2003. Tuber dormancy behaviour of tuberosum potatoes under West Central plains. In National Symposium on Processing and Export Potential of Potatoes in Asia, CPRI, Modipuram, 10 March, 2003.
- Mandal, U.K., Ramesh, V., Sharma, K.L., Ramachandran, K. and Victor, U.S. 2003. Tension infiltrometer for estimating pore distribution in rainfed red soil under different land use systems. National Symposium on Emerging Trends in Agricultural Physics, IARI, New Delhi, 22-23 April, 2003.
- Maruthi, V., Vanaja, M., Rao, V.S., Khan, I.A., Subba Reddy, G., Latha, G. and Ramesh, G. 2003. Dryland weeds as medicinal plants. National seminar on Biodiversity, Conservation and Commercial Exploitation of Medicinal Plants. Osmania University, Hyderabad, 8-10 November, 2003.
- Mayande, V.M. 2003. Agriculture engineering: a key to second green revolution. Chief guest address, "Engineers' Day" celebrations, College of Agricultural Engineering (ANGRAU), Bapatla, 15 September, 2003.
- Mayande, V.M. 2003. Relevance of intercultural implements in enhancing productivity of dryland crops. National Seminar on Revival of Green Revolution through Dryland Mechanization. Bangalore, 29-30 May, 2003.
- Mayande, V.M. 2004. Agricultural engineering intervention for sustainable rainfed horticulture. 38th Annual Convention of Indian Society of Agricultural Engineers, College of Agricultural Engineering & Technology, Dapoli, 16-18 January, 2004.
- Mishra, P.K. 2003. Analysis of some indigenous methods of soil moisture conservation by soil amendment and mulching. International Conference on Water and Environment. Regional Research Laboratory (CSIR), Bhopal. 15-18 December, 2003.
- Mishra, P.K. 2004. Analysis of some indigenous methods of water harvesting and ground water recharging structures. National Conference on Traditional Knowledge Systems of India, E-Proceedings, IIT, Kharagpur, 9-11 January, 2004.
- Mishra, P.K. 2004. Re-look on indigenous knowledge on soil and water conservation in semi-arid India for addressing researchable issues. Conference on Water Resources Development and Management Practices (WARM-2004), M.V.S.R. Engineering College, Hyderabad, 27 February, 2004.
- Mishra, P.K. 2004. Documentation and analysis of indigenous methods of in-situ moisture conservation and runoff management. National Symposium-cum-exhibition on Enhancing Productivity and Sustainability in Rainfed Agro-ecosystem, NATP, Hyderabad, 24-26 March, 2004.
- Mishra, P.K. and Osman, M. 2004. Analysis of some indigenous methods of water harvesting and ground water recharging structures. National Conference on Traditional Knowledge Systems of India, IIT, Kharagpur, 9-11 January, 2004.

- Nimbole, N.N. and Raghuram Reddy, P. 2003. Ratooning of pigeonpea (*Cajanus cajan*) as a source of recurring vegetable and household medicine. National Seminar on Biodiversity, Conservation and Commercial Exploitation of Medicinal plants, Osmania University, Hyderabad, 8-10 November, 2003.
- Nirmala, G. 2003. Mechanisms to promote community participation in watershed programme in A.P. National seminar on Extension Strategy on Water Conservation and Irrigation Management, MPKV, Rahuri, 13-14 December, 2003.
- Om Prakash, Sastry, G., Reddy, Y.V.R. and Jayachandra Reddy, M. 2004. Impact of watershed programme on groundwater and surface water development. 3rd National Seminar on Inland water resources and environment, University of Kerala & Limnological Association of Kerala, Thiruvanthapuram, 2-4 February, 2004.
- Prabhakar, M., Prasad Y.G. and Srinivasa Rao. M. 2003. Biology of *Microplitis maculipennis* Szep. larval parasitoid of castor semilooper, *Achaea janata* L. National Symposium on Frontier Areas of Entomological Research, IARI, New Delhi, 5-7 November, 2003.
- Prasad, J.V.N.S., Korwar, G.R., Rao, K.V., Rama Rao, C.A., Srinivas, K. and Rao, S.N. 2003. Industry promoted agro forestry systems for pulpwood production under rainfed conditions in India. International conference on Rural Livelihoods, Forests and Biodiversity, Bonn, Germany, 19-23 May, 2003.
- Pratibha, G. and Korwar, G.R. 2003. Crop diversification in semiarid regions with medicinal plants. National Seminar on Biodiversity, Conservation and Commercial Exploitation of Medicinal Plants, OU, Hyderabad, 8-10 November, 2003.
- Pratibha, G. and Korwar, G.R. 2003. Diversification in semiarid regions with aromatic plants. National Seminar on New Perspectives in Spices, Medicinal and Aromatic Plants, Goa, 27-29 November, 2003.
- Pratibha, G. and Korwar, G.R. 2003. Crop diversification through medicinal, aromatic and dye-yielding plants for sustainability in semi-arid areas. First National Interactive Meet on Medicinal & Aromatic plants, CIMAP, Lucknow.
- Pratibha, G. and Korwar, G.R. and Yadav, S.K. 2004. Potential and prospects of *Indigofera tinctoria* - a dye yielding and multipurpose crop for semi-arid regions. National Seminar on Research and Development in Production, Protection, Quality, Processing and Marketing of Medicinal and aromatic Plants, Hisar, 27-29 February, 2004.
- Ragnuram Reddy, P., Vanaja, M., Reddy, B.M.K., Subba Reddy, G. and Maruthi, V. 2003. In situ conservation of biodiversity of medicinal plants under dryland conditions. National seminar on Biodiversity, Conservation and Commercial Exploitation of Medicinal Plants, Osmania University, Hyderabad, 8-10 November, 2003.
- Raghuram Reddy, P., Vanaja, M., Reddy, B.M.K., Subba Reddy, G. and Ramakrishna, Y.S. 2003. Policy issues for safeguarding bio-diversity of Indian medicinal plants. National seminar on Biodiversity, Conservation and Commercial Exploitation of Medicinal Plants, Osmania University, Hyderabad, 8-10 November, 2003.
- Rajeshwar Rao, G. and Korwar, G.R. 2003. Research priorities of pongamia as biodiesel plant. Consultative workshop on Scientific Strategies for Production of Non-edible Vegetable Oils for Use as Biofuels, IISc, Bangalore, 6-7 September, 2003.
- Rajeshwar Rao, G. and Korwar, G.R. 2003. Research priorities to popularize *Jatropha* among farming community. National workshop on *Jatropha* and Other Perennial Oilseed Species, BAIF, Pune, 5-7 August, 2003.
- Ramakrishna, Y.S., Rao, J.V. and Korwar, G.R. 2003. Biomass energy source development in

- agroforestry in rainfed areas. UNCCD's Asia-Pacific Regional Agroforestry Workshop, Bangalore, India, 17-20 December, 2003.
- Ramakrishna, Y.S., Sharma, K.D. and Mishra, P.K. 2003. Integrated watershed management in dryland tracts. National Conference on Land use/Land cover and Management Practices. Centre for Land Use Management (CLUMA), Hyderabad, 21-22 August, 2003.
- Ramakrishna, Y.S. and Osman, M. 2004. Community-based land use planning for natural resource management for livelihood security. National Seminar on Soil Survey for Land Use Planning and National Convention of Indian Society of Soil Survey and Land Use Planning, NBSS & LUP, Nagpur, 20-21 January, 2004.
- Ramana, D.B.V., Reddy, N.N. and Rao, G.R. 2003. Performance of Nellore Tup Lambs under Horti-pastoral systems. National Symposium on Agroforestry and Sustainable Production and Silver Jubilee of Agroforestry Initiative in India, IGRI, Jhansi.
- Rama Rao, C.A., Ramakrishna, Y.S., Reddy, Y.V.R. and Shaik Haffis 2003. Foreign trade in agricultural commodities and some implications. National Seminar on Impact of New Economic Policies on Rural Industries. National Institute of Rural Development, Hyderabad, 8-10 September, 2003.
- Ramesh, V., Mandal, U.K., and Korwar, G.R. 2003. Improving soil physical properties of dry land alfisols with fly ash. National Symposium on Emerging Trends in Agricultural Physics, IARI, New Delhi, 22-24 April, 2003.
- Rao, G.R., Mishra, V.K. and Gupta, B. 2003. Dynamics of herbage in chirpine based silvipastoral system in North-West Himalaya. National Symposium on Agroforestry and Sustainable Production and Silver Jubilee of Agroforestry Initiative in India. IGRI, Jhansi.
- Rao, V.S. 2004. Improvement in traditional method of processing of amla. National Conference on Traditional Knowledge Systems of India, E-Proceedings, IIT, Kharagpur, 9-11 January, 2004.
- Reddy, B.M.K., Raghuram Reddy, P., Maruthi, V., and Vanaja, M. 2003. Utility of the biodiversity of medicinal plants in dryland agriculture. National Seminar on Biodiversity, Conservation & Commercial Exploitation of Medicinal Plants, Osmania University, Hyderabad, 8-10 November, 2003.
- Saidulu, R., Jayachandra Reddy, M., Rama Rao, C.A. and Reddy, Y.V.R. 2004. Socio-economic condition of indigenous people through watershed management in the context of globalization and liberalization. National Workshop on Impact of Liberalization on Agriculture and Rural Poor. NIRD, Hyderabad, 19-21 January, 2004.
- Saidulu, R., Jayachandra Reddy, M., Rama Rao, C.A., Reddy, Y.V.R. and Sastry, G. 2004. Agroforestry and rural development with special reference to Ralegan Siddhi watershed management. Workshop on Devolution and Community Based Forest Management, NIRD, Hyderabad, 1-3 March, 2004.
- Sastry, G., Reddy, Y.V.R. and Singh, H.P. 2003. Recharge dams for the artificial infiltration of floodwater to stabilize ground water table in semi-arid tracts of India. National Conference on Integrated Sustainable Water Resources Planning And Management. Birla Institute of Technology & Science, Pilani, 11-12 October, 2003.
- Sastry, G., Reddy, Y.V.R., Om Prakash, Rama Rao, C.A. and Singh, H.P. 2003. Augmentation of fresh water resources through watershed development and management in semi-arid regions of India. International Seminar on Watershed Development, Visakhapatnam, 16-18 October, 2003.
- Sastry, G., Reddy, Y.V.R., Om Prakash and Singh, H.P. 2003. Watershed development programmes for runoff and soil loss moderations to increase crop productivity. National Seminar on Hydrology of Small Watersheds, Thiruvanthapuram, May 6-7, 2003.

Annual Report 2003-04

- Sastry, G., Reddy, Y.V.R., Reddy, N.N. and Singh, H.P. 2003. Watershed development programmes for reduction in SPRs in river valley catchment of India. International Yellow River Forum (IYRF) on River Basin Management, China, May, 2003.
- Shaik Haffiz, Singh, S.N. and Reddy, Y.V.R. 2003. Women in agriculture in Rural India : An empirical analysis. National Conference, NIRD, Hyderabad, 1-2 November, 2003.
- Sharma, K. L., Singh, H. P., Mandal, U. K., Srinivas, K., Vittal, K. P. R., Ramesh, V. and Grace, J. K. 2003. Assessment of soil quality using physical, chemical and biological characteristics in Alfisol under sorghum-castor rotation. 8th International Symposium on Soil and Plant Analysis, Somerset West, South Africa, 13-17 January, 2003.
- Sharma, K.L., Singh, H.P., Mandal, U.K., Vittal, K. P.R., Balloli, S. S. and Kusuma Grace, J.2003. Soil quality indicators for soil management-emerging concepts. National Seminar on Soil Survey for Land Use Planning, NBSS&LUP, Nagpur, 20-21 January, 2004.
- Singh, H.P., Subba Reddy, G. and Maruthi V. 2003. Rain water conservation and management technologies in rainfed agriculture focusing indigenous knowledge. National symposium on Rainwater Management for Water Security, Jawaharlal Nehru Krishi Vishwa Vidyalyaya, Jabalpur, 6-7 January, 2004.
- Singh, S.N., Rama Rao, C.A. and Reddy, Y.V.R. 2003. Review of employment trends during pre and post economic reforms. National Conference on Impact of New Economic Policy on Rural Industries, NIRD, Hyderabad, 8-10 September, 2003.
- Singh, S.N., Shaik Haffis, Om Prakash and Reddy, Y.V.R. (2003). Drought mitigation vs. watershed management in the semi-arid tropics of India. International Seminar on Watershed Development, Visakhapatnam, 16-18 October, 2003.
- Singh, S.N., Shaik Haffiz and Reddy, Y.V.R. 2003. Labour wages discrimination amongst gender: A relevant example of gender inequality in India. National Conference, NIRD, Hyderabad, 1-2 November, 2003.
- Singh, S.N., Shaik Haffis, Singh, S.R. and Reddy, Y.V.R. 2003. Dryland agro-eco systems and livelihood in India. Third Biennial Conference of Indian Society for Ecological Economics, Biodiversity and Quality of Life, Kolkata, December 18-20, 2003.
- Singh, S.N., Anil Kumar, B. and Reddy, Y.V.R. 2004. Experience of liberalization on employment and poverty in Indian economy. National Workshop on Impact of Liberalization on Agriculture and Rural Poor. NIRD, Hyderabad, January 19-21, 2004.
- Singh, S.N., Anil Kumar, B. Sastry, G. and Reddy, Y.V.R. 2004. Food insecurity in drought years of India. 3rd National Seminar on Inland water resources and environment. University of Kerala & Limnological Association of Kerala, Thiruvanthapuram, February 2-4, 2004.
- Singh, S.N., Hegde, M.R. and Reddy, Y.V.R. 2004. Economics of sustainable development of wasteland in India. International Conference on Sustainable Development of Natural Resources, Banaras Hindu University, Varanasi, 11-14 February, 2004.
- Srinivas, K., Prasad J.V.N.S. and Rao, S.N. 2003. Eucalyptus - based agroforestry systems for improving the productivity of arable lands. National symposium on Agroforestry and Sustainable Production and Silver Jubilee of Agro-forestry Initiative in India, IGFR, Jhansi, 7-9 November, 2003.
- Srinivasa Rao, Ch., Ali, M., Ganeshamurthy, A.N. and Singh, R.N. 2003. Sub-soil nutrient availability in different soil types of pulse growing regions of India. 68th annual convention of

- Indian Society of Soil Science, CSAU&T, Kanpur, 4 - 8 December, 2003.
- Srinivasa Rao, Ch., Ali, M., Ganeshamurthy, A.N., Singh, R.N. and Singh, K.K. 2003. Nutrient deficiencies in different soil types of pulse growing regions of India. National Symposium on Pulses in Crop Diversification and Natural Resource Management. IIPR, Kanpur, 20-22 December, 2003.
- Srinivasa Rao, Ch., Ali, M., Ganeshamurthy, A.N., Ghansham Singh, Singh, R.N. and Singh, K.K. 2003. Fixation and recovery added phosphorus and potassium in different soil types of pulse growing regions of India. National Symposium on Resource Management for Eco-friendly Crop Production, CSAU &T, Kanpur, 26-28 February, 2003.
- Srinivasa Rao, Ch., Singh, R.N., Singh, S.K. and Singh, K.K. 2003. Grain yields and nutrient removal by different pulse based cropping sequences in farmers' fields under different nutrient management options. National Symposium on Resource management for Eco-friendly Crop Production, CSAU &T, Kanpur, 26-28 February, 2003.
- Srinivasa Rao, M., Dharma Reddy, K., Singh, T.V.K. and Subba Reddy, G. 2003. Yield infestation relationships in long duration pigeonpea. National symposium on Frontier Areas of Entomological Research, 5-7 November, 2003.
- Subba Reddy, G. 2004. Improved practices in dryland farming. Workshop on Agriculture, Horticulture and Soil Conservation, MCRHRD Institute, Hyderabad, 23-25 March, 2004.
- Subba Reddy, G. 2004 Success stories under TAR-IVLP. National Symposium cum Exhibition on Enhancing Productivity and Sustainability in Rainfed Agroecosystem, CRIDA - NATP, Hyderabad, 24-26 March, 2004.
- Subba Reddy, G., Maruthi V. and Sanjeeva Reddy, B. 2004. Traditional Knowledge for risk management in rainfed agriculture. National Conference on Traditional Knowledge Systems of India, IIT, Kharagpur, 9-11 January, 2004.
- Vanaja, M. Maheswari, M., Raghuram Reddy, P., Yadav, S.K., Jyothi Lakshmi, N. and Venkateswarlu, B. 2003. Identification of efficient rainfed food and oilseed crops and their cultivars in seedling stage under elevated CO₂. National seminar on Physiological Interventions for Improved Crop Productivity and Quality: opportunities and constraints", S.V.Agric. College, Tirupati, 12 - 14 December, 2003.
- Venkateswarlu, B. 2003. Implications of IPRs in commercialization of agricultural biotechnologies after the TRIPS agreement. National Conference on WTO Impact on Agriculture, MANAGE, Hyderabad, 26-27 June, 2003.
- Venkateswarlu, B. 2003. Rural biocenters as a model for application of biotechnology in dryland agriculture. National conference on convergence of Biotechnologies to Address the problems of Dryland Agriculture, Hyderabad, 13-14 October, 2003.
- Venkateswarlu, B. and Srinivasa Rao, Ch. 2003. Pulses research under rainfed eco system achievements and future outlook. National Symposium on Pulses for Crop Diversification, IIPR, Kanpur, 20-22 December, 2003.
- Venkateswarlu, B. and Ramakrishna, Y.S. 2004. Soil microbial diversity in rainfed agro ecosystem. National symposium on Preservation of Microbial Resources - New Techniques and Role of Biocenters, NBAIM, New Delhi, 16-17 March, 2004.
- Venkateswarlu, B. and Srinivasa Rao, Ch. 2004. Limitations in the adoption of organic farming. National Symposium on Organic Farming, MAU, Parbhani, 6 March, 2004.
- Victor, U.S., Mandal, Uttam Kumar, Rao, K.V. and Vittal, K.P.R. 2003. Assessment of different water balance models for root zone soil moisture estimation under rainfed chickpea. National Symposium on Emerging trends in Agricultural Physics IARI, New Delhi, 22-23 April, 2003.
- Vittal, K.P.R., Sharma, K.L., Vamsi Krishna, P., Srinivas, K., Mandal, U.K. and Kusuma Grace, J. 2004.

Effect of different landuse systems on physico-chemical parameters and soil fertility in Alfisol under semi-arid tropical conditions. National Seminar on Soil Survey for Land use Planning & National Convention of Indian Society of Soil Survey and Land Use Planning, NBSS&LUP, Nagpur, 20-21 January, 2004.

Yadav, S.K., Vanaja, M., Mohan Krishna, M., Jyothi Lakshmi, N., Maheshwari, M., Reddy P.R. and Venkateshwarlu, B. 2003. Seed reserve mobilization and utilization at seedling stages in sorghum under enhanced carbondioxide levels. National seminar on Physiological Interventions for improved Crop Productivity and Quality: Opportunities and Constraints, S.V. Agricultural College, Tirupati, 12-14 December, 2003.

9.5 Popular articles

CRIDA, 2004. Grameena vyavasayabhivrudhiki CRIDA karyacharana pranalika. Eenadu, 21 January, 2004.

CRIDA, 2004. Vyavasayam, grameenabhivrudhiki CRIDA. Andhra Jyothi, 21 January, 2004.

CRIDA, 2004. Mahila rythula sikshana sadassu. Eenadu, 6 February, 2004.

CRIDA, 2004. Adhuna padhatula dwara adhika digubadulu sandhincha vachhu. Andhra Jyothi, 6 February, 2004.

Korwar, G.R. 2003. Agroforestry for livelihoods. Krishibandhu 1(1): 12-13.

Korwar, G.R. 2003 On-farm generation of green leaf manure in dryland areas. Krishibandhu 1(4): 62-63.

Mayande, V.M., Sanjeeva Reddy, B., Srinivas, I., Sriramulu, V. and Veeradas, S. 2003. Metta vyavasayaniki adhuna parikaralu. In Mettasagulo Melaina Sanketika Vignanam, CRIDA, Hyderabad.

Ranade, D.H., Chaurasia, M.C., Sharma, R.A and V.M. Mayande. 2003. Malwa ke Paramparik va

Unnat Krishi Yantra. Bulletin No.: NATP/MMPDM/CRIDA/IB-01/03. JNKVV, Indore.

Ranade, D.H., Sharma, R.A and V.M. Mayande. 2003. Improved Seed Drill- NRCS Design: A success story. JNKVV, Indore.

Rao, J.V. 2003. Bhada-pada Jameenugalally paryaya Belegalu. Krishi Ke Bandhu 1(1):19-21.

Rao, J.V., Osman, M. and Reddy, N.N. 2003. Pashugrasapu pantalu mariyu chetla pempakam In Metta Sagulo Melaina Sankethika Vignanam, CRIDA, Hyderabad.

Reddy, N.N. 2003. Agri-Horti paddhatulatho sathphalithalu. Andhra Jyothi, 17 October, 2003.

Reddy, N.N. 2003. Atavee vyavasayam tho sirulu. Andhra Jyothi, 27 August, 2003.

Reddy, N.N. 2003. Beedubhoomullo pandla thotala pempakam. Andhra Jyothi, 16 July, 2003.

Reddy, N.N. 2003. Boppailo antara pantalu. Andhra Jyothi, 17 June, 2003.

Reddy, N.N. 2003. Jaama thotala pempakam - Melakuvalu. Andhra Jyothi, 5 November, 2003

Reddy, N.N. 2003. Maamidi thotalanu aasinche purugulu, thegullu. Andhra Jyothi, 9 December, 2003

Reddy, N.N. 2003. Maamidi thotalu - Yaajamaanyam. Andhra Jyothi, 2 December, 2003.

Reddy, N.N. 2003. Metta pandla thotalalo kuragaayala saagu - Melakuvalu Andhra Jyothi, 22 September, 2003.

Reddy, N.N. 2003. Metta pranthalaku anuvaina Agri horticulture vidhanalu. Andhra Jyothi, 15 October, 2003.

Reddy, N.N. 2003. Yerragarpanelallo anjira sagu. Andhra Jyothi, 29 June, 2003.

Reddy, N.N. and V.S. Rao 2003. Varshadarapu pandla thotalu. In Metta Sagulo Melaina Sankethika Vignanam. CRIDA, Hyderabad.

- Sanjeeva Reddy, B. 2003. Metta sedyaniki adhunika vyavasaya parikaralu. Annadata 35(5): 8- 11.
- Sanjeeva Reddy, B. and Hemantha Kumar. 2003. Pantala noorpidiki adhunika yantralu-Nurpidi cylinderlu panichese vidhanam. Annadata 35(8) : 19-20.
- Sidhpuria, M.S., Milakh Raj, Jatasra, D.S., Ashwani, K., Chopra, Deepak, Singh, Sube and Mayande, V.M. 1998. Animal drawn CRIDA Drill-Plough: A success story. CCSHAU, Hisar.
- Singh, S.V., Khan, I.A. and Luthra, S.K. 2003. Aloo ki unnat prajati-Kufri Anand. Krishi Chayanika 24 (2):20-22.
- Srinivasa Rao, M. and Rama Rao, C.A.2003. Aamudalalo Dasari Purugu Nivarana, Andhra jyothis. 1 August.
- Srinivasa Rao, M. Anil Kumar, B. and Sri Vani, G. 2003 Metta panatallo cheeda peedala nivarana-yajamanya padhatalu. Andhra jyothis, 10 October.
- Subba Reddy, G., Maruthi, V. Sanjeeva Reddy B., and Reddy, B.M.K. 2004. Saampradaya vyavasaaya saanketika vignanam - Aavashyakatha. Annadata, February, 2004.
- Subba Reddy, G., Sanjeeva Reddy, B., Subhramanyam, K.V. and Maruthi, V. (Eds.) 2003. Mettasagulo Melaina Sanketika Vignanam, CRIDA, Hyderabad. p.70.

9.6 T.V. and Radio talks

- Joseph, R. Activities of KVK in adopted villages of Rangareddy dist. AIR, Hyderabad, 24 September, 2003.
- Rami Reddy, R.D. Plant Protection in Pigeonpea, AIR, Hyderabad, 22 July, 2003.
- Reddy, N.N. Beedubhoomullo teku sagu paddhatulu. Annadata ETV, 23 July, 2003.
- Reddy, N.N. Mamidilo anthara pantalu. Annadata ETV, 21 July 2003
- Reddy, N.N. Mamidi thotalalo kattarimpu vidhanalu. Annadata ETV, 22 July, 2003.
- Reddy, N.N. Mettapantalaku neeti viniyogam- Thotala pempakam. AIR, Hyderabad, 31 May, 2003.
- Reddy, N.N. Mamidi thotalalo pashu grasalu mariyu gorrela pempakam. Annadata ETV, 24 July, 2003,
- Reddy, N.N. Pandla thotalalo gorrela pempakam. Annadata ETV, 15 September, 2003,
- Reddy, N.N. Rabi lo soyachikkudu saagu. AIR, Hyderabad. 10 November, 2003,
- Sanjeeva Reddy B. Metta vyavasaya nelallo bhusaram, thema parirakshinche paddathulu. AIR, Hyderabad, 7 August, 2003.
- Venkateswarlu, B. Steps farmers need to take post - WTO, AIR, Hyderabad, 21 August, 2003.

10 Ongoing Projects

10.1 CRIDA

Institute Code No.	Project Title	Investigators	Year of start	Likely year of termination
1	2	3	4	5
Division of Resource Management				
1. RM/AM/15	Studies on the influence of climate variability on agricultural crop patterns for select dryland crops	U.S.Victor K.P.R.Vittal	2000	2004
2. RM/AF/07	Evaluation and exploitation of plant species for alternate value added products in marginal lands	G.Pratibha G.R.Korwar B.Venkateswarlu M.Vanaja	1996	2004
3. RM/AF/08	Effect of canopy management of subabul trees on the fodder yield of promising perennial pasture species under silvopastoral system and comparative performance of small ruminants	G.R.Rao A.K.Mishra V.Ramesh J.V.N.S.Prasad	2000	2004
4. RM/LU/12	Low till farming strategies and integrated plant nutrient supply for rainfed semi-arid tropics	K.L.Sharma K.P.R.Vittal G.R.Korwar B.Venkateswarlu V.Maruthi K.V.Rao U.K.Mandal	1998	2008
5. RM/LU/13	Spectral characteristic of rainfed <i>kharif</i> sorghum	U.K.Mandal N.N.Srivastava V.Ramesh K.L.Sharma M.Vanaja	2001	2004
6. RM/LU/14	Improving soil health and tree establishment of Alfiosl with fly ash	V.Ramesh G.R.Korwar U.K.Mandal J.V.N.S.Prasad	2001	2006
7. RM/TOT/15	Integrated nutrient management for sorghum and castor	N.N.Mimbole R.V.Adake U.K.Mandal K.L.Sharma G.R.M.Sankar	1998	2008
8. RM/FM/01	Energy use in crop production and livestock rearing in A.P.	C.R.Thyagaraj B.Sanjeeva Reddy J.V.N.S.Prasad	2003	2006
9. RM/AM/16	Radiation and water use efficiency of sorghum pigeonpea intercropping system	N.N.Srivastava P.Vijay Kumar J.V.N.S.Prasad M.S.Prasad	2003	2007
10. RM/20/12	Organic cultivation of vegetable type pigeonpea	N.N.Nimbole J.V.N.S.Prasad	2003	2006

1	2	3	4	5
Division of Crop Sciences				
11. CS/CP/07	Evaluation of maize for nutritive and sustainable grain, fodder and silage production	P.R.Reddy I.A.Khan D.B.V.Ramana A.K.Mishra M.Vanaja S.Venkateswarlu	2002	2007
12. CS/CP/06	Managing abiotic stress tolerance in drylands : Physiological and molecular approaches	M.Maheswari M.Vanaja N.Jyothi Lakshmi P.R.Reddy S.K.Yadav B.Venkateswarlu G.Subba Reddy	2002	2007
13.CS/ALU/01	Studies on extraction and storage of curry leaf essence	S.K.Yadav G.R.Korwar B.Venkateswarlu M.Vanaja	2002	2004
14.CS/FU/12	Onfarm generation of organic matter : A potential source of nutrient supply and soil health	B.Venkateswarlu P.R.Reddy V.Ramesh	1994	Long term
15. CS/PP/08	Life table analysis, economic threshold levels and IPM modules for major pests of castor	M.Prabhakar Y.G.Prasad M.Srinivasa Rao G.R.Korwar K.Nagasree	2001	2004
16. CS/AF/04	Sustainable land use through agri-horti and horti-pasture systems in rainfed Alfisol watershed	J.V.Rao V.S.Rao N.N.Reddy N Jyothi Lakshmi	2000	2005
17. CS/Hort/02	Development of suitable agrotechniques for horticultural crops in drylands	V.S.Rao N.N.Reddy	2001	2005
18. CS/CI/03	Cataloguing and characterisation of crop varieties grown in rainfed agroeco system of India	I.A.Khan G.R.M.Sankar J.V.Rao G.Subba Reddy	2000	2003
19. CS/SS/01	Integrating the multinutrient extract into existing soil test interpretation	S.S.Balloli V.Ramesh	2003	2004
20. CS/CP/07	Mechanism of drought tolerance in rainfed short duration pulses	N.Jyothi Lakshmi M.Maheswari M.Vanaja S.K.Yadav B.Venkateswarlu G.Subba Reddy P.R.Reddy	2003	2007
Transfer of Technology				
21. TOT/16	An evaluation of various soil and rainwater conservation practices in Alfisols	M.V.Padmanabhan P.R.Reddy P.K.Mishra K.L.Sharma G.R.Korwar Y.V.R.Reddy G.R.Maruthi Sankar K.V.Rao	1999	2004

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1	2	3	4	5
22. TOT/17	Use of top feeds as supplements to small ruminants under grazing conditions	A.K.Mishra G.R.Korwar Mohd.Osman G.R.Rao D.B.V.Ramana	2000	2004
23. TOT/18	A study on role of village institutions on management of programmes on area development on watershed basis in Southern Telangana of Andhra Pradesh	G.Nirmala N.Babjee Rao C.A.Rama Rao M.S.Prasad G.R.M.Sankar	2000	2004
24. TOT/20	Zero energy cool chamber storage studies on dryland fruits and vegetables	K.Sreedevi Shankar V.S.Rao K.V.Subrahmanyam I.Srinivas	2002	2004
25. TOT/21	Impact assessment of IVLP project	K.Nagasree K.V.Subrahmanyam A.K.Mishra B.M.K.Reddy G.Subba Reddy	2002	2004

10.2 NATP

Sl. No.	Project Title	Investigators	Year of start	Likely year of termination
1	2	3	4	5
1.	Near real-time monitoring of agrometeorological conditions for contingency planning in Andhra Pradesh (RRPS-32)	A.V.R.Kesava Rao, Y.S.Ramakrishna, G.Subba Reddy, G.G.S.N.Rao, U.S.Victor	2000	2004
2.	Identification of research gaps in intercropping system under rainfed conditions in India (ROPS-10)	J.V.Rao, I.A.Khan	2001	2003
3.	Impacts of watershed management on sustainability of land productivity and socio economic status (ROPS-14)	G.Sastry, Y.V.R.Reddy, P.K.Mishra, M.Osman	2000	2003
4.	Agro economic characterisation, constraint analysis and delineation of efficient ecozones using soil type and rainfall data in chickpea and pigeonpea based cropping systems (RPPS-9)	G.R. Maruthi Sankar, C.R.Thyagaraj, A.V.R.Kesava Rao, K.V.Subrahmanyam	2000	2003
5.	Evaluation and improvement of indigenous methods of moisture conservation and runoff management (RPPS-10)	K.D.Sharma, B.M.K.Reddy, K.V.Subrahmanyam, M.Osman, K.Ravi Shankar	2000	2003
6.	Delineating the efficient productive zones for cotton production system using GIS based crop models (RCPS-4)	K.V.Rao, U.S.Victor, K.P.R.Vittal, J.V.N.S.Prasad	2000	2003
7.	Develop agri-horticulture and agroforestry systems in kharif sorghum area decreasing regions for overall sustainability of the production system (RNPS-9)	N.N.Reddy, J.V.Rao, G. Rajeshwar Rao, A.K.Mishra	2000	2004
8.	Developing sustainable alternate land use systems for industrial biomass production from drylands (RNPS-26)	J.V.N.S.Prasad, G.R.Korwar, K.V.Rao, M.Osman, G.Rajeshwar Rao, G.Pratibha, U.K.Mandal	2001	2003
9.	Development of weather based forewarning systems for crop pests and diseases (MM)	Y.S.Ramakrishna, Y.G.Prasad, A.V.R.Kesava Rao, G.G.S.N.Rao, M.Prabhakar, M.Srinivasa Rao, P.Vijay Kumar	2001	2004

1	2	3	4	5
10.	Land use planning for management of agricultural resources (MM)	K.P.R.Vittal, G.Ravindrachary, U.K.Mandal, K.Srinivas, K.L.Sharma, V.Ramesh, G.R.Korwar, G.Pratibha, J.V.N.S.Prasad, K.V.Rao, P.K.Mishra, M.Osman, V.S.Rao, N.N.Srivastava, G.G.S.N.Rao, G.Nirmala, N.Babjee Rao, A.Vidhyadhari, C.A.Rama Rao	2001	2004
11.	Use of improved tools for mechanization of dryland agriculture	V.M.Mayande, I.Srinivas, R.K.Adake	2001	2004
12.	Forecasting of diseases and insects in sorghum and pearl millet cropping system perspective (RNPS-13)	N.D.Das N.N.Srivastava, Y.G.Prasad	2000	2003
13.	Integrated National Agricultural Resources Information System INARIS (MM)	Y.S.Ramakrishna A.V.R.Kesava Rao, G.G.S.N.Rao, G.R.M.Sankar, P.Vijay Kumar	2001	2004
14.	Technology assessment and refinement of nutritive cereal-based rainfed agro-ecosystem through IVLP for Southern Telangana region, Andhra Pradesh (RE-IVLP-2)	G.Subba Reddy A.K.Mishra, A.Samrajyam, B.M.K.Reddy, S.Dixit	1998	2004
15.	Influence of different agroforestry models on soil fertility and resource conservation under conditions in SAT (CGP)	G.R.Korwar G.Pratibha, K.Srinivas, V.Ramesh	2002	2005
16.	Effective clonalization of high value horticulture and tree species for dryland agriculture (RNPS-27)	B.M.K.Reddy	2001	2004
17.	Collection, documentation and validation of indigenous technical knowledge (MM)	G. Subba Reddy V.Maruthi, B.Sanjeeva Reddy, G.Nirmala, N.Babjee Rao	2000	2003
18.	New approaches to integrated pest management in rainfed rice based production systems (RRPS-22)	Y.S.Ramakrishna G.G.S.N.Rao, A.V.R.Kesava Rao	2000	2004
19.	Evaluation of cultivars of major oilseed crops of the production system for moisture and nutrient constraints in different soil types (ROPS-12)	G.Pratibha K.L.Sharma G.R.Korwar	2000	2004
20.	Upgradation and evaluation of mini dal mill (RPPS-4)	B.Sanjeeva Reddy R.K.Adake	2000	2003
21.	Optimising nutrient supply in relation to moisture availability for enhanced productivity and stability of rainfed cotton based production system (RCPS-2)	K.Srinivas K.L.Sharma, B.M.K.Reddy, G.R.M.Sankar	2000	2004
22.	Development of regional scale watershed plans and methodologies for identification of critical areas for prioritised land treatment in the watersheds of oilseeds, pulses, cotton and nutritious cereals production systems (RNPS-2)	P.K.Mishra M.Osman, V.Ramesh	2000	2004
23.	Assessment and improvement of soil quality and resilience for rainfed production system (RRPS-20)	K.L.Sharma U.K.Mandal, K.P.R.Vittal, V.Ramesh	2000	2004

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1	2	3	4	5
24.	Improving the utilization of coarse cereal crop residues by strategic supplementation for livestock feeding (RNPS-17)	A.K.Mishra S.K.Yadav N.Babjee Rao	2000	2003
25.	Identifying systems for carbon sequestration and increased productivity in semi-arid tropical environments (RNPS-25)	V. Ramesh, M.Vanaja, K.L.Sharma, B.Venkateswarlu, K.Srinivas, V.Maruthi	2000	2004

10.3 Externally funded

Sl. No.	Project Title	Investigators	Year of start	Likely year of termination
1.	Micropropagation of neem and teak plants and extension of technology through rural bio-centers (AP-NL)	B.Venkateswarlu G.R.Korwar, G.Pratibha, M.Vanaja	1997	2004
2.	Enhancing tolerance of sorghum to abiotic stress through genetic manipulation (AP-NL)	M.Maheswari, S.K.Yadav, B.Venkateswarlu, M.Vanaja, N. Jyothi Lakshmi	2001	2004
3.	Biointensive integrated pest management in dryland crops in selected villages (AP-NL)	Y.G.Prasad, M.Prabhakar, M.Srinivas Rao, G.Nirmala, V.Maruthi, B.Venkateswarlu, R.Dasharathrami Reddy	2002	2004
4.	Network project on agroforestry in Nalgonda and Mahaboobnagar districts of Andhra Pradesh (AP-NL)	G.R.Korwar, H.P.Singh, G.Pratibha, M.Osman, P.K.Mishra, K.L.Sharma	1999	2003
5.	Crop - crop diversity as a key component of IPM of dryland crop pests (AP-Cess)	M.Srinivas Rao, M.Prabhakar, Y.G.Prasad, V.Maruthi, C.A.Rama Rao, K.Srinivas	2003	2006
6.	Interaction of elevated CO ₂ and moisture stress on seed viability, seed germination and initial plant establishment of different dryland crops (AP-Cess)	M.Vanaja, M.Maheswari, P.R.Reddy, S.K.Yadav, K.Srinivas	2003	2005
7.	Crop diversification for sustainability of drylands through dye yielding crops (AP-Cess)	G.Pratibha, G.R.Korwar, M.Srinivas Rao, S.K.Yadav, B.Venkateswarlu	2003	2006
8.	Social Science Information Repository (NCAP)	Y.V.R. Reddy, C.A.Rama Rao	2001	2015
9.	Studies on women in agriculture in India with special emphasis on crop production technologies (AP-Cess)	Y.V.R.Reddy, Shaik Haffiz	2002	2003
10.	Enabling rural poor for better livelihoods through improved natural resource management in SAT India (DFID)	Y.S.Ramakrishna, K.V.Subrahmanyam, B.Venkaeswarlu, P.K.Mishra, V.M.Mayande, M.Osman, S.Dixit, A.K.Mishra, V.Maruthi, C.A.Rama Rao, K.Nagasree	2003	2005
11.	Studies on economics of milk production with particular emphasis on optimal allocation of feeds and fodder to dairy animals in semi-arid regions (AP-Cess)	Y.V.R.Reddy, Shaik Haffiz	2003	2004
12.	Watershed based NRM strategies for rainfed area of Prakasam district in Andhra Pradesh (AP-Cess)	M.Osman, K.V.Rao	2002	2005
13.	Development of long-term hazard planning, management and vulnerability reduction action plan in respect of drought for the state of Andhra Pradesh (Govt. of A.P.)	P.K.Mishra, M.Osman	2002	2004

1	2	3	4	5
14.	Empowerment of women through participatory dryland technology interventions (UNDP)	V.Maruthi, G.Pratibha, G.Nirmala, G.Rajeshwar Rao, M. Srinivas Rao, C.A.Rama Rao, K.V.Rao, D.B.V.Ramana, B.Sanjeeva Reddy, N.Babjee Rao	2003	2004
15.	Evaluation of Eucalyptus and Leucaena based agroforestry systems for industrial biomass production for drylands (AP-Cess)	J.V.N.S.Prasad, G.R.Korwar, K.V.Rao, G.Rajeshwar Rao, U.K.Mandal, C.A.Rama Rao	2004	2006
16.	Evaluation of regenerative agricultural technology with low external inputs (AP-Cess)	V.Maruthi, K.Srinivas, B.Sanjeeva Reddy, C.A.Rama Rao, M.Srinivasa Rao, M.Vanaja	2003	2006
17.	Assessment of impact of sustainable land management practices initiated in developed / treated watersheds in rainfed agro-ecoregion of Telangana, A.P.-a GIS-based study (AP-Cess)	Kausalya Ramachandran, U.K.Mandal, K.L.Sharma, V.Ramesh, M.Vanaja, G.Nirmala	2004	2007
18.	Assessing soil phosphorus and potassium supplying power under different rainfed production systems and yield maximisation of some dryland crops by optimum nutrient supply (PPIC)	Ch.Srinivas Rao, G.Ravindra Chary, U.K.Mandal, K.L.Sharma, K.P.R.Vittal	2003	2005
19.	Development of tree-borne oilseeds (NOVOD)	G.Rajeshwar Rao	2003	2004
20.	Refining regional level prediction of yield for cotton (Technology Mission on Cotton)	K.V.Rao, J.V.N.S.Prasad, U.S.Victor, K.P.R.Vittal	2003	2005
21.	National facility of Agromet Data Bank at CRIDA (AP-Cess)	G.S.S.N.Rao, Y.S.Ramakrishna, K.P.R.Vittal, U.S.Victor, P.Vijay Kumar	2003	2006
22.	Mitigation of fodder scarcity through fodder Banks in drought prone areas (NABARD)	G.Rajeshwar Rao, D.B.V.Ramana, J.V.N.S.Prasad, V.Ramesh, K.V.Rao	2003	2004
23.	Survey, collection evaluation and multiplication of elite germplasm of Pongamia and Jatropha (AP-Cess)	G.Rajeshwar Rao, G.R.Korwar, K.V.Rao, D.B.V.Ramana, V.Ramesh, G.Pratibha	2004	2007

11 Consultancy, Patents and Commercialization

11.1 Consultancy

- Four projects sponsored by AP - Netherlands scheme through Institute of Public Enterprise, Hyderabad are currently in operation:
 - i) Micropropagation of neem and teak plants (II Phase)
 - ii) Network project on agro-forestry in Nalgonda and Mahaboobnagar districts
 - iii) Bio-intensive integrated pest management in dryland crops in selected villages
 - iv) Enhancing tolerance of sorghum to abiotic stresses through genetic manipulation
- Impact evaluation study of NWDPR watershed at Peddagadda in Srikakulam district of A.P. (Ministry of Agriculture, Govt. of India)
- Development of long-term hazard planning, management and vulnerability reduction action planning in respect of drought for the state of A.P. (Govt. of A.P.)
- Enabling rural poor for better livelihoods through improved natural resource management in SAT India (DFID)

11.2 Patents

Patents were applied for five equipments, viz., Orchard Sprayer, Vegetable Preservator,

Castor and Groundnut Stripper and Tractor Drawn Planter.

- Patent no. 181133 for drill plough
- Patent no.183884 for groundnut planter
- Applied for Banana Fibre Extractor

11.3 Commercialization

- Seven industries located in AP, MP, Maharashtra and Rajasthan signed MoUs with CRIDA and adopted 11 designs of different CRIDA equipments for production and sale.
- A combined income of Rs.1,90,119/- (Rs.1,64,119/- from GRF and Rs.26,000/- from HRF) was generated by selling farm produce like grass, firewood, vegetables, fruits, henna leaf and powder, curry leaf and henna seedlings, and seed of castor, maize, sorghum, leaucena and the like.
- Soil and plant analytical service worth Rs.19,150/- was provided to farmers, NGOs, ICAR Institutes, SAUs and the like.
- Micropropagated neem and teak plants worth Rs.42,000/- were sold to farmers and NGOs.
- One hundred thirty four dryland agriculture implements amounting to Rs.3,16,590/- were sold.

12 QRT, RAC, Management Committee, SRC

12.1 Quinquennial Review Team (QRT)

The IV QRT was formed by ICAR in May 2000 to evaluate the work of CRIDA and AICRPDA. It had the following constitution:

Chairman

Dr. S.S.Khanna, Ex-Vice Chancellor, NDUA&T

Members

Dr. H.C.Sharma, Advisor to VC, NDUA&T, Faizabad

Dr. J.Venkateswarlu, Ex-Director, CAZRI

Dr. M.V.R.Prasad, Ex-Director, DOR

Dr. V.Veerabhadraiah, Director (Extension), UAS, Bangalore

Prof. S.R.Singh, Prof. and Head, BHU, Varanasi

Dr. B.Venkateswarlu, Principal Scientist, CRIDA and Member - Secretary

The report which the team had submitted to ICAR on July 14, 2001 was accepted by ICAR vide letter F.No.4-10/2000-IA-II dated 1 May, 2003.

12.2 Research Advisory Committee (RAC)

Chairman

Dr. S.A.Patil, Hon'ble Vice - Chancellor, UAS, Dharwad

Members

Dr. P.C. Bhatia, ADG (Agronomy) Retd., ICAR, New Delhi

Dr. A. Padma Raju, Director of Research, ANGRAU, Hyderabad

Dr. V.P. Singh, Dean, College of Veterinary Science & A.H, JNKVV, Indore

Dr. S.D.Singh, Principal Scientist (Agronomy & WM) Retd., CAZRI, Jodhpur

Dr. Gurbachan Singh, ADG (Agronomy), New Delhi



Dr. K.D.Muthana, Principal Scientist (Forestry) Retd., Mysore

Sri Gyan Chand Mehata, Bihar

Smt. Mani Sinha, Bihar

Dr. H.P.Singh, Director, CRIDA, Hyderabad (till 31 May 2003)

Dr. Y.S.Ramakrishna, Director, CRIDA, Hyderabad (from 1 June 2003)

Dr. J.V.Rao, Principal Scientist & Head, Agroforestry Cell, CRIDA and Member - Secretary

The XII and XIII RAC meetings were held on 14 May, 2003 and 23 February, 2004. Some major recommendations made are listed below:

- Detailed investigations and a thorough review of literature may be made before initiating / recommending use of fly ash.
- Custard apple and *jamun* may be included as horticultural entries in the project on "In situ conservation of plant biodiversity". The House suggested terming 'biosecurity' in place of 'biodiversity'.
- A critical review of lift irrigation projects and their utility in the present context of receding ground water levels in rainfed areas may be made.
- Success stories emanating from drought periods may be documented. Depending on these,

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contingent crop plans may be developed for future implementation.

- Close interaction may be ensured by AICRPAM with AICRPDA, state departments, and related coordinated projects for better implementation of recommendations from Agromet advisories.
- Success stories from TAR-IVLP may be popularized in different rain-fed eco-regions.
- Close collaboration and linkages need to be developed among various agricultural institutions / state departments particularly for sharing library, laboratory and field facilities for judicious use of the expensive resources.

12.3 Institute Management Committee (IMC)

Chairman

Dr. H.P.Singh, Director, CRIDA, Hyderabad
Hyderabad (till 31 May, 2003)

Dr. Y.S.Ramakrishna, Director, CRIDA, Hyderabad
(from 1 June, 2003)

Members

Dr. A.Padma Raju, Director of Research, ANGRAU,
Hyderabad

Dr. M.A.Shanker, Chief Scientist, UAS, Bangalore
Shri Gyan Chand Mehata, Bihar

Smt. Mani Sinha, Bihar

Dr. G.Subba Reddy, Head, Division of Crop
Sciences, CRIDA, Hyderabad

Dr. Y.V.R.Reddy, Head, Design and Analysis,
CRIDA, Hyderabad

Dr. J.V.Rao, Principal Scientist, CRIDA, Hyderabad

Shri B.Pandu Reddy, F&AO, CRIDA, Hyderabad

Shri Ashish Roy, SAO, CRIDA and Member -
Secretary

The XXXII and XXXIII IMC meetings were held on 13 May, 2003 and 22 February, 2004. The following recommendations were made:

- Since the Council is following Govt. of India rules *mutatis mutandis*, it was recommended to



adopt the revised list of private hospitals / diagnostic centers issued on 23 December, 2002 by the Ministry of Health and Family Welfare, Gol, New Delhi for treatment of CRIDA employees and their families.

- Committee recommended condemnation of three tractors subject to out come of the RTA's report.
- The members advised more importance to INM and IPM to improve the quality of agricultural produce.
- Use of heavy implements / machinery may be discouraged and importance be given to those methods of cultivation which employ light machinery.

12.4 Staff Research Council (SRC)

The annual SRC meeting of the institute was held on 21 May, 2003 under the chairmanship of Dr. H.P.Singh, Director. It reviewed 26 (9 Division of Resource Management, 10 Division of Crop Sciences, 1 Design & Analysis, and 6 Transfer of Technology) ongoing projects. Six projects were concluded since they achieved their objectives, and six were extended for periods varying from six months to four years. Five new project proposals were presented, and all were approved after incorporating minor technical modifications. The meeting also reviewed progress made under 28 NATP projects which were in operation at CRIDA. The technical programme for 2003-04 was finalized for 25 projects (cf 10.1).

13 Participation of Scientists in Conferences, Meetings, Workshops and Symposia

Period	Name of the Scientist	Conferences / Meetings / Workshops / Symposia	Venue
April 2-3, 2003	K. D. Sharma G.R.Korwar	Joint ICRISAT-ICAR Policy Advisory Committee Meeting	ICRISAT, Hyderabad
14-16 April, 2003	A. K. Mishra	Planning workshop on Enhancing livelihood of poor livestock keepers through increasing use of fodder	ICRISAT, Hyderabad
22-24 April, 2003	U.K.Mandal	National Symposium on Emerging Trends in Agricultural Physics	IARI, New Delhi
25 April, 2003	G. R. Korwar	Development of descriptors for henna and in-situ conservation of plant biodiversity	CRIDA, Hyderabad
28 April, 2003	V.M. Mayande	National seminar on "Patents protection, valuation and commercialization"	India International Centre, New Delhi
29-30 April, 2003	G. R. Korwar	Combating land degradation and increasing production in Madhya Pradesh and Eastern Rajasthan	ICRISAT, Hyderabad
13 May, 2003	G. R. Korwar	Water Vision of Forest Department	AP Forest Department, Hyderabad
28-30 May, 2003	V.M. Mayande	National seminar on "Revival of Green Revolution through mechanization of dryland agriculture"	UAS, Bangalore
12 July, 2003	P. K. Mishra M. Osman	Issues related to water management in the post-drought situation and the possible action	CWS, Hyderabad
5- 7 August, 2003	G.R.Rao	National workshop on jatropha and other perennial oilseed species	BAIF, Pune
10-12 August, 2003	K.L. Sharma U.K.Mandal	Annual review meeting on "Assessment and improvement of soil quality and resilience for rainfed production system"	BCKVV, Kalyani
6-7 September, 2003	G.R.Rao	A consultative workshop on scientific strategies for production of non-edible oils for use as biofuels	I.I.Sc., Bangalore
11-12 September, 2003	G.R.Rao	Implementation of Network Project on Tree Borne Oilseeds	NOVOD, Gurgaon

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Period	Name of the Scientist	Conferences / Meetings / Workshops / Symposia	Venue
14-16 September, 2003	V.M. Mayande	Engineers' Day Celebration	ANGRAU, Bapatla
29-30 September, 2003	K.V.Subrahmanyam	PME Cell Workshop	NCAP, New Delhi
3 October, 2003	A.K.Mishra	Fodder and stover quality	NRCS, Hyderabad
9- 11 October, 2003	Kausalya Ramachandran	Agricultural sustainability through land use planning for rainfed regions in India	NISNET, Hyderabad
9- 11 October, 2003	Kausalya Ramachandran	Interlinking of rivers	NISNET, Hyderabad
8 November, 2003	P. K. Mishra M. Osman	Social Regulation of Water Management	CWS, Hyderabad
7-9 November, 2003	A.K.Mishra J.V.N.S. Prasad	National symposium on Agroforestry and sustainable production and silver jubilee of agro forestry initiative in India	IGFRI, Jhansi
8-10 November, 2003	N. N. Nimbole	National Seminar on Biodiversity, Conservation and Commercial Exploitation of Medicinal Plants	Osmania University, Hyderabad
12-14 November 2003	K.V.Subrahmanyam P. K. Mishra M. Osman D.B.V.Ramana K.Srinivas	Process Documentation	BIRD-K, Tiptur
30 November - 5 December, 2003	V.M. Mayande	KISAN 2003-Agri Exhibition	College of Agriculture, Pune
6 December, 2003	P. K. Mishra K.V. Rao	Andhra Pradesh Water Vision- Follow up Capacity Building	APARD, Hyderabad
12 December, 2003	G.R.Rao	Network Project on Tree Borne Oilseeds to be taken up by ICAR	NBPGR, New Delhi
13-14 December, 2003	N.Babjee Rao	National Seminar on Extension Strategy for Efficient Irrigation Water Management and Water Conservation	Rahuri
17-20 December, 2003	G. R. Korwar	Asia-Pacific Regional Agroforestry Workshop	Bangalore
17-20 December, 2003	Y.S.Ramakrishna J.V.Rao	Regional Agroforestry workshop (UNCCD)	Bangalore
15-18 January, 2004	V.M. Mayande	38 th ISAE Convention	Dapoli
21-22 January, 2004	P. K. Mishra K.V.Rao	Andhra Pradesh Water Vision - Follow-up	Water Conserva- tion Mission, Hyderabad

Period	Name of the Scientist	Conferences / Meetings / Workshops / Symposia	Venue
14-18 February, 2004	K.V. Subrahmanyam A.K. Mishra D.B.V. Ramana	Mid Term Review Workshop of DFID-NRSP project R8192	CRIDA
27-29 February, 2004	G. R. Korwar	National Seminar on "Research and Development in Production, Protection, Quality, Processing and Marketing of Medicinal and Aromatic Plants	HAU, Hisar
4 March, 2004	A. K. Mishra	Workshop on Enhancing livelihood of poor livestock keepers through increasing use of fodder	ICRISAT, Hyderabad
6-7 March 2004	U. K. Mandal	Drainage and water management for control of salinity and water logging in irrigated agricultural lands	ANGRAU, Rajendranagar
28 March, 2004	Pukhraj Singh	Vanilla Cultivation	Hyderabad
29 March, 2004	Pukhraj Singh A.Sambraiyam A.Vidyadhari	Workshop on Medicinal Plants	Secunderabad

14 Workshops, Seminars, Summer Institutes, Farmers' Day etc., organised by the Institute

14.1 Workshop, Seminars, Summer Institutes, Farmers' Day

Programme	Period	Venue
CRIDA Foundation Day : Open house discursion on Improved Rainfed Technology for Betterment of Farm Community	26 April, 2003	CRIDA, Hyderabad
Summer School on 'Drought Management'	6-26 May, 2003	CRIDA, Hyderabad
Farmers Day	6 September, 2003	GRF, CRIDA
Winter School on "Wasteland Development in Rainfed Areas"	1-30 September, 2003	CRIDA, Hyderabad
World Food Day	16 October, 2003	Pochamma Thanda, R.R.District
Women in Agriculture Day	4 December, 2003	Saireddyguda, R.R.District
Workshop of KVK's, DATTCs on formation of TT clubs in collaboration with NABARD	29-30 December, 2003	CRIDA, Hyderabad
Meeting of KVK with line departments and NGO's working in R.R.dist.	17 January, 2004	CRIDA, Hyderabad
National Science Day	27-28 February, 2004	CRIDA& KVK, HRF, Hyderabad
International Women's Day	8 March, 2004	CRIDA, Hyderabad



14.2 Farmers' Day

Farmers' Day was organized on 6 September, 2003 at GRF. About 1800 farmers from the surrounding districts visited the farm. On this occasion, not only did they have an opportunity to see for themselves

the benefits of the new technologies, they also had a face-to-face interaction with the scientists of the institute for discussing problems encountered by them. They also had an opportunity to meet representative of various farm input suppliers.



Farmers' Day celebration

14.3 National Science Day

The National Science Day was celebrated at CRDIA on 27 February, 2004. On this event a Press Meet was conducted to highlight the achievements of the Institute. A quiz competition on this year's theme "Creating Scientific Awareness in the Community" was conducted in which children from 10 schools participated. Certificates and prizes were awarded to the winners. A separate function was held at KVK, Hayathnagar Research Farm on 28 February for the school children of Ranga Reddy District.



Science Day

14.4 CRIDA Foundation Day

The Institute's 19th Foundation Day was celebrated on 26 April, 2003. Shri Vadde Shobhanadreeswara Rao, Hon'ble Minister for Agriculture, Govt. of A.P. was the Chief Guest, and Dr. Venugopala Chari, Hon'ble Member of Parliament

and Chairman, Central Assurance Committee was the Guest of Honour. Delivering his Foundation Day lecture, Hon'ble Minister had lot of praise for CRIDA and hoped that its continued efforts would raise the productivity levels of rainfed crops.



Foundation Day celebration

14.5 Hindi Day / Fortnight

During the Hindi fortnight in September 2003, several competitions like Hindi-English Technical Terminology, Hindi Noting and Drafting, Essay Writing in Hindi for Hindi speaking and non-Hindi speaking employees, Hindi Typing etc. were organized and prizes were distributed among the winners by the Chief Guest of the function. Hindi Day valedictory function was organized on 15 September, 2003. A Hindi Workshop was also organized during the month of December, 2003 for the administrative and technical staff to overcome their hesitation while working in Hindi.



Hindi Day celebration

15 Distinguished Visitors

15.1 Individual

1. Dr. M.S.Swaminathan, MSSRF, Chennai
2. Dr. B.S.Dhillon, Director, NBPGR, New Delhi
3. Dr. A.K.Singh, NBPGR, New Delhi
4. Dr. Zhangyingevi, Yunnan Academy of Agricultural Sciences, China
5. Dr. Yin Dixin, Guizhon Academy of Agricultural Science, China
6. Dr. Chin Ong, ICRAF, Nairobi, Kenya
7. Dr. Torshar Anderson, ICRAF, Nairobi, Kenya
8. Dr. Aichikitaizi, ICRAF, Nairobi, Kenya
9. Dr. Charles Mutawaba, ICRAF, Nairobi, Kenya
10. Dr. Mary R.Mgema, ICRAF, Nairobi, Kenya
11. Dr. Basheer Jama, ICRAF, Nairobi, Kenya
12. Dr. Enyew, Amhar, RRI, Ethiopia
13. Dr. Paulos Shaga Dubale, Director, Soil and Water Management Research, Ethiopia
14. Dr. Antony Esilaba, Kenyan Agricultural Research Institute, Kenya
15. Dr. Shama Elamin Babbiker Dawelbait, Head, Water Management Research, Sudan



Dr. Swaminathan visits CRIDA

16. Prof. Nuhu Hemed Hatibu, Professor of Soil and Water Management, Tanzania
17. Dr. S.M.Ocampo Jr. President, M.M.State University, Philippines
18. Dr. C.Baljit Singh, Project Management Specialist, USAID
19. Dr. Jim Verdin, Unites States Geological Service, USA
20. Dr. Kelly Sponberg, National Oceanic and Atmospheric Administration, USA
21. Dr. William C. Medrano, Director, Bureau of Agriculture, Govt. of Philippines
22. Dr. Daisuke Iijima, JICA, Tokyo, Japan
23. Dr. Mitsuo Yoshida, JICA, Tokyo, Japan
24. Mr. Tomoyuki Nakano, Embassy of Japan.
25. Dr. Enyew Adgo, Director, Natural Resource Management Research, Ethiopia.

15.2 Group

1. Twelve member delegation from World Agroforestry Centre, ICRAF, Nairobi, Kenya
2. Fifteen member delegation from AMAREW Project, Ethiopia (6 day study visit)



A delegation from ICRAF, Nairobi



A delegation from Ethiopia on a field visit

3. Agriculture Development Coordinators, ITDA, Uttoor, Adilabad
4. Training officers, SBIRD, Hyderabad
5. Scientists from C.S.W.R & T.I., Kota
6. Scientists from C.S.W.R & T.I., Bellary
7. Training participants, DOR, Hyderabad
8. Watershed Committee members, Jharkhand
9. Forest Department Trainees, Govt. of A.P.
7. Farmers from Karnataka Agricultural Department
8. Women farmers from ANTWA, Kadapa
9. Farmers from F.T.C., Chittoor
10. KVK trainee farmers, Nalgonda
11. Women farmers under UNDP Samithi

15.3 Farmer

1. Women farmers, APMSS, Hyderabad
2. Progressive farmers, PEACE, Medak
3. Women farmers, YFA, Hyderabad
4. Progressive farmers, Shimla, H.P.
5. Women farmers, Farmers Training Center, Suryapet, Nalgonda
6. Rythu mitra group farmers, Dhanwada mandal, Mahabubnagar

15.4 Student

1. ARS Probationers, NAARM, Hyderabad
2. Agriculture and Polytechnique students, A.R.S., Maruteru.
3. ANGRAU Poly Technic College, Palem
4. Kerala Agricultural University
5. UAS, Bangalore
6. Tamil Nadu Agricultural University, Coimbatore
7. ANGRAU, Bapatla
8. Pandit Jawaharlal College of Agriculture, T.N.
9. Adiparasakti College, Kavali, T.N
10. St. Patricks High School, Hyderabad

16 Personnel

(As on March 31, 2004)

Dr. H.P.Singh

Dr. Y.S.Ramakrishna

Sri Ashish Roy

Sri B.Pandu Reddy

Sri R.K.Shukla

Sri V.Govardhan

Sri S.R.Yadav

Sri K.Chandrasekhar

Director (upto 31.5.2003)

Director (since 1.6.2003)

Senior Administrative Officer

Finance and Accounts Officer

Asst. Administrative Officer

Asst. Administrative Officer

Asst. Director (OL)

Public Relations Officer

Division of Resource Management

Dr. K.D.Sharma

Dr. G.R.Korwar

Dr. G.Shastry

Dr. U.S.Victor

Shri. N.N.Srivastava

Shri N.N.Nimbole

Dr. P.K.Mishra

Er. C.R.Thyagaraj

Dr. V.M.Mayande

Dr. Md. Osman

Dr. Kausalya Ramachandran

Dr. K.L.Sharma

Dr. G.Rajeswar Rao

Dr. Ch. Srinivasa Rao

Dr. G.Pratibha

Dr. K.Srinivas

Dr. K.V.Rao

Er. I.Srinivas

Dr. B.Sanjeeva Reddy

Dr. U.K.Mandal

Dr. J.V.N.S.Prasad

Er. Ravikanth V. Adake

Dr. V.Ramesh

**Principal Scientist (S&WCE) & I/c Head
(upto 30 September, 2003)**

**Principal Scientist (Agronomy) & Head I/c
(Since 14 October, 2003)**

Principal Scientist (S&WCE)

Principal Scientist (Ag. Meteorology)

Principal Scientist (Ag. Meteorology)

Principal Scientist (Agronomy)

Principal Scientist (S&WCE)

Principal Scientist (FM&P)

Principal Scientist (FM&P)

Senior Scientist (Agronomy)

Senior Scientist (Geography)

Senior Scientist (Soil Science)

Senior Scientist (Forestry)

Senior Scientist (Soil Science)

Senior Scientist (Agronomy)

Scientist (Sr. Scale) (Soil Science)

Scientist (Sr. Scale) (S&WCE)

Scientist (Sr. Scale) (FM&P)

Scientist (Sr. Scale) (FM&P)

Scientist (Sr. Scale) (Soil Physics)

Scientist (Sr. Scale) (Agronomy)

Scientist (FM&P)

Scientist (Soil Physics)

Division of Crop Sciences

Dr. G.Subba Reddy

Dr. J.V.Rao
Dr. B.Venkateswarlu
Dr. P.Raghuram Reddy
Shri N.D.Das
Dr. V.S.Rao
Dr. Y.G.Prasad
Dr. N.N.Reddy
Dr. M.Maheswari
Dr. S.K.Yadav
Dr. M.Vanaja
Dr. B.M.K.Reddy
Dr. S.S.Balloli
Dr. M.Srinivas Rao
Dr. V.Maruthi
Dr. S.Venkateswarlu
Dr. G.Jayaram Reddy
Dr. M.Prabhakar
Dr. N.Jyothi Lakshmi

Principal Scientist & I/c. Head

Principal Scientist (Agronomy)
Principal Scientist (Microbiology)
Principal Scientist (Plant Breeding)
Principal Scientist (Plant Pathology)
Principal Scientist (Horticulture)
Senior Scientist (Entomology)
Senior Scientist (Horticulture)
Senior Scientist (Plant Physiology)
Senior Scientist (Biochemistry)
Senior Scientist (Plant Physiology)
Senior Scientist (Agronomy)
Senior Scientist (Soil Science)
Senior Scientist (Entomology)
Senior Scientist (Agronomy)
Senior Scientist (Agronomy)
Scientist (Sr. Scale) (Agronomy)
Scientist (Sr. Scale) (Entomology)
Scientist (Sr. Scale) (Plant Physiology)

Section of Design and Analysis

Dr. Y.V.R.Reddy

Dr. M.S.Prasad
Dr. C.A.Rama Rao
Dr. G.Nirmala

Principal Scientist (Ag. Economics) & Head

Principal Scientist (Ag. Extension) & OIC, KVK
Senior Scientist (Ag. Economics)
Scientist (Sr. Scale) (Ag. Extension)

Section of Transfer of Technology

Dr. K.V.Subrahmanyam

Sri M.V.Padmanabhan
Dr. A.K.Mishra
Sri N.Babjee Rao
Sri K.Ravi Shankar
Dr. K.Nagasree
Smt. Sreedevi Shankar
Dr. D.B.V.Ramana

Principal Scientist (Ag. Economics) & Head

Principal Scientist (SWCE)
Senior Scientist (LP&M)
Scientist (Ag. Extension)
Scientist (Ag. Extension)
Scientist (Ag. Extension)
Scientist (Food & Nutrition)
Scientist (LP& M)

All India Coordinated Research Project for Dryland Agriculture

Dr. K.P.R.Vittal

Dr. G.R.Maruthi Sankar

Dr. G.Ravindra Chary

Project Coordinator

Principal Scientist (Ag. Statistics)

Scientist Sr. Scale (Agronomy)

All India Coordinated Research Project on Agrometeorology

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Project Coordinator (Officiating)

Principal Scientist (Ag. Meteorology)

Senior Scientist (Ag. Meteorology)

Research Coordination and Management Unit

Dr. I.A.Khan

Dr. Sreenath Dixit

Principal Scientist (Genetics)

Senior Scientist (Ag. Extension)

17 Infrastructure Development

17.1 CRIDA Campus

- Horticulture and Entomology labs were renovated
- Agroforestry laboratory was developed
- Dryland gallery / museum was renovated

17.2 HRF

- Overall developmental (16 ha) and fencing work in Phase-III (1600 m)
- Two percolation tanks in Phase-III (600 and 1000 m³) and one in Phase-II (96 m³)
- Temporary boundary wall (700 m)

17.3 GRF

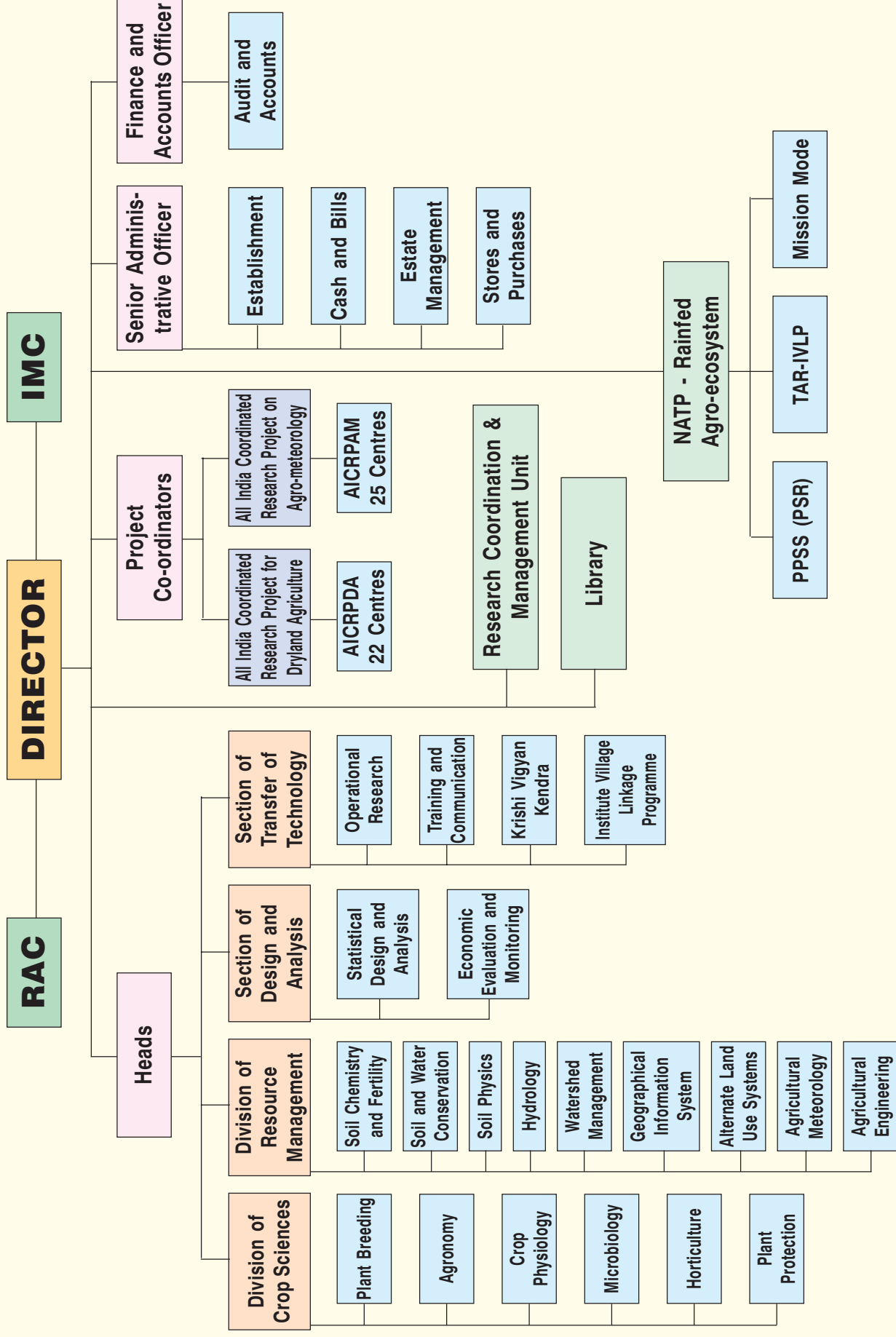
- Renovation of three staff quarters (GRF)

Acronyms

ACIAR	Australian Center for International Agricultural Research
AICRPAM	All India Coordinated Research Project on Agrometeorology
AICRPDA	All India Coordinated Research Project for Dryland Agriculture
ANGRAU	Acharya N.G.Ranga Agricultural University
AP-NL	Andhra Pradesh-Netherlands
AU	Andhra University
CAZRI	Central Arid Zone Research Institute
CCPI	Cooperating Center Principal Investigator
CIAE	Central Institute of Agricultural Engineering
CICR	Central Institute for Cotton Research
cm	Centimeter
CoPI	Co-Principal Investigator
CRRRI	Central Rice Research Institute
CTRI	Central Tobacco Research Institute
cv	Cultivar
DAS	Days after sowing
DFID	Department For International Development
DOR	Directorate of Oilseeds Research
DRR	Directorate of Rice Research
DST	Department of Science and Technology
FAO	Food and Agriculture Organization
FYM	Farm yard manure
g	Gram
GRF	Gunegal Research Farm
h	Hour
ha	Hectare
HRF	Hayathnagar Research Farm
HQ	Headquarters
IARI	Indian Agricultural Research Institute
IASRI	Indian Agricultural Statistics Research Institute
ICAR	Indian Council of Agricultural Research
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IIHR	Indian Institute of Horticultural Research
IISS	Indian Institute of Soil Science
IIT	Indian Institute of Technology
IMC	Institute Management Committee
IPE	Institute of Public Enterprise

IVLP	Institute Village Linkage Programme
JNTU	Jawaharlal Nehru Technological University
kg	Kilogram
KVK	Krishi Vigyan Kendra
LAE	Land area equivalent
LAI	Leaf area index
LER	Land equivalent ratio
LGP	Length of growing period
m	Meter
MANAGE	National Institute of Agricultural Extension Management
mm	Millimeter
MPUAT	Maharana Pratap University of Agriculture and Technology
NAARM	National Academy of Agricultural Research Management
NATP	National Agricultural Technology Project
NBAIM	National Bureau of Agriculturally Important Microorganisms
NBSS&LUP	National Bureau of Soil Survey and Land Use Planning
NCMRWF	National Center for Medium Range Weather Forecasting
NGO	Non-governmental Organisation
NIANP	National Institute for Animal Nutrition and Physiology
NRCS	National Research Center for Sorghum
NRM	Natural Resource Management
NRSA	National Remote Sensing Agency
NWDPRA	National Watershed Development Program for Rainfed Areas
OU	Osmania University
PDBC	Project Directorate on Biological Control
PI	Principal Investigator
PMC	Project Management Committee
RAC	Research Advisory Committee
RH	Relative humidity
Rs	Rupees
RUE	Radiation use efficiency
SAP	Scientific Advisory Panel
SAU	State Agricultural University
SMW	Standard Meteorological Week
SRC	Scientific Research Council
t	Tonne (1000 kg.)
TAR	Technology Assessment and Refinement
TNAU	Tamil Nadu Agricultural University
TTC	Trainers' Training Center
UAS(B)	University of Agricultural Sciences, Bangalore
UAS(D)	University of Agricultural Sciences, Dharwad

CRIDA - ORGANISATIONAL CHART





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