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ICAR RCER

वार्षिक प्रतिवेदन
Annual Report
2009 - 2010

पूर्वी क्षेत्र के लिए भारतीय कृषि अनुसंधान परिषद् का अनुसंधान परिसर

आई॰ सी॰ ए॰ आर॰ परिसर, पोस्ट-बिहार वैटनरी कॉलेज, पटना-800 014 (बिहार)

ICAR RESEARCH COMPLEX FOR EASTERN REGION

ICAR PARISAR, P.O. - BIHAR VETERINARY COLLEGE, PATNA-800 014 (BIHAR)

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PATNA - 800 014 (BIHAR)

Preface

It gives me immense pleasure to bring out the ninth Annual Report of ICAR Research Complex for Eastern Region, Patna. This report contains the research, extension, and training activities of the Complex during the period 2009-10. The institute is mandated to undertake multi-commodity and multi-disciplinary research for management of natural resources to enhance productivity of agricultural production system.

During the reported period, the research, extension and agricultural development activities continued to gain momentum. Under natural resource appraisal and inventorization, the soil quality and land use pattern was assessed among the major land use systems in Bihar. To strengthen the plant genetic resource management, improved lines of solanaceous vegetables, cucurbits and legumes were identified and maintained. Among mango based multi-tier cropping system, maximum paddy equivalent yield (8.61 t/ha) was recorded in case of Mango + Guava + Paddy during the 11th year. In case of rejuvenated mango plants of cv. Amrapali, maximum yield (61.79 kg/ plant) was recorded with rejuvenation pruning at 2.0 m height. Under ultra high density orchard in guava, pruning three times a year with irrigation (60% PE), application of recommended dose of nutrients, soil application of 2 kg FYM, 50 g Trichoderma, 50 g Azotobacter, 50 g Mycorhizae, 0.1% foliar Zn application and 0.3% boric acid resulted in maximum gross income. The characterization and classification of ground water quality of Patna district showed that arsenic content increased with depth. Spatial thematic maps were also developed for arsenic and iron distribution in the area. Increased yield of cucumber has been observed with subsurface placement of laterals for drip irrigation and fertigation. Advancement in sowing date has resulted in higher yield of rice during the simulation of adaptation strategy for future climate change scenario. The adaptive research on mono and poly culture of scampi has paved the way for its farming beyond December. Makhana bran was effectively incorporated in the diet of poultry broiler without affecting growth and feed conversion efficiency. ELISA procedures were standardized for diagnosis of Brucellosis and IBR in dairy cattle and PPR and blue tongue in goat and sheep, respectively. Assessment of livestock water productivity has been initiated in Indo-Gangetic plains with a baseline survey regarding resource availability, cropping pattern, livestock population and production. Under the outreach programme of the Complex, scientists visited farmer's fields at Gumla, Khunti, Latehar, Chatra and Hazaribagh districts of Jharkhand; Vaishali, and Patna districts of Bihar and Keonjhar districts of Orissa to provide technical support with regard to agri-horticultural and fisheries interventions. Twelve cropping systems were introduced in NAIP cluster at Vaishali district resulting in increased cropping intensity from 200-300 percent. In all 2868 SHGs have been formed in 11 districts of 3 states under Research in Use programme.

The Complex organized twenty farmers' training programmes under the project "Scaling up of water productivity in Agriculture for improved livelihood" across districts of Bihar. Besides several group meetings, farmer-scientists interaction and meets were organized in different parts of Bihar and Jharkhand. Models of multiple use of water and IFS, developed by the institute to enhance water productivity and farmers' income were demonstrated to farmers. An ICAR sponsored Winter School on 'RCTs for enhancing productivity and sustainability' was also organized at the Institute.

During the year various infrastructural facilities were created. Modernization of existing laboratories with modular furniture and advance new equipment was successfully completed making them high-tech. A high-tech shade net of size 2000 m^2 was also created at Central Research (CR) farm. Besides, four fish ponds for conducting fish culture were constructed.

I am highly grateful to Dr. Mangala Rai, Ex-Secretary, DARE and Ex-Director General, ICAR and Dr. S. Ayyappan present Secretary, DARE and DG, ICAR for their continued keen interest, guidance and support. I am thankful to Dr. A. K. Singh, DDG (NRM) for his constant encouragement, valuable guidance and support at every stage of the research and development activities of the Complex. Thanks are also due to ADG (Agronomy), ICAR for his support and co-operation from time to time. All Heads of the Divisions/ Research Centres deserve appreciation for their co-operation and furnishing the material for the report. The undersigned acknowledges the support of his colleagues in creating a favorable and healthy working environment at the complex. The efforts of Dr. R.D. Singh, Head, RCMS, Dr T. K. Srivastava, PS and editorial board members namely, Dr. N. Chandra, Dr. A. Dey, Dr. A. Islam, Dr. R. Elanchezhian, Dr. A. Rahaman, Dr. (Mrs.) Shivani, and Dr. Bikash Das and secretarial assistance by Mr. Kishan Singh and Mrs. Anima Prabha in bringing out the report are highly appreciated.

(M.A.Khan)
Director

Dated: July, 2010

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सारांश - 2009-10

प्रसंग 1 : संसाधन मूल्यांकन तथा सूचीकरण

- बिहार के समस्तीपुर में, अधिकांश वर्षों के दौरान प्रसामान्य अंतर वनस्पति सूचकांक (एन.डी.वी.आई.) खरीफ की तुलना में रबी ऋतु में अधिकतम पाया गया।
- मधेपुरा (द्वितीय अंचल), सबौर (अंचल तृतीय क) तथा पटना (अंचल तृतीय ख) में, वार्षिक वर्षा की रूपरेखा के विश्लेषण से इसमें वृद्धि की प्रवृत्ति पायी गयी। वार्षिक वर्षा में वृद्धि सबौर में अधिकतम तथा पटना में न्यूनतम पायी गयी ।
- दक्षिण बिहार की मिट्टियों की गुणवत्ता एवं भू–उपयोग मूल्यांकन से पता चलता है कि यहाँ मुख्यतः छः भूमि उपयोग पद्धतियाँ (धान–गेहूँ, मक्का– आलू, अरहर, ईख, आम के बगीचे तथा कृषि–वानिकी) हैं। मिट्टी का संहनन धान–गेहूँ पद्धति में अधिक पाया गया । मिट्टी में जैविक कार्बन का भंडार आम के बगीचों में सर्वाधिक तथा इसके बाद कृषि–वानिकी की मिट्टी में पाया गया जबकि ईख की खेती वाली मिट्टी में कार्बन का भण्डार सबसे कम पाया गया।

प्रसंग 2 : पौध संसाधन प्रबंधन तथा प्रक्षेत्र, बागवानी एवं जलीय फसलों का सुधार

- बिहार के मुंगेर जिले से आम के जीनरूप "लोहा जंग" का संग्रह किया गया। आम के एक सौ सत्रह निरूपित जीनरूपों में से आम के प्रभेद हिमसागर को उपजशील पाया गया । लीची के जीनरूप देशी को फलों की गुणवत्ता तथा उत्पादन हेतु होनहार पाया गया। अमरूद के जीनरूपों में 'इलाहाबाद सफेदा' तथा 'सरदार' उत्तम पाये गये जबकि सपोटा में जीनरूप 'मुरब्बा' उत्तम पाया गया।
- सब्जी की विविध फसलों में, बैंगन, टमाटर, मिर्ची, धनिया, परवल, खीरा, लौकी, कद्दू, झींगी, नेनुआ, राजमा, लोबिया, चौलाई, बोरो, सब्जी के लिए सोयाबीन, स्वोर्ड बीन, जैक बीन, विंग्ड बीन, लाइमा बीन, मृदु सेम, याम बीन, ग्वार, कुन्दरू, तथा चठैल के उन्नत प्रभेदों की पहचान की गयी।

प्रसंग 3 : प्रक्षेत्र, बागवानी तथा जलीय फसलों के लिए उन्नत उत्पादन तकनीक

- आम आधारित बहुस्तरीय फसल पद्धति में धान के समतुल्य अधिकतम उपज (8.6 टन/हे.) ग्यारहवें वर्ष में, आम–अमरूद–धान से प्राप्त हुई।
- आम्रपाली आम के पुनर्नवीकृत पेड़ों में, 61.79 किग्रा./पेड़ का अधिकतम उत्पादन उन पेड़ों से प्राप्त हुआ जिनमें 2 मीटर की ऊँचाई पर छँटाई की गयी तथा छँटाई उपरांत विकसित प्राथमिक एवं द्वितीयक शाखाओं की लंबाई को अनियंत्रित रखा गया।
- परवल का अधिकतम संचयी उत्पादन, 50 सेमी. के अंतःपंक्ति अंतराल तथा 160 किग्रा./हे. की दर से नत्रजन डालने से प्राप्त हुआ।
- सब्जी आधारित विभिन्न सस्यक्रमों में धान के समतुल्य अधिकतम उपज (1168.90 क्विंटल/हे.) लोबिया–भिण्डी–मटर क्रम के साथ प्राप्त हुई।
- अमरूद के अति–उच्च सघन बगीचे में, वर्ष में तीन बार (मार्च, मई, तथा अक्तूबर) छँटाई 60 प्रतिशत पी.ई. (पैन वाष्पीकरण) की सिंचाई + पोषक तत्वों की शत–प्रतिशत अनुशंसित मात्रा ± मिट्टी में 2 किग्रा. गोबर की खाद + 50ग्राम ट्राइकोडर्मा + एजोटोबैक्टर + 50ग्राम माइकोराइजा + जिंक सल्फेट (0.1 प्रतिशत) तथा बोरिक अम्ल (0.3 प्रतिशत) के पर्णीय अनुप्रयोग के फलस्वरूप रु.5.56 लाख/हे. की अधिकतम सकल आय प्राप्त हुई।
- एक किग्रा. प्लूरोटिड फलोरिडा मशरूम के उत्पादन हेत 4.16 से 5 लीटर तक जल की आवश्यकता पड़ती है जबकि एक किग्रा. नीले ऑइस्टर मशरूम (एच. अल्मेरियस) के उत्पादन में 4.16 से 5.5 लीटर पानी लगता है।

- धान–मसूर सस्यक्रम में पोषक प्रबंधन से ज्ञात हुआ कि 40 किग्रा. गंधक डालने से मसूर की पैदावार अधिकतम (963.8 किग्रा./हे.) रही जबकि धान की पैदावार बिना गंधक के न्यूनतम (6080 किग्रा./हे) तथा 6 किग्रा. जिंक के प्रयोग से अधिकतम (6602 किग्रा./हे.) हुई।
- धान के सत्यम प्रभेद में सितम्बर के प्रथम सप्ताह में गंधी कीट की संख्या ई.टी.एल. से ऊपर (2.7 कीट/हिल) दर्ज की गयी।
- खीरा वर्ग की फसलों में डाउनी मिल्ड्यू रोग की महामारी पर किए गए अध्ययन के अंतर्गत करेले एवं झींगी में बुआई के 37 दिनों बाद 13वें पत्ते पर इसका सर्वाधिक प्रकोप पाया गया।

प्रसंग 4 : समेकित भूमि एवं जल प्रबंधन

- किसानों को समेकित कृषि के घटकों के चयन में सहायता करने हेतु एक 'निर्णय सहायक टूल' (डी.एस.टी.) का विकास तीन सूचकों यथा लाभ–लागत अनुपात, भूमि उत्पादकता तथा जल उत्पादकता को ध्यान में रखकर किया गया।
- परीक्षण अध्ययन में देखा गया कि रानी तालाब एवं बिक्रम गेट से पर्याप्त जल की समान मात्रा में आपूर्त्ति ग्यारह सप्ताह (23वें से 32वें तक तथा 33वाँ सप्ताह) तक केवल तीन वितरणियों (आदमपुर, आर.पी.चैनल–पाँच तथा रेवा वितरणी) में की जा सकती है जबकि शेष बचे सप्ताह में आपूर्त्ति–माँग का अनुपात 0.7 से 0.2 के बीच रहता है। यदि रानीतालाब गेट में डिजाइन विमुक्ति की जाती है तो जल 15 सप्ताह (23वें से 37वें तक) तक समान एवं पर्याप्त रूप से छोड़ा जा सकता है तथा शेष अवधि में आपूर्त्ति–माँग का अनुपात 0.9 से 0.7 के बीच रहता है।
- पटना जिले के मनेर प्रखण्ड में भूजल के निरूपण एवं वर्गीकरण से पता चलता है कि गहरायी बढ़ने के साथ आर्सेनिक के स्तर में 1.65 से 2 पी.पी.एम की वृद्धि हुई तथा सब्जी एवं अनाज की फसलों में 2 से 5 पी.पी.एम.तक आर्सेनिक संचित हुआ। इस क्षेत्र में आर्सेनिक एवं लौह के वितरण के स्थानिक थीमैटिक नक्शे भी बनाये गये।
- द्वितीयक जलाशय अथवा नलकूप से सिंचाई के अंतर्गत विभिन्न सस्यक्रमों की जलोत्पादकता के अध्ययन के अनुसार अधिकतम जलोत्पादकता रु. 7.48/मी^{3} धान–आलू–प्याज में पायी गयी तथा इसके बाद धान–बंदगोभी–लोबिया (रु. 6.45/मी^{3}) तथा धान–गेहूँ–मूंग (रु. 6.07/मी^{3}) में पायी गयी।
- बहुआयामी जल उपयोग के अंतर्गत, कालान्तरित जल–गुणवत्ता के मूल्यांकन से पता चला कि ऑक्सीजन संतृप्तता एवं ताप में विपरीत सम्बंध है। अगस्त से फरवरी माह के दौरान जलाशयों में नाइट्रेट, फॉस्फेट एवं पोटाशियम की सान्द्रता क्रमशः 0.1–0.7, 0.04–0.6, तथा 2.5–4.0 पी.पी.एम के बीच पायी गयी।
- आई.एच.ए.सी.आर.ई.एस. मॉडल के क्षमता–निर्धारण तथा प्रामाणिकीकरण से पता चला कि यह मॉडल ब्राह्मणी बेसिन के सभी चार जलग्रहण क्षेत्रों में अच्छा काम करता है।
- विभिन्न बहुभुज लघु–फुहारे वाली नोजलों की तुलना में अष्टभुज प्रोटोटाइप सर्वाधिक उपयुक्त पाया गया तथा यह 1.0 किग्रा./सेमी^{2} दाब पर चल सकता है एवं अच्छी दूरी तक गोलाई में पानी का छिड़काव कर सकता है।
- गुरूत्व सतही टपक सिंचाई तथा फर्टिगेशन अनुप्रयोग से पता चला कि पार्श्व नलिकाओं को सतह के नीचे व्यवस्थित करने से खीरा–ककड़ी की उपज में वृद्धि हुई।
- धान के लिए अनुकूलन रणनीति के परीक्षण से पता चला कि वर्तमान बुआई तिथि की तुलना में यदि किसान 7 दिन तथा 14 दिनों पूर्व बुआई करें तो भविष्य में अनुमानित उपज ह्रास में कमी आएगी। गेहूँ में 14 दिन पूर्व की तुलना में 7 दिन पूर्व की बुआई के साथ अधिक मात्रा में नत्रजन डालने से अधिक लाभ हुआ। पिछात गेहूँ मे समयोचित गेहूँ की अपेक्षा समयपूर्व बुआई का अच्छा प्रभाव देखा गया।

- हैड सी.एम.3 के प्रयोग से प्राप्त वर्षा एवं तापमान में परिवर्तन के पूर्वानुमानों से प्राप्त परिणामों से 2ए एवं बी 2ए दोनों परिदृश्यों के अंतर्गत वार्षिक धाराप्रवाह में वर्ष 2020 के दौरान वृद्धि तथा वर्ष 2050 के दौरान कमी का संकेत मिला है। परीक्षण परिणामों से, मानसून ऋतु में भी धारा प्रवाह में कमी तथा मानसूनपूर्व ऋतु में वृद्धि का संकेत मिला।
- हरित खाद फसल (सिस्बानिया), गोबर की खाद तथा पिछली फसल के अवशेष को मिट्टी मे मिलाने से मृदा सूक्ष्मजीव बायोमास कार्बन तथा मौजूद नत्रजन में वृद्धि हुई तथा धान की उपज बढ़ी।

प्रसंग 5 : पशुधन एवं मात्स्यिकी सुधार तथा प्रबंधन

- स्कैम्पी (एम.रोजेनबर्गाई) की एकल तथा बहुप्रजातीय पालन पर किए गए शोध के परिणामस्वरूप दिसम्बर के बाद भी इसकी खेती का मार्ग प्रशस्त हुआ। बिहार के मौसमी जलजमाव वाले क्षेत्रों में स्कैम्पी (झींगा) के पालन के नवीन प्रयास से यहाँ के कृषक एवं उद्यमियों को काफी लाभ पहुँचेगा। तालाबों में एकल मत्स्यपालन तंत्र के अंतर्गत जयंती रोहू (एल. जयंती) के पालन के परीक्षणों में इसकी वृद्धि रोहू (एल. रोहिता) से स्पष्टतः अधिक देखी गयी।
- शुरूआती अध्ययन से पता चला कि मखाना की भूसी को ब्रॉयलर कुक्कुट के आहार में 6 प्रतिशत के स्तर तक मिलाने से उनकी वृद्धि एवं खुराक पर कोई कुप्रभाव नहीं पड़ता। चावल की भूसी की 50 प्रतिशत मात्रा तक मखाने की भूसी मिलाकर खिलाने पर सूखा चारा खुराक तथा पाचन में कोई विशेष परिवर्तन नहीं देखा गया।
- बकरी की ब्लैक बंगाल प्रजाति ब्याँत के प्रतिशत के मामले में विख्यात है। सर्वेक्षण में पाया गया कि तृतीय प्रसव से जुड़वाँ एवं त्रियुग्मित बच्चों का प्रतिशत 85 रहा।
- दुधारू पशुओं में ब्रुसेलोसिस तथा आई.बी.आर तथा बकरी एवं भेड़ में क्रमशः पी.पी.आर. तथा ब्लू टंग रोगों का पता लगाने हेतु एलीसा विधियों को मानकीकृत किया गया।
- गहन दुग्धशाला आधारित उत्पादन में एक एकड़ के मॉडल में 40 प्रतिशत क्षेत्र चारा उत्पादन के लिए सुरक्षित रखकर, चार संकर गायों को जोड़ा जा सकता है। संकर गायों से 2200 किग्रा. दुग्ध उत्पादन होता है।
- भारत के गांगेय मैदानों में पशुधन जल उत्पादकता का निर्धारण प्रारम्भ किया। संसाधन उपलब्धता, सस्यक्रम, पशुधन संख्या तथा उत्पादन पर एक आधारभूत सर्वेक्षण किया गया तथा सभी गाँवों में फसल–पशुधन–जल सम्बंध में विभिन्न संस्थाओं की भूमिका का अध्ययन किया गया।

प्रसंग 6 : विभिन्न पारिस्थितिक तंत्रों के लिए आवश्यकता आधारित कृषि प्रणाली मॉडलों का विकास

- फसल तंत्रो में अधिकतम उत्पादन (40.49 टन/हे.) धान–टमाटर–लौकी में तथा इसके बाद धान–आलू–प्याज (33.45 टन/हे.) तथा धान–गाजर– लोबिया (21.91 टन./हे.), धान–धनिया–भिण्डी (19.73 टन/हे.) एवं धान–सरसों–टमाटर (10.84 टन/हे.) में पाया गया। सिंचाई के स्तरों में अधिकतम समतुल्य उपज (26.09 टन/हे.) अनुशंसित स्तर पर तथा इसके बाद उर्वरक के अनुशंसित स्तर के 50 प्रतिशत के स्तर पर प्राप्त हुआ तथा 6.58 प्रतिशत तक की वृद्धि हुई।
- एक एकड़ के सब्जी–आधारित समेकित कृषि तंत्र मॉडल में, धान्य– आधारित खेती की अपेक्षा सब्जी–आधारित खेती अधिक लाभदायक पायी गयी। फसलों, वर्मी कम्पोस्ट तथा बकरीपालन को चारे की खेती सहित अपनाने पर केवल फसलों की खेती की तुलना में किसानों को कहीं अधिक आय की प्राप्ति हुई।
- एक एकड़ के समेकित कृषि तंत्र मॉडल में, लोबिया–फूलगोभी–टमाटर फसल तंत्र को कुक्कुटपालन + मशरूम + बकरीपालन के साथ अपनाने से अधिकतम शुद्ध आय की प्राप्ति हुई तथा दो एकड़ के मॉडल में, धान–गेहूँ + सब्जी + पशुपालन + मत्स्यपालन + बतखपालन से अधिकतम शुद्ध आय की प्राप्ति हुई।
- मधुमक्खियों के लिए आहार के कृत्रिम विकल्प की खोज से पता चला कि सोया आटा से बना आहार अन्य विविध मिश्रणों की अपेक्षा अधिक पसंद किया गया।

प्रसंग 7 : सामाजिक–आर्थिकी, तकनीक का हस्तांतरण तथा मानव संसाधन विकास

- एन.ए.आइ.पी के अंतर्गत, पॉली–टनेल के भीतर खीरा वर्ग की ग्रीष्मकालीन खेती की तकनीकों के प्रदर्शन, नवस्थापित फल–आधारित बहुस्तरीय सस्यक्रम में सब्जी की अंतरफसली खेती, पॉली हाउस में सब्जी की नर्सरी लगाना तथा मशरूम उत्पादन के फलस्वरूप झारखण्ड के जामताड़ा तथा दुमका जिले के किसानों की आय में वृद्धि हुई।
- कृषक सहभागी कृषि शोध परियोजना (एफ.पी.ए.आर.पी.) के अंतर्गत इको हैचरी की कार्यप्रणाली के प्रदर्शन से 80 लाख स्पॉन का उत्पादन हुआ। इससे बिहार में मत्स्य जीरा की उपलब्धता तथा मत्स्योत्पादन में वृद्धि की सम्भावना बढ़ी है।
- कृषक सहभागी कृषि शोध परियोजना के अंतर्गत पॉलीथीनयुक्त 'दोबा' में वर्षा जल संचयन द्वारा फल उद्यान स्थापना को 89 किसानों के खेतों पर प्रदर्शित किया गया।
- परिसर के तकनीक बढ़ाने के कार्यक्रम के अंतर्गत कृषकों के खेतों में सब्जी की उन्नत किस्मों पर 357 प्रदर्शन प्रस्तुत किए गए ।
- परिसर के प्रसार कार्यक्रम के अंतर्गत केन्द्र के वैज्ञानिकों ने किसानों को फलों के बगीचे लगाने, इन बगीचों मे वितान–प्रबंधन, नर्सरी प्रबंधन, जीर्णोद्धार के तरीकों तथा टमाटर की वर्षाकालीन खेती के विषय में तकनीकी सहयोग देने के उद्देश्य से झारखण्ड के गुमला, खूँटी, लातेहार, चतरा तथा हजारीबाग जिलों, बिहार के मुंगेर जिले तथा उड़ीसा के क्योंझर जिले के किसानों के खेतों का भ्रमण किया।
- वर्ष भर में कुल 282 किसानों ने बागवानी के विविध विषयों पर आयोजित 11 कृषक प्रशिक्षण कार्यक्रमों में भाग लिया।
- 'प्रयोग में अनुसंधान' कार्यक्रम के अंतर्गत तीन राज्यों के 11 जिलों में एक साथ 2868 स्वयं सहायता समूह का सृजन किया गया। समाज के वंचित वर्ग द्वारा समाज कल्याण विकास की योजनाओं को अपनाये जाने तथा उन्हें नवीन कृषि तकनीकों से अवगत कराने के लिए संचार उत्पाद विकसित किए गए।
- बिहार के मुजफ्फरपुर और शिवहर जिलों में किए गए सामाजिक–आर्थिक एवं जैव भौतिक सर्वेक्षण के अनुसार इन क्षेत्रों मे छोटे एवं सीमान्त किसानों की बहुलता है। यहाँ की खेती धानप्रमुख है तथा यहाँ 25 से 50 प्रतिशत क्षेत्र लवण–प्रभावित हैं।
- वैशाली जिले के एन.ए.आई.पी. समूहों में 12 सस्यक्रम अपनाये गए जिसके फलस्वरूप सस्य–सघनता 200 प्रतिशत से बढ़कर 300 प्रतिशत तक हो गयी।
- उत्पादन, प्रति गृहस्थी आय तथा रोजगार को बढाने के उद्देश्य से मुख्य फसलों की पुरानी किस्मों की जगह 30 नयी किस्में लायी गयीं। नवीन किस्मों द्वारा रोजगार सृजन में 4 प्रतिशत से 15.2 प्रतिशत, तथा प्रति हेक्टेयर फसल क्षेत्रफल से प्राप्त होनेवाली आय में 30 से 153 प्रतिशत तक की वृद्धि हुई।
- दरभंगा जिले में 44 हे. क्षेत्र में 96 परिवारों द्वारा मत्स्यपालन के साथ–साथ मखाना की खेती की गयी ।
- मखाना के तालाब से प्रथम बार की मत्स्य प्राप्ति में देखा गया कि इस वर्ष सूखे के बावजूद प्रति हे. आय रु. 6,289 थी तथा रोजगार में 12 श्रमदिवस की वृद्धि हुई।
- आय में वृद्धि हेतु बंध के ऊपर बागवानी फसलें (फल एवं सब्जियाँ) लगाकर तथा तालाबों में मखाना–सह–मत्स्यपालन द्वारा बहुआयामी जलप्रयोग का आरम्भ किया गया साथ ही कुक्कुटपालन, मधुमक्खीपालन तथा वर्मी कम्पोस्ट जैसे अलग से आय देने वाली गतिविधियाँ शुरू की गयीं। इसके लिए आवश्यक प्रशिक्षण, तकनीकी जानकारी आदि मखाना अनुसंधान केन्द्र, दरभंगा के वैज्ञानिकों द्वारा प्रदान की गयी।
- दो प्रायोगिक तालाबों में मखाना का औसत उत्पादन क्रमशः 0.26 तथा 0.34 टन/हे. तथा मत्स्योत्पादन क्रमश 0.60 एवं 1.02 टन/हे. रहा।

EXECUTIVE SUMMARY - 2009-10

Theme 1 : Resource appraisal and inventorization

- Maximum value of Normalized Difference Vegetation Index (NDVI) has been observed during rabi season in most of the years compared to *kharif* season over Samastipur, Bihar.
- The trend analysis of annual rainfall at Madhepura (Zone-II), Sabour (Zone-IIIA) and Patna (Zone-IIIB) indicated an increasing trend. Increase in annual rainfall was found to be maximum at Sabour and minimum at Patna.
- The soil quality and land use assessment in south Bihar (agro-ecological zone 9) shows that there are six major land use systems (rice-wheat, maize-potato, red gram, sugarcane, mango orchards and agro-forestry). High soil compaction was observed in rice-wheat system. Soils of mango orchard contain highest organic carbon stock followed by agro-forestry, whereas lowest carbon stock was observed in sugarcane growing soil.

Theme 2 : Plant genetic resource management and improvement of field, horticultural and aquatic crops

- Mango genotype "Loha Jung" was collected from Munger district of Bihar. One hundred seventeen mango genotypes were characterized and the mango cultivar Himsagar was found promising. Litchi genotype Deshi was found promising for fruit quality and yield. Guava cultivars Allahabad Safeda and Sardar were found promising whereas in sapota, the genotype Murabba was found promising.
- Among different vegetable crops, improved lines of brinjal, tomato, chilli, capsicum, pointed gourd, cucumber, bottle gourd, pumpkin, ridge gourd, sponge gourd, french bean, cowpea, amaranthus, drumstick, vegetable soybean, sword bean, jack bean, winged bean, lima bean, velvet bean, yam bean, cluster bean, ivy gourd, and spine gourd were identified/maintained.

Theme 3 : Improved production technologies for field, horticultural and aquatic crops

- Among the mango based multitier cropping systems, the maximum paddy equivalent yield (8.61 t/ha) was recorded in case of mango + guava + paddy during the 11th year.
- In case of rejuvenated mango plants of cv. Amrapali, the maximum yield of 61.79 kg/plant was recorded with rejuvenation pruning at a height of 2.0 m without maintenance of length of primary and secondary shoots emerged after pruning.
- The highest cumulative yield of pointed gourd was recorded with 50 cm intra-row spacing and application of nitrogen @ 160 kg/ha.
- Among different vegetable based cropping sequences, the maximum paddy-equivalent yield of 116.89 t/ha was realized with cowpea- okra- pea cropping sequence.
- In case of ultra-high density orchard in guava, pruning three times a year (March, May and October) + irrigation 60% PE + application of 100% of recommended dose of nutrients + soil application of 2 kg FYM + 50 g *Trichoderma* + 50 g *Azotobacter* + 50 g *Mycorrhizae* + Foliar application of $ZnSO_4$ (0.1%) and boric acid (0.3%) resulted in maximum gross income of Rs. 5.56 lakh / ha.
- Water requirement for producing one kg of *Pleurotus florida* mushroom is 4.16 to 5.0 litres whereas for producing one kg blue oyster mushroom *(Hypsyzigus ulmarius)* it is 4.16 to 5.5 litres.
- Nutrient management in rice- lentil cropping system showed maximum lentil seed yield of 963.8 kg/ha with 40 kg sulphur, whereas in rice the minimum (6.08 t/ha) and maximum (6.60 t/ha) grain yield was obtained with zero sulphur and 6 kg zinc, respectively.

- In rice, gundhi bug population was recorded above ETL (2.7 bugs/hill) in Satyam variety in 1st week of September.
- Under the studies on epidemiology of downy mildew disease of cucurbits, maximum disease severity in bitter gourd and ridge gourd was observed 37 days after sowing on 13th leaf.

Theme 4 : Integrated land and water management

- A Decision Support Tool (DST) capable of facilitating farmers in selection of Integrated Farming System components was developed keeping in view the performance indicators i.e. benefit-cost ratio, land productivity, and water productivity.
- Simulation studies showed that canal water from Ranitalab and Bikram gate can be supplied equitably and adequately during 11 weeks (23^{rd}-32^{nd} weeks and 33^{rd} week) only in three distributaries (Adampur, RPC V and Rewa distributary) whereas during remaining weeks the supply-demand ratio varied from 0.7 to 0.2. If the design discharge is supplied at Ranitalab gate, water can be released equitably and adequately during 15 weeks (23^{rd}-37^{th} weeks) and the supply- demand ratio varied from 0.9 to 0.7 during remaining periods.
- Characterization and classification of ground water quality in Maner block of Patna district showed that arsenic content increased from1.65 ppm to 2.20 ppm with the depth and accumulate from 2.0 to 5.0 ppm in vegetable and cereal crops. Spatial thematic maps were also developed for arsenic and iron distribution in the area.
- Water productivity of different crop sequences under irrigation from secondary reservoir as well as tube well showed that rice-potato-onion sequence resulted in the highest water productivity (Rs. 7.48/m^3) followed by rice-cabbage-cowpea (Rs. 6.45/m^3) and rice-wheat-green gram (Rs. 6.07/m^3).
- Temporal water quality assessment under multiple uses of water indicated inverse relationship between oxygen saturation and temperature. During December to August concentration of nitrate, phosphate and potasium, increased from 0.01- 0.07, 0.4 - 0.6 and 2.5 - 4.0 ppm, respectively.
- Calibration and validation of IHACRES model indicated that IHACRES model performs reasonably well in all the four sub-catchments of Brahmani basin.
- Comparison of different multi-arm low sprinkling nozzle showed that the eight-arm prototype is the most appropriate and can be operated below 1.0 kg/cm^2 pressure with considerable throw distance and radial water distribution.
- Gravity subsurface drip irrigation and fertigation indicated increased yield of cucumber due to subsurface placement of the laterals.
- Simulating the adaptation strategy for rice shows that advancing the sowing date by 7 and 14 days compared to present day farmers practice results in reducing the simulated yield decline in future scenarios. In wheat 7 days advanced sowing as compared to 14 days advancement with higher dose of nitrogen has most beneficial effect. In case of late sown wheat, effect of advancement in sowing has more pronounced effect as compared to timely sown wheat.
- Simulation results using Had Cm3 predicted changes in rainfall and temperature, indicated increase in annual stream flow during 2020 and decreased annual stream flow in Bhawani Basin during 2050 under A2a as well as B2a emission scenarios. Besides, decrease in stream flow during monsoon and increase during pre-monsoon seasons were predicted.

- Soil microbial biomass carbon and available nitrogen increased in soil and resulted in higher yield of paddy when incorporated with green manure crop (*Sesbania*), FYM and residue of preceding crop.

Theme 5 : Livestock and fishery improvement and management

- The adaptive research on monoculture and polyculture of scampi *(M. rosenbergii)* has paved way for its farming beyond December. The farmers and entrepreneurs will be highly benefited from the new approach of scampi farming in seasonally waterlogged areas of Bihar. Trials on the culture of Jayanti Rohu *(L. jayanti)* under polyculture systems in ponds have shown significantly higher growth than that of rohu *(L. rohita)*.
- Initial study revealed that makhana bran can be incorporated in the diet of poultry broiler up to 6% level without affecting growth and feed conversion efficiency. Dry matter intake and digestibility did not differ significantly up to 50 per cent of replacement of rice bran.
- The Black Bengal breed of goat is the most popular for kidding percentage. The survey revealed that twinning and triplets from 3rd kidding accounted for 85 per cent.
- ELISA procedures were standardized for diagnosis of Brucellosis and IBR in dairy cattle and PPR and Blue tongue in goat and sheep, respectively.
- In intensified dairy based production system, 4 crossbred cows can be integrated in one acre model with sparing of 40 per cent area for fodder production. Lactation yield of crossbred cows is 2200 kg.
- Assessment of livestock water productivity has been initiated in Indo-Gangetic Plains, India. A baseline survey regarding resource availability, cropping pattern, livestock population and production and role of different institutions in crop-livestock-water nexus in all the villages have been studied.

Theme 6 : Development of need based farming system models for different ecosystems

- Among the cropping systems, maximum yield equivalence was recorded in rice-tomato-bottle gourd (40.49 t/ha) followed by rice-potato- onion (33.45 t/ha) and rice-carrot-cowpea (21.91 t/ha), rice-coriander-okra (19.73 t/ha) and rice-mustard-tomato (10.84 t/ha). Among levels of irrigation, maximum yield equivalence was recorded at optimum level (25.83 t/ha) followed by sub- optimum level (24.74 t/ha) and the increase was to the tune of 4.40 per cent. Among levels of nutrient, maximum yield equivalence was recorded at recommended level (26.09 t/ha) followed by 50% of recommended level of fertilizer and the increase was to the tune of 6.58 per cent.
- In one-acre vegetable based integrated farming system model, vegetable based cropping system was found to be more profitable than cereal based cropping system. Integration of crops, vermicompost and goatry along with fodder crop was found more beneficial for farmers than growing crops only.
- In one-acre IFS model, cowpea-cauliflower-tomato cropping system along with poultry + mushroom + goatry fetched the highest net income and in 2-acre model, rice-wheat + vegetable + livestock + fisheries + duckery gave highest net return.
- Investigation over artificial dietary substitute for honey bee, showed that diet made of soya flour was the most preferred amongst various combinations.

Theme 7 : Socio-economics, technology transfer and HRD

- Under the NAIP, demonstration of technologies on summer season cultivation of cucurbits under polytunnels, intercropping of vegetables in newly established fruit based multitier cropping systems, raising of vegetable nursery under polyhouse and mushroom cultivation resulted increased income of the farmers in Jamtara and Dumka districts of Jharkhand.

- The eco-hatchery operation demonstrated to farmers under FPARP lead to production of 80 lakhs spawn. This offers scope in fish seed availability and increase in fish production in Bihar.
- Under the FPARP, technology of rainwater harvesting in polythene lined Doba for establishment of fruit orchards has been demonstrated in 89 farmers' fields.
- Under Technology Acceleration programme of the Complex, 357 demonstrations on improved vegetable varieties were conducted in farmers' fields.
- Under the outreach program of the Complex, scientists of the centre visited farmers' fields at Gumla, Khunti, Latehar, Chatra and Hazaribagh districts of Jharkhand, Munger districts of Bihar and Keonjhar district of Orissa to provide technical support to farmers on establishment of fruit orchards, canopy management of fruit orchards, nursery management, rejuvenation techniques and rainy season cultivation of tomato.
- A total number of 282 farmers attended 11 farmers' training programmes conducted during the year on different topics in horticulture.
- Altogether 2868 SHGs have been formed in 11 districts of 3 states under Research into Use programme. Communication products have been developed for efficient uptake of new agricultural knowledge and convergence of social welfare/developmental scheme by socially disadvantaged groups.
- Socio-economic and bio-physical survey of Muzaffarpur and Sheohar districts of Bihar revealed that these areas are dominated by small and marginal farmers with rice based cropping system, with 25-50 per cent area being salt affected.
- Twelve cropping systems were introduced in the NAIP cluster at Vaishali district resulting in increased cropping intensity from 200 percent to 300 per cent.
- Thirty new varieties of major crops were introduced to replace the old varieties in order to increase production, income per household and employment.
- Introduction of new crop varieties increased employment generation from 4 per cent to 15.2 per cent and income from 30 per cent to 153 per cent per hectare of cropped area.
- Integration of fish with makhana was introduced in 44 ha of land involving 96 households in Darbhanga district.
- In first harvest of fish from makhana pond, it was observed that the increase in income/ha was Rs. 6289 and increase in employment was 12 man days in spite of drought this year.
- Multiple uses of water in makhana cum- fish culture in the ponds with horticultural plants (fruits and vegetable) on the bunds was introduced to enhance income. Also, the alternate income generating activities such as poultry, bee keeping and vermi-composting were introduced in the vicinity of the farmer's pond. The required training, technical know-how were imparted by the scientists of Research Centre for Makhana, Darbhanga.
- The average yield of makhana seed in two experimental ponds was 0.26 and 0.34 t/ha and fish yield was 0.60 and 1.02 t/ha.

INTRODUCTION

Historical Perspective

The eastern region comprising of eastern Uttar Pradesh, Bihar, Jharkhand, West Bengal, Assam, Orissa and Chhatisgarh and representing 22 per cent of the geographical area of the country supports 33 per cent of country's population. Though the region is endowed with rich natural resources to support higher agricultural production, livestock and fisheries, the production levels have remained low mainly due to lack of location-specific production technologies, poor dissemination of scientific farming knowledge to farmers, natural calamities e.g. floods, water logging and droughts, and social conflicts. The region has, however, the potential to usher in second green revolution.

ICAR Research Complex for Eastern Region, Patna came into existence on 22nd February 2001 after merger of Directorate of Water Management Research, Patna with the Complex. On 1st April 2001, Central Horticultural Experimental Station, Ranchi and Central Tobacco Research Station, Pusa were merged in the Complex. The ICAR Research Complex for Eastern Region, Patna is a broad based framework to address diverse issues relating to water and land resources management, crop husbandry, horticulture, aquatic crops, fishery, livestock and poultry, agro-processing and socio-economic aspects in holistic manner for enhancing research capability and providing a backstopping for improvement in agricultural productivity and sustainability in the eastern region. ICAR Research Complex for Eastern Region comprises four Divisions and two Research Centres viz. Division of Land and Water Management (DLWM), Division of Crop Research (DCR), Division of Livestock and Fishery Management (DLFM), Division of Socio-Economic Extension and Training (DSEET), ICAR-RCER, Research Centre, Ranchi and ICAR-RCER, Research Centre for Makhana, Darbhanga. The Complex is now a multi-commodity and multi-disciplinary institutional framework to address research issues and to develop technologies relevant to prevailing biophysical and socio-economic environment of the eastern region with the following mandate.

Mandate

"To undertake strategic and adaptive research for efficient integrated management of natural resources to enhance productivity of agricultural production systems comprising of field, agricultural and horticultural crops, aquatic crops, agro-forestry, livestock, avian and fisheries in different agro-ecological zones of the eastern region".

The modalities to achieve the mandate are

- To facilitate and promote coordination and dissemination of appropriate agricultural technologies through network/consortia approach involving ICAR institutes, State Agricultural Universities, and other agencies for generating location-specific agricultural production technologies through sustainable use of natural resources.
- To provide scientific leadership and to act as a centre for vocational as well as advanced training to promote agricultural production technologies.

- To act as repository of available information and its dissemination on all aspects of agricultural production systems in the eastern region.
- To collaborate with relevant national and international agencies in liaison with state and central government departments for technology dissemination.
- To provide need based consultancy and advisory support for promoting agriculture, horticulture and livestock in the eastern region.
- Socio-economic evaluation and impact assessment of agricultural technologies.

The Complex functions through following Divisions / Centres / KVK

1. Land and Water Management (LWM)
2. Crop Research (CR)
3. Livestock and Fishery Management (LFM)
4. Socio-Economic Extension and Training (SEET)
5. ICAR-RCER, Research Centre, Ranchi
6. ICAR-RCER, Research Centre for Makhana, Darbhanga
7. Krishi Vigyan Kendra, Buxar

The Indo Gangetic Basin Co-ordination Unit of CGIAR Challenge Program on Water and Food also functions at the Complex with its Director as the Benchmark Basin Coordinator.

Infrastructural facilities

The complex was housed in 26,322 sq. ft. area in leased building at WALMI Campus, Phulwari Sharif up to 15th January, 2007. Subsequently shifted to its new laboratory-cum-office building near Bihar Veterinary College. The site location is at about 25°35' N and 85°5' E at 67m above mean sea level. The main office is located at Patna, 2 km away from J.P.N. Airport, 7 km away from Patna railway station and 9 km away from Patna, Bus stand. The institute has developed hi-tech laboratories on soil physical and chemical analysis and plant analysis, and a pressurized irrigation laboratory.The Institute has a well-developed library. The Complex is well equipped with modern computing facilities, LAN and Internet. The ICAR-RCER, Research Centre, Ranchi (Jharkhand) is located at Plandu 17 km away from Ranchi on Ranchi-Tata road (NH-33). Research Centre for Makhana is located at Basudevpur, Darbhanga.

The Complex has three research farms viz. 4.0 ha at WALMI complex, 17.0 ha at Sabajpura and 26.0 ha at main campus near airport. The research farms of RC, Ranchi are located at four places: Plandu (70.4 ha), Churu (99.2 ha), Garake (7.5 ha) and Lalkhatanda (41.7 ha). The Research Centre for Makhana has research farm of 10 ha.

At present the staff of ICAR-RCER, Patna is accommodated in 37 residential quarters available in WALMI campus and 13 residential quarters at main campus near airport.

The Complex has two VIP suites in Kisan Bhawan and 16 rooms in Chhatrawas leased from WALMI. The organizational setup of the Complex is given in Fig. 1.

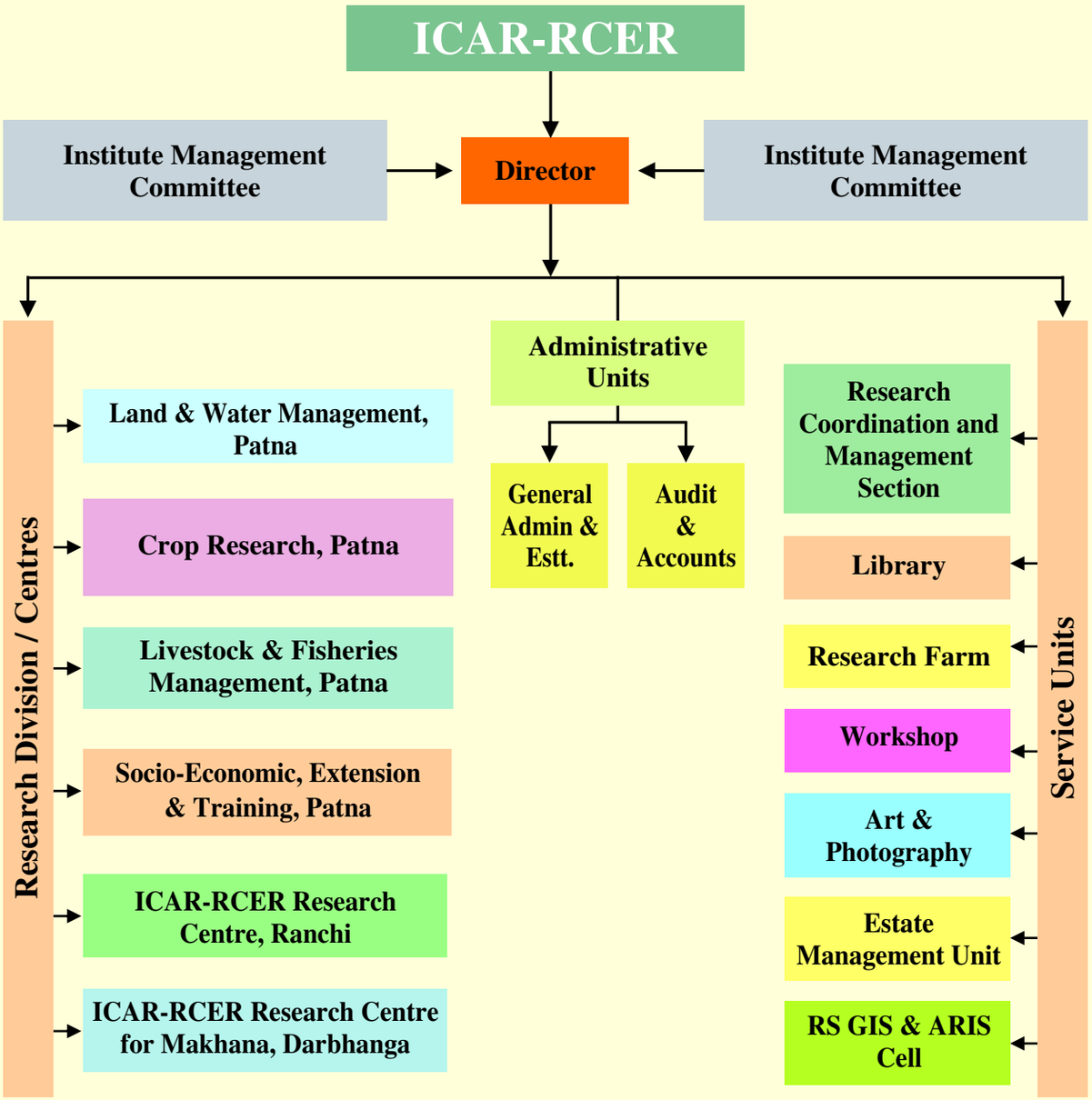


Fig. 1. Organogram of ICAR Research Complex for Eastern Region, Patna

Research thematic areas and sub-areas

Theme-1 : Resource appraisal and inventorization

- Inventorization of resources including use of modern tools for planning and monitoring
- Constraints analysis and prioritization.

Theme-2 : Plant genetic resource management and improvement of field, horticultural and aquatic crops

- Collection, conservation and evaluation
- Development of improved cultivars

Theme-3 : Improved production technologies for field, horticultural and aquatic crops

- Standardization of production and multiplication technologies
- Integrated nutrient management
- Integrated pest management
- Post harvest technology and value addition of agricultural produce

Theme-4 : Integrated land and water management

- Conservation agriculture including RCTs
- Integrated management of rain, canal and groundwater including on-farm water management
- Assessment of water productivity and multiple uses of water
- Assessment and management of flood prone/water logged/water congested areas including Tal, Diara, Chaur and Mauns
- Participatory watershed management including rain water harvesting
- Modern irrigation methods including small holder irrigation
- Climate change

Theme-5 : Livestock and fishery improvement and management

- Fish seed, feed and management of fish ponds
- Ecology, fishery, biology and fish production dynamics of flood plain wetlands
- Development of technologies for improving livestock and poultry health and production
- Techniques of fodder production round the year and enrichment of crop residues and agricultural by products
- Crop-livestock integration through dairy based enterprises

Theme-6 : Development of need based farming system models for different eco-systems

- Documentation of farming systems in different eco-systems of the region
- Assessment and development of need based & site specific farming system models

Theme-7 : Socio-economics, technology transfer and HRD

- Participatory technology development
- Technology transfer, assessment and refinement
- Livelihood analysis and impact assessment of agricultural technologies
- Socio-economic, institutions and policy guidelines for governance of resource management
- Information and service delivery systems

Finance

Summary of allocation and expenditure during the year 2009-2010 under plan and non-plan budget along with externally funded schemes is presented below.

Main Institute *(Rupees in Lakhs)*

Head of Account	Revised Estimate (2009-10)		Actual Expenditure (2009-10)	
	Plan	Non-plan	Plan	Non-plan
Establishment charges*	0.00	1161.77	0.00	1160.65
T.A.	8.00	3.78	7.97	3.77
HRD	2.10	0.00	2.09	0.00
Works #	281.00	2.16	280.02	2.15
Other charges	258.90	96.11	234.72	96.03
Total	**550.00**	**1263.82**	**524.80**	**1262.60**

*Including labour wages and OTA
Works means repair and maintenance under Non-Plan.

KVK, Buxar *(Rupees in Lakhs)*

Head of Accounts	Revised Estimate (2009-10)	Actual Expenditure (2009-10)
	Plan	Plan
Establishment charges	43.00	28.68
T.A.	1.00	0.99
HRD	0.00	0.00
Work	0.00	0.00
Other charges	10.95	9.15
Total	**54.95**	**38.82**

Staff position

The total sanctioned staff strength of the Complex is 258. The breakup of the posts (sanctioned and in- position during 2009-10) under different categories is given below.

Category	Sanctioned	In-position
Scientific	93	54
Technical	61	55
Administrative	41	35
Supporting	63	40
Total	**258**	**184**

KVK, Buxar

Category	Sanctioned	In-position
Projec Manager	01	0
SMS	06	05
Farm Manager	01	01
Programme Asstt.	01	0
Programme Asstt. (Computer)	01	0
Office Suptd.	01	0
Jr. Steno	01	0
Driver-cum-mechanic	02	0
SSS	02	01
Total	**16**	**07**


RESEARCH ACHIEVEMENTS

Theme 1 : Resource appraisal and inventorization

1.1.1 : Agricultural drought and flood risk assessment using satellite and meteorological indices over eastern region of India

(N. Subash and A. Abdul Haris)

The main objectives are to assess the agricultural losses from droughts and floods through vegetation and meteorological indices and also to identify the areas facing higher drought and flood risk over eastern region of India. During the first year meteorological data were collected from Faizabad, Jorhat, Sabour, Samastipur, Patna, Raipur, Ranchi, Bhubaneshwar and Mohanpur.

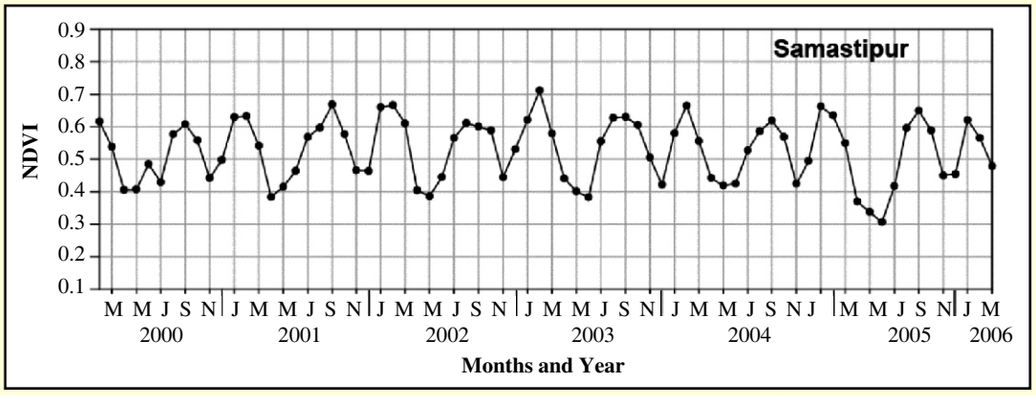


Fig. 2. Temporal variation of NDVI over Samastipur

Monthly composite MODIS imageries of eastern region from 2000 to 2008 were taken from NASA. The preliminary results indicated the maximum value of Normalized Difference Vegetation Index (NDVI) during wheat season in most of the years compared to rice season over Samastipur (Fig. 2), and temporal variation closely follows the rice-wheat season. The comparison between Standardized Precipitation Index (SPI) during June to September and maximum NDVI during rice and wheat season over Samastipur showed no direct relation between maximum NDVI and SPI values during monsoon months (Table 1).

Table 1 : SPI during June to September and maximum NDVI during rice and wheat season over Samastipur during 2000-2005

Year	SPI				Max. NDVI	
	June	July	August	Sept.	Rice	Wheat
2000	2.33	- 0.13	- 0.29	2.33	0.61	0.63
2001	2.33	2.33	0.08	2.33	0.67	0.67
2002	0.21	2.33	2.33	- 0.71	0.61	0.71
2003	2.33	- 0.95	2.18	2.33	0.63	0.66
2004	2.33	2.33	-1.30	-3.03	0.62	0.66
2005	- 0.54	- 0.26	-1.23	-1.12	0.65	0.62

1.1.2 : Modeling the performance of few major cropping systems in eastern India in the light of projected climate change (NAIP-Comp-4)

(S.S.Singh, N.Subash and R.C.Bharati)

Study has been initiated on climate change scenarios, occurrence of extreme events and their agro-climatic analysis for 2020, 2030 and 2050 for some agro-climatic zones of Bihar and to prepare the pest (diseases) projections in rice-wheat system under projected climate scenarios. It also dealt with modelling the impact of projected climatic scenarios on performance of rice-wheat systems and their resource use efficiency to identify adaptation measures in Bihar.

From all four agro-climatological zones of Bihar, four representative districts, viz., Samastipur (zone-I), Madhepura (zone-II), Sabour (zone-IIIA) and Patna (zone-IIIB) were selected for climate studies based on data availability (Fig. 3). The daily meteorological parameters available at various research stations were collected. The Mann-Kendall nonparametric test was applied in order to detect trends in seasonal and annual rainfall and rainydays for all the four locations. The slopes of the trends were calculated by fitting the data series into method of least square linear fitting.

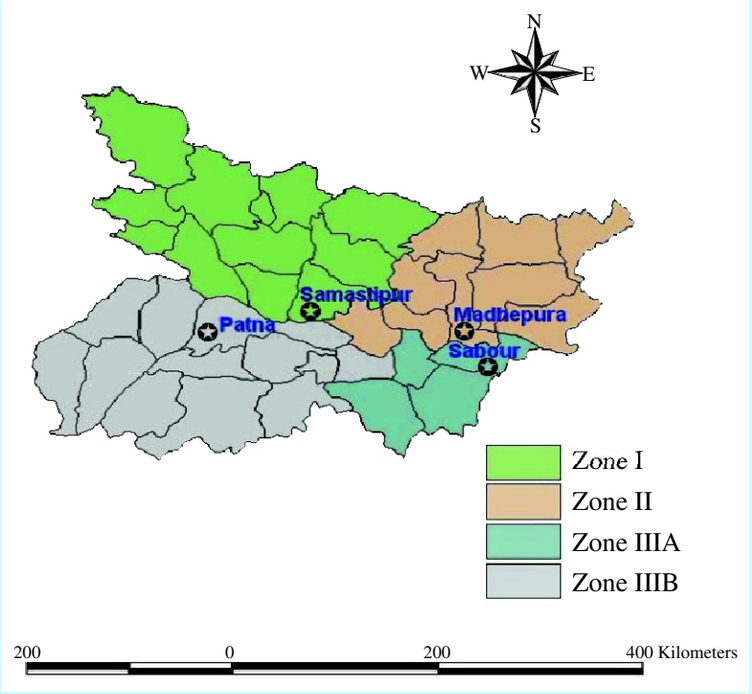


Fig. 3. Study sites in AEZs of Bihar

Time series of annual and seasonal rainfall and their linear trends at different stations are presented in Fig. 4. The annual rainfall at all the sites except Samastipur indicated an increasing trend. Maximum increase in annual rainfall was found at Sabour (40.1% of mean/30 years at 95% confidence level) and minimum for Patna (10.1% of mean/30 years). Seasonally, rainfall showed an increasing trend in winter and monsoon seasons for all the sites. Madhepura and Sabour showed a significant increasing trend in monsoon rainfall at the rate of 51.3% and 32.8% of mean/30 years, respectively. However Madhepura indicated a decreasing trend in summer while all other sites showed an increasing trend. During post monsoon season, all sites except Sabour, indicated an increasing trend in rainfall. As far as monthly variation is concerned, at Samastipur, significant increasing trend of rainfall during the months of July, August and September at the rate of 41.9, 83.2, and 112.7% of the mean / 30 years, respectively have been observed.

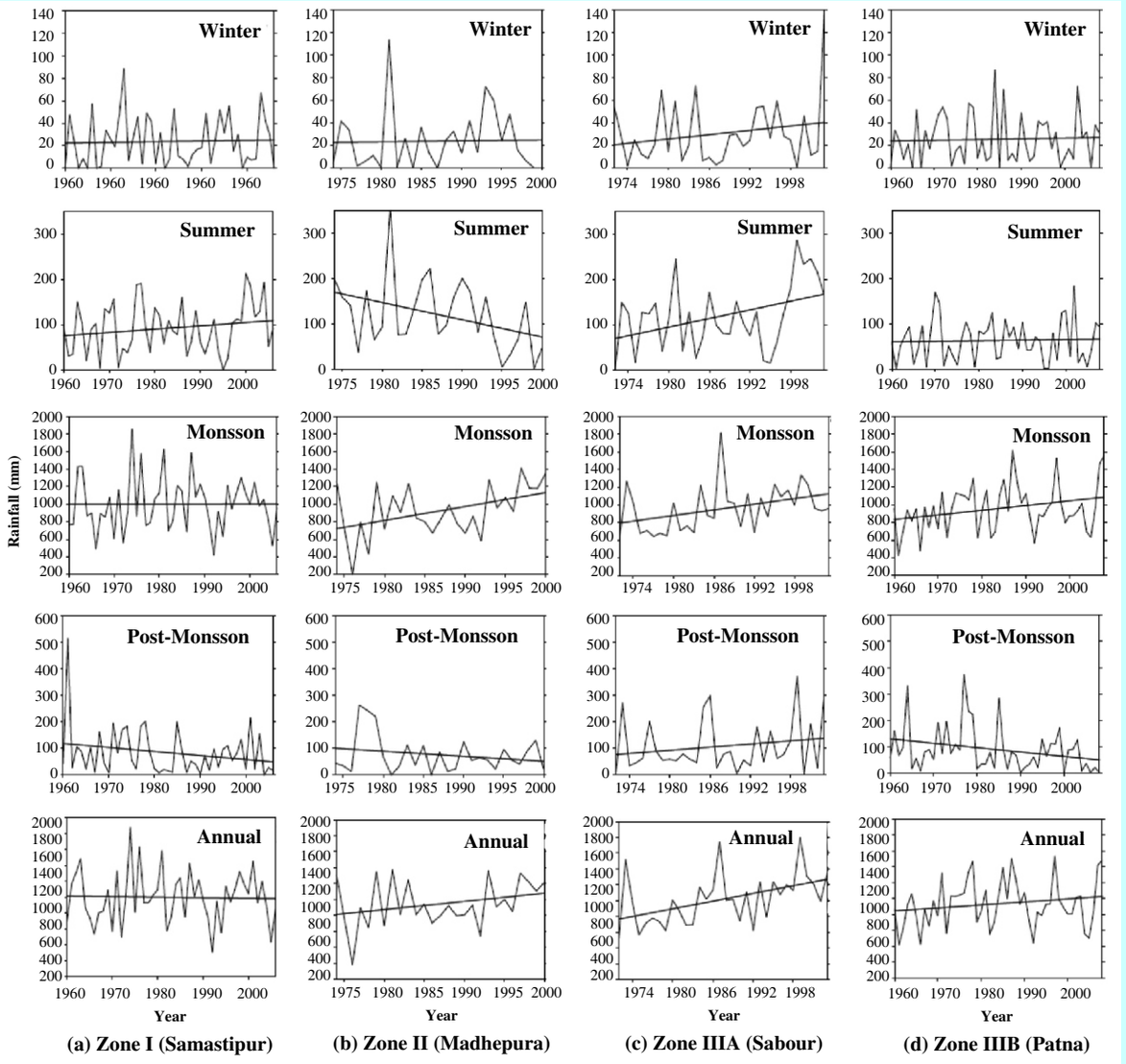


Fig. 4. Variability and linear trends of rainfall in AEZs of Bihar

At Patna significant increasing trend in June rainfall at the rate of 44.5% of the mean/30 years and decreasing trend in October rainfall at the rate of -64.5% of the mean/30 years was observed. The decreasing trend of October rainfall may affect the germination of wheat crop during November December.

Mean annual rainy days vary from 52 (Patna) to 62 days (Sabour). The CV varies from 14.2 % at Sabour to 19.7 % at Madhepura (Table 2). Analysis of rainy days indicates that rainy days increased in the winter season and annually for all the sites. However, except Madhepura, in all other sites rainy days were found to be increasing during monsoon season. A significant (at 95% confidence level) increasing trend in annual rainy days at the rate of 24.0% of mean / 30 years has been observed for Sabour. During monsoon, except Samastipur, in all other sites rainy days were found to follow the increasing trend. A significant

increasing trend in rainy days at the rate of 21.3% of the mean / 30 years has been noticed for Sabour during monsoon. A significant increasing trend of rainy days in the order of 55.6% and 46.6% of the mean / 30 years has been noticed during April and May, respectively for Samastipur. A significant increasing trend in rainy days during April (96.3 % of the mean/30 years) and June (35.7% of the mean/30years) has been noticed for Sabour.

Table 2 : Monthly, seasonal and annual distribution of rainy days at different sites in Bihar

Month/ Season	Zone I			Zone II			Zone IIIA			Zone IIIB		
	Mean	SD	CV	Mean	SD	CV	Mean	SD	CV	Mean	SD	CV
January	1.0	1.2	118.2	1.0	1.1	113.3	1.2	1.0	86.7	1.1	1.0	91.1
February	1.2	1.3	108.8	0.7	0.9	121.9	1.4	1.4	96.7	1.2	1.3	111.5
March	0.8	1.2	154.5	1.2	1.6	127.0	1.2	1.3	116.5	0.8	1.1	147.2
April	1.5	1.5	98.5	1.7	1.4	81.1	1.7	1.7	101.6	0.9	1.2	127.5
May	3.5	2.2	62.4	4.2	3.0	71.7	4.7	2.8	60.2	2.5	2.0	79.3
June	7.4	3.0	41.0	8.0	4.3	54.6	9.1	3.6	39.7	6.2	3.2	51.0
July	13.6	3.5	25.9	12.7	5.8	45.5	14.4	3.8	26.3	13.6	3.9	28.5
August	12.1	3.4	28.5	10.1	4.4	43.7	12.9	3.5	27.1	12.4	3.1	25.3
September	10.0	3.0	29.6	9.4	3.8	40.5	10.1	3.4	33.2	9.3	3.5	37.3
October	2.9	2.1	72.2	2.7	2.2	79.4	3.9	2.8	72.1	3.0	2.3	76.7
November	0.5	0.9	172.6	0.4	0.8	207.2	0.6	0.8	127.3	0.5	0.9	179.5
December	0.6	0.9	153.2	0.7	1.2	165.7	0.7	1.0	149.8	0.5	0.9	168.1
JF (Winter)	2.2	1.8	81.6	1.7	1.5	90.4	2.6	1.9	70.9	2.3	1.7	74.7
MAM (Summer)	5.8	2.8	49.0	7.1	4.0	55.8	7.5	4.3	56.9	4.2	2.8	66.8
JJAS (Monsoon)	43.0	6.6	15.3	40.3	9.4	23.4	46.6	6.5	13.9	41.5	7.5	18.1
OND (Post monsoon)	4.0	2.5	61.2	3.9	3.3	84.5	5.2	2.9	55.9	4.0	2.8	68.3
Annual	55.1	8.0	14.5	53.0	10.4	19.7	61.9	8.8	14.2	52.1	9.2	17.7

Meteorological information

ICAR-RCER, Patna

Mean maximum monthly temperature varied from 22.6 ^{o}C in the month of January to 38.5 ^{o}C in April. Mean minimum monthly temperature varied from 10.6 ^{o}C in December to 32.0 ^{o}C in September (Table 3). A maximum daily sunshine hour of 8.6 hours/day was recorded in the month of February and minimum of 3.1 hours/day in August.

The total annual precipitation was 625.8 mm, out of which 77.3 per cent received during southwest monsoon. Distribution of rainfall during monsoon months also varied. It was deficient in all the months with maximum deficit of 71.3 per cent in July followed by 61.7 per cent in June (Table 4).

Table 3 : Monthly meteorological information of Patna

Month	Rainfall (mm)	Temperature (°C)		Relative Humidity (%)		Sunshine (h/day)
		Max.	Min.	Max.	Min.	
January	0.0	22.6	10.8	90.6	66.5	3.8
February	0.0	28.1	12.7	71.5	47.6	8.6
March	0.0	32.8	17.2	55.8	31.8	7.4
April	0.0	38.5	21.7	44.7	21.7	8.5
May	95.2(4)	35.7	24.1	60.3	44.1	7.8
June	52.0(5)	38.4	26.8	63.9	42.2	8.1
July	97.6(9)	34.2	26.6	81.7	67.0	6.1
August	249.2(16)	33.2	26.5	84.6	69.9	3.1
September	85.0(4)	33.7	32.0	81.0	64.6	6.1
October	41.4(4)	32.1	21.6	74.0	56.3	7.1
November	0.0	28.6	15.8	77.5	63.7	6.3
December	5.4(1)	24.5	10.6	83.4	61.9	4.6
Annual mean/ Total	625.8(43)	31.9	20.5	72.4	53.1	6.5

(The figures in parenthesis indicate the number of rainy days)

Table 4 : Distribution of monsoon rainfall at Patna

Month	Rainfall (mm)		Percent departure from normal
	Normal	2009	
June	135.6 (6)	52.0(5)	-61.7
July	339.6(14)	97.6(9)	-71.3
August	260.4(13)	249.2(16)	-4.3
September	210.9(10)	85.0(4)	-59.7
Total	**946.5(43)**	**483.8(34)**	**-48.9**

ICAR-RCER Research Centre, Ranchi

Mean maximum monthly temperature varied from 19.9°C in the month of January to 43.7°C in April. Mean minimum monthly temperature varied from 9.7 °C in January to 21.4°C in July (Table 5). Mean relative humidity varied from 88.3 per cent in the month of March to 64.7 per cent in April. The total annual precipitation was 1239 mm, of which 77.2 per cent received during south-west monsoon.

Table 5 : Monthly meteorological information at ICAR-RCER Research Centre, Ranchi during 2009

Month	Rainfall (mm)	Temperature (°C)		Relative Humidity (%)
		Max.	Min.	
January	27.0	19.9	9.7	73.7
February	0.0	23.5	11.3	70.6
March	16.0	26.0	13.9	88.3
April	0.0	43.7	18.2	64.7
May	86.0	29.5	19.3	77.4
June	60.0	30.9	21.0	76.7
July	368.0	25.3	21.4	80.0
August	210.0	23.1	19.6	74.1
September	319.0	25.6	20.3	79.0
October	95.0	23.1	14.7	76.2
November	24.0	22.1	11.9	74.5
December	34.0	18.2	7.9	70.5
Annual mean/ Total	1239.0	25.9	15.8	75.5

1.1.3 : Development of a composite crop yield forecast system for rice and wheat in Bihar

(R.C. Bharati, S.S.Singh, Abhay Kumar, Anil Kumar Singh, Ujjawal Kumar and Manibhushan)

Logistic and ARIMA models of order (0, 1, 1) were fitted and combined to give a composite estimate of forecast for different crops yield in each agro climatic zone of Bihar. It was observed that for rice yield the Logistic curve fits the time series data in all the Zones with 'r' values ranging from 0.94-0.98. The ARIMA projection of rice yield indicates increasing trend of yield in all the zones of Bihar. The estimate of the variances of the estimated rice yield was found higher for logistic model and low for ARIMA (0, 1, 1) model in all the agro climatic zones of Bihar. The per cent forecast error is less than 5 in all the agro climatic zones however, the per cent forecast error exceeded the limit while considering the whole Bihar for forecasting rice yield. This indicates the reliability of zone wise forecasting and heterogeneity among agro climatic zones. Due to the wide variation in the variances of the estimate, the composite estimates of all the models have been obtained using the inverse of the variances as weights.

1.1.4 : Assessment of soil quality in different agro-ecosystems of south Bihar

(K. Rajan and Sanjeev Kumar)

Long term effect of cultural practices under different agricultural land uses were assessed to determine soil quality. A comprehensive quantitative assessment through Soil Quality Index (SQI) involving soil physical, chemical and biological properties was employed in different agro-eco regions of south Bihar. Two agro-ecological regions 9 (hot sub-humid with alluvium derived soils (south Bihar plain) and growing period of 150-180 days) and 13 (hot sub-humid (moist) with alluvium derived soils (north Bihar plain) with growing period of 180 to 210 days) are occupying the major areas in south Bihar. Major

soils were demarcated within each agro-ecological region. There are three types of soils namely alluvial, red and hilly soils. Major land uses were identified in each soil. Long term use of lands for a particular crop and cropping systems with similar cultural practices were selected for study. Soil quality assessment was done in old alluvium soils of agro-ecological zone 9 in south Bihar (Gaya and Jehanabad districts) during the reporting year.

There were six major agri-cultural land uses viz., rice-wheat, maize-potato, red gram, sugarcane, mango orchards and agro-forestry identified in old alluvium of agro-ecological regions 9. The analytical result explains that the soil compaction was severe in rice-wheat system which recorded the highest BD (1.58 Mg m^{-3}) followed by red gram (1.54 Mg m^{-3}) and the lowest BD was recorded in sugarcane growing soils (1.43 Mg m^{-3}). Lowest pH was recorded in red gram growing soils (6.0) and highest in rice-wheat system (7.9). Electrolyte concentration was found highest in maize-potato system (0.23 dSm^{-1}) followed by sugarcane growing soil (0.16 dSm^{-1}) and the lowest concentration recorded in red gram growing soil (0.04 dSm^{-1}). Soil organic carbon stock was observed highest in mango orchards (9.6 kg m^{-2}) followed by agro-forestry (7.9 kg m^{-2}) and the lowest stock was observed in sugarcane growing soils (Fig. 5). Available soil water was measured up to 60 cm depth which was varying from 8.0 cm in red gram growing soil to 14.0 cm in mango orchard (Fig. 6).

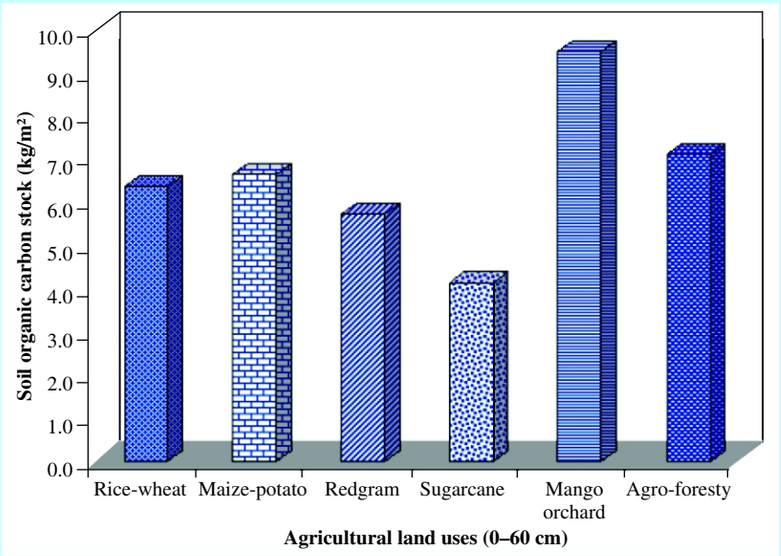


Fig. 5. Soil organic carbon stock under different agricultural land uses in old alluvium of agro ecological region 9 of south Bihar

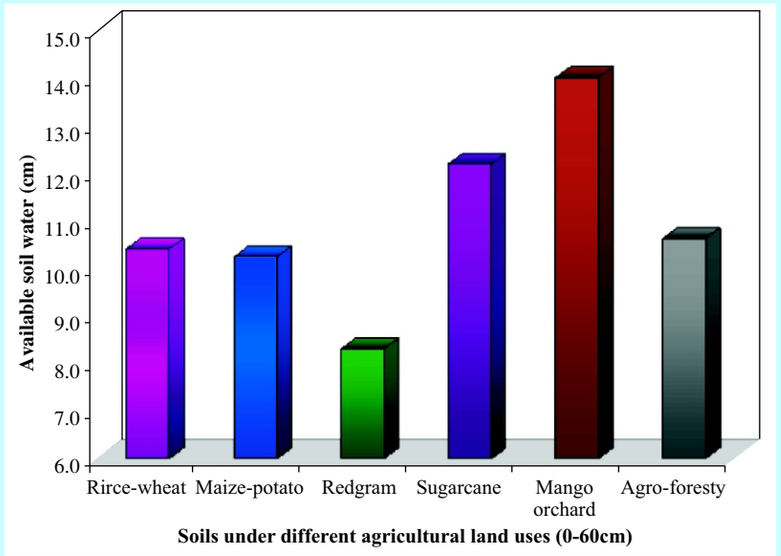


Fig. 6. Available soil water under different agricultural land uses in old alluvium of agro ecological region 9 of south Bihar

Theme 2 : Plant genetic resource management and improvement of field, horticultural and aquatic crops

2.1.1 : Genetic resource management and improvement of fruit and ornamental crops

(Bikash Das, B.R. Jana, S. Kumar and I. Tirkey)

Mango

Under the trial on collection, conservation, evaluation and characterization of germplasm, one mango genotype "*Loha Jung*" was collected from Munger district of Bihar. A total of 117 mango genotypes were evaluated and characterized based on 34 fruit characters and yield. The average fruit weight and pulp weight ranged between 103.5 g and 42.8g (Bhura) to 963.5 g and 750.1g (Sahabale), respectively. The pulp content ranged between 37.5 per cent i in Amine to 89.7 percent Nasik Pasand. Maximum TSS was recorded in case of the genotype Dashehari-51 (25.8°B) whereas the highest TSS/Acid ratio was recorded in case of the genotype Bhura (282.8). However, based on fruit quality parameters, the genotypes Piyara Phulo, Darbar-E-Kalam, Hur, Mahmood Bahar, Amin Abdul Ahmed Bahar and Kumar Pahar were found promising (Fruit weight 250 to 600g, Pulp content > 70%, TSS > 19°B, TSS/Acid 100 to 150, pulp- fibreless). Under the trial on performance evaluation of 20 commercial varieties, variety Himsagar was found to be most promising with respect to fruit yield and quality (fruit wt. > 250 g, pulp content >70%, TSS >19°B and yield > 80 kg/plant of age 29 years). Other high yielding varieties found promising were Zardalu, Bombay Green, Bangalora, Maldah, Neelam, Fazli, Langra, Swarnarekha and Chausa. Twenty four hybrids of mango were evaluated for fruit quality and the hybrids Mallika, Manjeera and Ratna were found promising for the trait (fruit wt. > 250 g, pulp content >70%, TSS >19°B).

The cultivar Himsagar found most promising amongst commercial mango cultivars

Litchi

Performance of 23 litchi genotypes was evaluated for fruit quality and yield. The fruit weight ranged from 9.85 g in Swarna Roopa to 22.9 g in Deshi. The seed weight ranged from 1.2 g (CHL-9) to 4.03 g (Ajhauli) whereas, the pulp weight ranged from 5.15 g (Green) to 16.61 g (Deshi). The pulp per cent ranged from 46.48 (Green) to 72.54 (Deshi). The maximum TSS (21.2°B) was recorded in Lal Bombai. Per cent fruit drop ranged from 15.4 per cent

(Green) to 61.3 per cent (Late Bedana). Among the fully grown up plants, the maximum fruit yield was recorded in case of CHES-II (39.1 kg/plant). However, keeping in view of the overall performance, Deshi was found most promising (fruit weight 20.1 g, pulp content 72.5 per cent, TSS 20.2°B and yield 32.5 kg/plant).

Guava

Thirty two guava genotypes were evaluated based on their fruit physico-chemical parameters. The results of the quality attributes of rainy season guava crops revealed maximum fruit weight of 196.8 g in cultivar Sardar. The cultivar Pear shaped recorded the maximum T.S.S. of 10.66°B followed by cultivar Barkhana (9.6°B). The maximum total sugar content of 6.12 per cent was found in cultivar Chittidar A.C. followed by Pear shaped (5.91%). The cultivars Florida Fleshed and Kairala seedling accounted for maximum ascorbic acid content of 313.3 and 312.4mg/100gm, respectively.

In case of winter season guava, the cultivar Allahabad Safeda and Chittidar A.C. recorded the maximum fruit weight of 272 g and 265.6 g, respectively. Maximum T.S.S. content of 14.6°B was found in cultivar Pear shaped followed by Sardar (11.96°B). It has been found that the cultivar Chittidar A.C. had the highest total sugar content of 6.96 per cent followed by Pear shaped (6.72%). The cultivar Florida Fleshed accounted for the maximum ascorbic acid content of 358.6mg/100gm pulp, followed by the cultivar Kairala seedling (357.6 mg/100gm).

In summer crops, the cultivar Seed Drop had the maximum fruit weight of 135.1 g. The highest T.S.S. content of 14.16^{0}B was found in cultivar Ishqwala followed by Mild Fleshed (13.26^{0}B). The cultivar Surkh Gudi exhibited the maximum total sugar content (7.41 %) whereas, the cultivar seed drop recorded the maximum ascorbic acid content (270.1mg/100 gm pulp).

From quality point of view, cultivars like Sardar, Pear shaped, Barkhana, Chittidar A.C., Kairala seedling, Florida Fleshed, Allahabad Safeda, Ishqwala, Surkh Gudi and Seed Drop were found suitable for cultivation under eastern plateau and hill region.

Sapota

Performance of nine sapota genotypes of 10 years age were evaluated. The average fruit weight ranged from 52.4 g (Bhuripatti) to 145.2 g (DHS-2) whereas, the pulp content ranged between 79.8 per cent (DHS-1) to 88.7 per cent (Mahayothi). The maximum yield was recorded in case of Bhuripatti (30.63 kg/plant). However, based on overall fruit quality and yield, the genotype Murabba was found most promising (fruit wt. 113.9 g, pulp content 88.01 per cent, TSS 25.25^{0}B and yield 7.37 kg per plant).

Sapota genotype Murabba found promising

2.2.2 : Evaluation of advance breeding lines and maintenance breeding in solanaceous and cucurbitaceous vegetable crops

(A.K. Singh, R.S. Pan, J.P. Sharma and P. Bhavna)

A. Brinjal

Evaluation of advanced breeding lines

16 progeny were evaluated in F_6 generation for desirable economic traits, reaction to fruit borer and disease reaction to bacterial wilt under natural field condition. From the existing population, twelve individual plant progenies were selected for further study (Table 6). Highest yield was recorded in Swarna Pratibha x HAB- 899-3-3 (85.28 t/ha) followed by HABL-2 x HAB- 381-1-1 (68.86 t/ha) and HABR-6 x HAB -899-1-3 (64.13 t/ha). All these progenies were found to be wilt resistant. Reaction against fruit borer was lowest in HABL-1x HAB-381-2-3 (21.79%) followed by Swarna Pratibha x HAB-792-4-1(23.69%) and HABL-1 x HAB-792-1-1(24.50%).

Table 6: Performance of promising advance breeding lines (F_6) of brinjal

Name of crosses	No. of fruits/ plant	Yield/ plant (kg)	Fruit yield (t/ha)	Fruit weight (g)	Fruit length (cm)	Fruit shape and colour	Fruit Borer damage (%)	Plant height (cm)
Swarna Pratibha x HAB-792-1-2	41	3.12	53.4	114.4	15.6	Long, dark purple	29.16	104.3
Swarna Pratibha x HAB-792-4-1	46	2.25	50.7	88.6	14.9	Long, dark purple	23.69	93.0
Swarna pratibha x HAB-792-3-1	43	2.87	46.1	117.	17.7	Long, dark purple	26.03	117.2
Swarna pratibha x HAB-792-5-2	61	4.20	56.8	110.6	15.2	Long, dark purple	31.73	88.9
HABL-1 x HAB-899-1-1	38	2.16	43.9	95.2	15.8	Long, green	30.06	63.6
HABL-2 x HAB-381-2-1	33	1.87	34.2	103.2	17.0	Long, dark purple	32.78	69.6
HABL-1 x HAB-792-1-1	43	3.47	47.8	84.4	18.6	Long, dark purple	24.50	87.8
HABL-1x HAB-381-2-3	55	2.91	55.9	55.8	15.2	Long, green	21.79	90.6
HABL-2 x HAB-381-1-1	47	2.50	68.8	80.0	14.4	Long, dark purple	34.91	85.2
Swarna Pratibha x HAB-899-3-3	31	2.72	85.3	156.0	18.0	Long, light purple	26.63	89.8
HABR-5 x HAB-381-1-1	32	1.82	51.3	83.8	11.3	Oblong, purple	35.77	51.3
HABR-6 x HAB-899-1-3	27	2.91	64.1	200.0	10.7	Round, purple	37.98	76.2

HABR-5 x HAB-381-1-1

HABL-1 x HAB-381-2-3

Promising lines of brinjal in advance generation

Evaluation of germplasm

102 germplasm received from NBPGR, New Delhi were evaluated with seven check in augmented block design. Highest yield was recorded in IC-285126 followed by IC-809900 (Table 7).

Table 7 : Promising lines of brinjal

Sl. No.	Acc. no.	No.of fruits/ plant	Yield/ plant (kg)	Fruit weight (g)	Fruit length (cm)	Fruit breadth (cm)	Fruit shape and colour	Plant height (cm)
1	EC-329327	15	1.48	150	9.3	5.6	Round purple	62
2	IC-809900	29	1.81	200	16.5	5.6	Long light purple	73
3	IC-090146	12	0.54	150	10.5	5.0	Oblong light green purple	58
4	IC-261786	13	0.85	125	17.0	4.0	Long green	68
5	IC-261793	3	0.39	275	8.5	9.5	Round green striped	64
6	IC-280952	14	0.71	150	15.0	4.5	Long light purple	62
7	IC-285126	21	3.29	300	11.4	8.2	Round green	84
8	IC-545948	32	1.53	50	4.3	5.0	Round green striped	67
9	IC-90141	13	0.93	300	13.4	7.4	Oblong light purple	68

AICRP (Vegetable Crops) trials

In brinjal long hybrid IET, 09/Brlhyb-5 (7.18 t/ha), AVT-1, 08/ Brlhyb-1(26.37 t/ha) followed by 08/ Brlhyb-3 (23.37 t/ha) and AVT-II HABH-13 (46.75 t/ha) and DBHL-20 (11.40 t/ha) performed better than the best check ARBH-201 (6.16 t/ha).

Three lines HABR-21 (round varietal IET), HABL-4 (long varietal IET) and HABL-5 (long varietal IET) were included for multilocational testing under AICRP (VC) trial**.**

B. Tomato

Evaluation of advanced breeding lines

Ten individual plant progenies were evaluated in F_6 generation for desirable economic traits and reaction to bacterial wilt under field condition. Fruit yield ranged from 22.31 49.96 t/ha and acidity varied from 0.22-0.33 %. The highest yield was recorded in Swarna Lalima × CH-193 followed by HAT-44 × HAT-9 and HAT-120 × HAT-162-5-2 (Table 8).

Table 8: Performance of promising advance breeding lines (F_6) of tomato

Sl. No.	Lines	Yield in (t/ha)	Fruit weight (g)	Fruit length (cm)	TSS (^{0}brix)	Acidity (%)
1	Swarna Lalima x CH-193	50.0	66.0	4.7	4.5	0.26
2	HADT-293 x Swarna Lalima	36.2	78.5	3.8	4.0	0.28
3	CHRT-4 x Swarna Lalima	44.7	100.0	4.8	4.2	0.25
4	BT 17-3 x Swarna Lalima	36.5	62.5	4.0	4.0	0.30
5	CHDT-7 x CH-180	33.8	59.5	3.8	4.2	0.31
6	HAT- 44 x HAT- 9	46.0	75.0	4.0	4.0	0.24
7	CHRT-4 x Swarna Lalima -1	63.6	110.0	4.8	4.0	0.26
8	HAT- 44 x HAT- 9-1	22.3	80.0	4.5	4.2	0.22
9	HAT-120 x HAT-162 -5-2	44.7	65.0	4.4	4.4	0.30
10	HAT-171 x Swarna Lalima	40.8	85.0	4.5	4.8	0.33

Promising Advance breeding lines

Development of improved variety / hybrid suitable for protected cultivation

Eight F_1 crosses were made using Swarna Lalima as female parent and eight exotic lines as male parent for development of bacterial wilt resistant hybrid / inbred. One promising F_1 hybrid and three promising open pollinated lines were evaluated under protected condition. Highest yield was recorded in hybrid Swarna Lalima x EC-596741 (18.8 t/ha; resistant to bacterial wilt) followed by EC-596741 (16.4 t/ha; resistant to bacterial wilt). First harvest was recorded after 70-80 days of transplanting. Harvesting period ranged from 180-200 days (Table 9).

Table 9 : Performance of promising lines and hybrid of tomato

Sl. No.	Name of entry	No. of fruits/ plant	Yield/ plant (kg)	Yield (t/ha)	Fruit weight (g)	Fruit length (cm)	Plant height (m)	TSS (° brix)	Acidity (%)
1	Swarna Lalima x EC-596747 (F1)	303	12.45	18.8	65	4.20	4.5	5.2	0.30
2	EC-596741	83	8.00	16.4	120	6.3	4.2	4.5	0.26
3	EC-596742	95	6.65	12.2	90	9.7	2.1	5.0	0.29
4	EC-596743	125	8.75	14.3	70	6.1	3.5	4.8	0.30

Swarna Lalima X EC-596747

EC-596742

Promising hybrid and variety under protected condition

AICRP (Vegetable Crops) trials

In tomato determinate hybrid IET, 09/TODHYB-9 (103.7 t/ha) followed by 09/TODHYB-8 (94.7 t/ha) and 09/TODHYB-4 (82.9 t/ha) performed better than the best check ARTH-3 (42.0 t/ha).

In tomato determinate hybrid AVT-I, 08/TODHYB-1 (110.0 t/ha) followed by 08/TODHYB-2(87.1 t/ha) and 08/TODHYB-3 (47.2 t/ha) performed better than the best check ARTH-3 (42.0 t/ha).

In tomato determinate hybrid AVT-II, TH-670 (105.0 t/ha) followed by DARL-305(100.9 t/ha) and NTH-1389 (99.1 t/ha) performed better than the best check ARTH-3 (42.0 t/ha).

In determinate AVT-II, highest yield was recorded in PAU-2374 (105.0 t/ha) followed by PAU-2372 (99.6 t/ha) and best check variety NDT-9 (119.5 t/ha).

In tomato determinate IET, 09/TODVAR-1 (102.9 t/ha) followed by 09/TODVAR-4 (100.4 t/ha) and 09/TODVAR-6 (84.1 t/ha) performed better than the best check H-86 (75.1 t/ha).

In tomato determinate varietal AVT-II, VTG-90 (102.9 t/ha) followed by HADT-294 (101.1 t/ha) and PAU-2371 (100.4 t/ha) performed better than the best check DVRT-2 (69.3 t/ha).

In cherry tomato varietal AVT-II, highest yield was recorded in HAT-20 (85.8 t/ha.) followed by VTG-95 (83.6 t/ha) and HAT-121 (76.9 t/ha.)

C. Chilli

Evaluation of advanced breeding lines

Individual plant progeny were evaluated in F_4 generation for desirable economic traits and reaction to bacterial wilt under field condition. Out of these 46 individual plant progenies were selected on the basis of green fruit yield, pungency, farmers preference for further and study in F_5. Fruit yield ranged from 0.41 1.2 kg/plant. Highest yield was recorded in HC-62 x HC-34-1-4-2 d followed by HC-8 x HC-51-4-4-1 and HC-7x HC-23-1 (Table 10).

Table 10 : Promising advanced breeding lines of Chilli

Name of crosses	No. of fruits/ plant	Yield/ plant (kg)	Fruit weight (g)	Fruit length (cm)	Fruit breadth (cm)	Plant height (cm)	No. of primary branches
HC-7 × HC-51-2	220	0.60	2.5	9.0	0.6	57.5	7.0
HC-7 × HC-33-1	278	0.70	3.0	9.0	0.5	61.0	10.0
HC-7 × HC-23-1	252	1.02	4.0	11.5	0.9	86.0	4.0
HC-7 × HC-5-3-3-2	216	0.70	2.0	7.0	0.5	79.0	6.0
HC-7 × HC-5-1-3-2	296	0.90	3.0	8.6	0.8	68.0	6.0
HC-7 × HC-5-1-6-1	256	0.75	1.5	6.5	0.4	80.0	7.0
HC-7 × HC-5-1-6-2	126	0.41	2.0	9.1	0.8	57.0	9.0
HC-7 × HC-5-1-6-3	195	0.65	1.5	6.5	0.6	68.0	7.0
HC-7 × HC-5-2-6-1	175	0.70	1.5	6.2	0.7	63.0	7.0
HC-7 × HC-5-2-6-2	155	0.50	1.5	6.5	0.6	63.0	5.0
HC-8 × HC-34-1-1	289	0.65	1.0	4.5	0.5	70.0	9.0
HC-8 × HC-34-1-2	196	0.65	1.0	4.5	0.8	75.0	8.0
HC-8 × HC-34-2-1	354	0.62	1.0	6.0	0.4	75.0	6.0
HC-8 × HC-34-2-2	430	0.85	1.5	5.5	0.5	74.0	7.0
HC-8 × HC-51-4-4-1	566	1.17	1.5	7.4	0.4	78.5	9.0
HC-8 × HC-51-2-5-2	275	0.70	2.5	6.5	0.7	61.0	8.0

HC-8 × HC-51-2-2	227	0.75	1.5	7.0	0.5	74.0	7.0
HC-8 × HC-51-2-6-2	354	0.77	1.5	7.3	0.8	81.0	7.0
HC-51 × HC-33-1-1	324	0.79	1.5	7.5	0.6	87.0	6.0
HC-8 × HC-51-1-1	230	0.70	1.5	7.3	0.4	64.5	7.0
HC-8 × HC-37-1-1	400	0.75	1.5	6.0	0.5	79.5	9.0
HC-8 × HC-37-2-1	238	0.67	1.5	5.0	0.7	69.0	6.0
HC-8 × HC-37-2-2	201	0.55	2.0	7.2	0.7	76.0	6.0
HC-8 × HC-62-1-1	256	0.75	1.5	5.2	0.7	65.5	7.0
HC-51 × HC-62-1-4-1	405	0.90	1.0	5.0	0.6	66.5	6.0
HC-51 × HC-62-1-4-2	184	0.55	1.0	5.1	0.8	67.0	8.0
HC-51 × HC-62-1-1	272	0.40	2.0	7.0	0.8	59.0	6.0
HC-51 × HC-62-1-2	191	0.50	1.0	6.2	0.5	65.0	6.0
HC-51 × HC-37-1-2-1	293	0.87	1.5	7.3	0.8	79.0	7.0
HC-33 × HC-5-1-2-1	292	0.72	1.0	6.7	0.5	59.5	5.0
HC-33 × HC-5-1-2-2	330	0.90	1.0	7.0	0.6	68.0	6.0
HC-33 × HC-5-1-1-2	292	0.50	1.0	5.0	0.7	58.0	4.0
HC-33 × HC-62-1-8-1	154	0.60	3.0	6.2	1.1	70.0	6.0
HC-33 × HC-62-1-8-2	195	0.85	2.0	8.0	0.9	71.0	6.0
HC-5 × HC-34-1-2-2	204	0.66	1.5	5.3	0.6	93.0	5.0
HC-5 × HC-34-2-8-1	316	0.55	1.0	5.0	0.6	70.0	6.0
HC-5 × HC-34-2-8-2	403	0.48	1.0	5.0	0.6	67.0	8.0
HC-62 × HC-34-1-8-1	296	0.80	1.5	7.0	0.6	79.5	7.0
HC-62 × HC-34-1-8-2	423	0.75	1.0	6.0	0.6	77.0	7.0
HC-62 × HC-34-1-8-3	285	0.50	1.0	6.0	0.6	76.5	4.0
HC-62 × HC-34-2-1-1	401	0.62	1.0	4.8	0.4	77.5	6.0
HC-62 × HC-34-2-1-2	384	0.50	1.0	5.0	0.6	59.5	6.0
HC-62 × HC-34-1-4-1	187	0.67	1.5	6.5	0.7	66.0	5.0
HC-62 × HC-34-1-4-2	493	1.22	1.0	5.1	0.6	75.5	7.0
HC-62 × HC-34-2-2-1	240	0.87	1.0	4.0	0.4	70.5	6.0
HC-62 × HC-34-4-2-2	327	0.70	1.0	4.5	0.7	90.0	7.0

D. Capsicum

Evaluation and characterization of exotic lines under protected condition

On the basis of desirable traits, 20 bacterial wilt resistant plants were selected. Two capsicum lines, EC-596749 and EC-596750 and seedlings from selected plant were grown in poly house. 18 bacterial

wilt resistant individual plant were selected for further study. Fruit weight length and breadth in the selected progeny ranged from 225 - 300 g, 9.0 - 11.5 cm and 6.0 - 8.1 cm, respectively.

EC-596750-2-1

EC-596750-6-1

Promising lines of Capsicum

Development of coloured capsicum variety

Seedlings from crosses involving commercial hybrid Orobelle (yellow colour) and Bomby (red colour) as a female parent and EC-596750 (multiple virus resistant) as a male parent were grown under protected condition and selfed seed were obtained. In 2009, seven bacterial wilt resistant yellow and red colour bearing fruits selected from segregating population for further study in F_3 generation. Fruit weight length and breadth ranged from 200-300 gm, 8.0- 10.5 cm and 6.0-8.0 cm (Table 11).

Table 11 : Premium attributes of improved lines of coloured capsicum

Sl. No.	Acc. no.	Fruit weight (g)	Fruit length (cm)	Fruit breadth (cm)	Fruit colour
1	Orobelle xEC-596750 -1	220	8.0	6.2	Green and Yellow
2	Orobelle xEC-596750 -2	200	9.2	7.0	Green and Yellow
3	Orobelle xEC-596750 -3	250	10.5	6.5	Green and red
4	Orobelle xEC-596750 -4	200	9.0	6.0	Green and red
5	Bomby xEC-596750 -1	290	10.5	7.0	Green and red
6	Bomby xEC-596750 -2	300	10.5	8.0	Green and red
7	Bomby xEC-596750 -3	275	10.0	7.5	Green and red

Orobelle x C-596750 -1

Bomby x EC-596750 -1

Promising lines of coloured capsicum

AICRP (Vegetable Crop) trials

In hybrid IET, 09/ CIPHIET -1(18.99 t/ha) followed by 09/ CIPHIET-2 (11.84 t/ha) and 09/ CIPHIET-5(11.77 t/ha) performed better than the best check Variety Nishant (10.88 t/ha).

In Varietal IET 09/ CAPVIET-6(18.19 t/ha) followed by 09/ CAPVIET-3 (17.45 t/ha) performed better than the best check Variety Nishant (14.25 t/ha).

E. Pointed gourd

Maintenance of germplasm

Field gene bank is being maintained with 55 lines.

Evaluation of promising clones

Six promising clones were evaluated. Highest yield was recorded in HAP-5 (32.5 t/ha, fruit weight 44g; fruit length10.77 cm; fruit breadth 3.82 cm) followed by HAP-40 (28.6 t/ha, fruit weight 34.8g; fruit length 7.62 cm; fruit breadth 3.62 cm) and HAPEL-1 (28.1 t/ha, fruit weight 55.0g; fruit length 10.26 cm; fruit breadth 3.78 cm).

F. Cucumber

Evaluation and maintenance of gynoecious lines

Progeny of ten individual plants obtained from the cross of Swarna Ageti x EC- 399587 (Gynoceious line) were evaluated in F_7 generation (Table 12). Out of these 10 plants were selected on the basis of predominance of female flower for further study.

Table 12 : Evaluation and maintenance of promising lines

Acc. No.	Node at first female flower appeared	Days to first female flowering	Node at first male flower appeared	Days to first male flowering	Fruit weight (gm)	Fruit length (cm)	Fruit breadth (cm)	Male flower (%)
Gyn-1	4	64	3	53	144	14.4	4.2	20-25
Gyn-2	3	65	5	65	160	16.0	4.6	1-2
Gyn-3	4	55	7	55	210	10.5	5.0	2-5
Gyn-4	3	56	4	54	166	15.8	4.1	2-5
Gyn-5	5	53	7	57	164	15.3	4.1	2-5
Gyn-6	5	65	8	63	172	16.0	4.4	4-5
Gyn-7	4	53	5	65	150	14.0	4.0	4-5
Gyn-8	9	62	7	61	120	15.0	3.8	4-5
Gyn-9	4	53	8	53	150	16.0	4.0	4-5
Gyn-10	5	61	2	55	100	14.0	3.8	20-25

Gyn-3

Gyn-2

Evaluation of promising lines developed through inter-specific hybridization

(*C. sativus* x *C. hardwickii*):

Five stable lines were identified, on the basis of yield, quality, earliness and plant type in F_{10} generation. Highest yield was recorded in HAC-159 followed by HAC-158 (Table 13).

Table 13 : Evaluation of promising lines developed through interspecific hybridization

Acc. No.	No. of fruits/ plant	Yield/ plant (kg)	Yield in (t/ha)	Fruit weight (g)	Fruit length (cm)	Fruit breadth (cm)	Fruit colour
HAC-158	12.0	3.0	41.0	250	16.0	5.0	Whitish green
HAC-159	15.0	3.1	42.5	184	13.2	5.0	Dark green
HAC-160	14.0	2.8	35.0	214	16.0	4.7	Whitish green
HAC-161	20.0	2.0	32.5	100	10.2	3.8	Whitish greeneen
HAC-162	16.0	2.5	36.0	133	14.0	4.0	Green

G. Bottle gourd

Maintenance and evaluation of germplasm

Germplasm were evaluated (25) and selfed seed of these lines has been produced.

Evaluation of promising germplasm during winter season

Promising germplasm (14) along with check cv. Arka Bahar were evaluated Fruit yield ranged from 1.53 - 3.67 kg/plant . Highest fruit yield was recorded in HABOG-6 followed by HABOG-27 and HABOG-16.These lines performed better than check cv. Arka Bahar (Table 14).

Table 14 : Evaluation of promising lines developed through interspecific hybridization of Bottle gourd

Acc. No.	Yield/ plant (kg)	No. of fruits/ plant	Yield (t/ha)	Node at which first female flower appeared	Days to 50% flowering	Fruit weight (kg)	Fruit length (cm)	Fruit breadth (cm)
HABOG-6	3.67	4.23	48.97	6.08	70.00	1.23	39.17	6.77
HABOG-7	2.55	3.53	34.10	4.75	65.00	1.39	44.00	7.33

HABOG-9	2.44	3.17	32.57	5.17	66.33	0.84	31.33	7.27
HABOG-10	2.26	2.60	30.13	5.92	73.0.0	1.34	40.00	7.03
HABOG-11	2.43	2.93	32.37	5.58	70.33	1.21	43.60	8.17
HABOG-12	1.53	1.93	20.39	8.17	82.00	1.15	11.33	15.4
HABOG-13	2.16	2.83	28.77	5.92	75.67	1.28	43.33	8.33
HABOG-16	3.08	3.30	41.15	4.50	67.33	0.95	29.17	6.90
HABOG-17	2.06	2.73	27.46	4.83	66.33	1.07	31.17	7.83
HABOG-22	2.88	3.37	38.46	6.50	67.00	1.27	37.17	8.83
HABOG-25	2.08	2.07	27.70	5.17	72.67	1.75	16.50	12.6
HABOG-26	1.71	2.20	22.88	5.58	71.67	1.33	43.00	7.33
HABOG-27	3.26	4.27	43.46	4.75	66.33	1.25	39.20	8.07
Arka Bahar	2.99	3.60	39.83	6.75	73.00	1.32	40.50	7.23
CV	24.3	23.9	2.42	17.4	6.61	16.9	29.10	28.9
C.D at 5%	0.86	0.98	11.47	1.76	4.72	0.27	4.75	1.40

Advancement of segregating generation

28 segregating populations were evaluated in F_2 generation. On the basis of yield, quality, earliness and plant type 16 individual plant progeny selected for evaluation in F_3 generation.

AICRP (Vegetable Crops) trials

In hybrid IET, 08/ BO Ghyb-6 (22.7 t/ha) followed by 08/ BOG hyb-2 (22.1 t/ha) and 08/ BOG hyb-7 (21.7 t/ha) performed better than the best check Hybrid NDBH-4 (16.4 t/ha).

In varietal IET, 08/ BOG var-7(21.7 t/ha) followed by 08/ BOG var-6 (19.2 t/ha) and 08/ BOG var-3 (19.1 t/ha) performed better than the best check variety NDBG-104 (10.1 t/ha).

G. Bitter gourd

Maintenance of germplasm

Twelve bitter gourd germplasm differing in fruit shape and colour were evaluated and maintained during summer season in field gene bank. Highest yield was recorded in HABG-12 followed by HABG-11 and HABG-17 (Table 15).

Table 15 : Evaluation of bitter gourd germplasm

Acc.No.	Yield in (t/ha)	Fruit weight (g)	Fruit length (cm)	Fruit breadth (cm)	Fruit surface	Fruit skin colour
HABG-1	13.4	55	19.4	2.3	Deep tubercle	Dark green
HABG-4	1.1	35	14.2	2.2	Light tubercle	Light green
HABG-7	2.9	60	13.0	2.0	Light tubercle	Light green
HABG-8	11.7	70	14.8	2.9	Deep tubercle	Dark green
HABG-10	12.5	113	15.5	3.4	Light tubercle	Light green

HABG-11	15.1	98	12.4	4.9	Deep tubercle	Dark green
HABG-12	17.5	137	13.3	5.4	Deep tubercle	Dark green
HABG-13	12.0	124	18.4	13.4	Deep tubercle	White
HABG-14	11.2	116	19.5	4.4	Deep tubercle	Whitish green
HABG-16	7.7	55	13.1	2.2	Deep tubercle	Whitish green
HABG-17	14.5	70	13.8	3.2	Deep tubercle	Whitish green
HABG-18	9.7	82	16.1	2.9	Light tubercle	Dark green

Advancement of segregating generation

Individual plant progenies (25) were evaluated in F_8 generation (summer season). Out of these, 12 single plants were selected for further study in F_9 generation Table 16). The seed of selected plant progenies were sown during first week of June for study in F_9 generation. On the basis of fruit yield, quality, earliness and plant type 12 stable lines were identified. Highest yield was recorded in HABG-28 followed by HABG-33 and HABG-30. These promising lines will be used as new entry for testing in AICRP (VC) for release as new variety.

Table 16: Evaluation of advance generation (F_9) during rainy season

Acc. No.	No. of fruits/ plant	Yield/ plant (kg)	Fruit weight (g)	Fruit length (cm)	Fruit breadth (cm)	Fruit surface	Fruit colour
HABG-23	20	1.5	131	17.1	3.4	Deep tubercle	White
HABG-24	15	2.0	129	23.1	3.2	Deep tubercle	Dark green
HABG-25	22	2.0	70	15.2	2.9	Deep tubercle	Light green
HABG-26	15	1.5	129	24.1	3.5	Deep tubercle	Light green
HABG-27	25	2.2	75	21.7	2.0	Light tubercle	White
HABG-28	32	2.5	60	16.0	3.0	Light tubercle	Green
HABG-29	22	2.1	58	12.2	2.7	Light tubercle	Green
HABG-30	25	2.3	101	19.3	2.6	Deep tubercle	Dark green
HABG-31	25	2.0	40	11.7	2.3	Deep tubercle	Dark green
HABG-32	30	2.0	35	14.2	2.2	Light tubercle	Light green
HABG-33	35	2.5	45	10.7	2.7	Deep tubercle	Dark green
HABG-34	36	2.0	42	10.6	2.8	Deep tubercle	Green

AICRP (Vegetable Crops) trials :

In varietal IET, 09/BIGVAR-3 (6.3 t/ha) followed by 09/BIGVAR-1 (5.8 t/ha) and 09/BIGVAR-2 (5.7 t/ha) performed better than the best check Pusa Domousmi (5.5 t/ha).

H. Pumpkin

Maintenance and evaluation of germplasm

Five germplasm lines were evaluated and maintained in field gene bank.

AICRP (Vegetable Crops) trials

In hybrid AVT-I, none of the hybrids was found better than the best check cv CM-350 (14.8 t/ha).

In varietal AVT-II, PPU-72 (17.9 t/ha) performed better than the best check cv CM-350 (14.8 t/ha).

I. Ridge Gourd

AICRP (Vegetable Crops) trials

In ridge gourd varietal AVT-I, highest yield was recorded in HARG-110 (18.5 t/ha) followed by HARG-109 (11.8 t/ha),and DRG-2 (11.3 t/ha).

J. Sponge Gourd

AICRP (Vegetable Crops) trials

In Sponge gourd AVT-II varietal trial, PSG-100 (23.2 t/ha), followed by PSG-110 (22.8 t/ha) and VR-2 (22.0 t/ha) performed better than the best check Pusa Chikni (11.1 t/ha).

2.2.3 : Management of plant genetic resources and improvement of leguminous and minor vegetable crops

(R.S. Pan, A.K. Singh, S. Kumar, J.P. Sharma, Bikash Das and I. Tirkey)

French bean

Germplasm of Bush type (20) and five of Pole type were maintained through fresh seed multiplication. Out of 12 bush type French bean lines evaluated under sowing on 15.3.209, Contender (14.67 t/ha) and HAFB-3 (5.92 t/ha) among the stringless and round podded lines and IIHR-909 (13.86 t/ha) and Swarna Priya (7.45 t/ha) among the flat podded lines were found promising for summer cultivation with a total of 7 pickings in a harvest period of 33 days (May 9th June 2009). The same lines when evaluated under sowing on 1.4.2009, the round podded lines, Contender (19.94 t/ha) and HAFB-5 (12.56 t/ha) and the flat podded lines, IIHR-909 (15.63 t/ha) and Swarna Priya (10.50 t/ha) were found very promising for summer cultivation with a total of 5 pickings in a harvest period of 23 days (23rd May -15th June, 2009).

Cowpea

Twelve germplasm of vegetable cowpea were maintained through fresh seed multiplication. Out of 4 bush type cowpea lines alongwith the check variety Pusa Komal evaluated during *Kharif* season, the light green and round podded lines HACP-43 (5.9 t/ha) and HACP-44 (5.2 t/ha) were early in flowering (36 days

& 1st picking in 47 days) and recorded 31.77 and 16.91 % yield increases over Pusa Komal (4.4 t/ha), respectively.

AICRP (Vegetable Crops) trials

In French bean (bush type) IET, the entries 09/FBBVAR-7 (20.1 t/ha), 09/FBBVAR-4 (18.6 t/ha), and 09/FBBVAR-2 (18.2 t/ha) performed very well compared to the best check IIHR-909 (15.2 t/ha). In French bean (bush type) AVT-II, Pant B-3 (162.7 q/ha), DPPFBBS-1 (16.1 t/ha) and DWD-FB-57 (15.1 t/ha) performed better than the best check Arka Komal (13.7 t/ha). In Cowpea (bush) IET, the entry 09/COPBVAR-4 (9.5 t/ha) performed better than the best check Kashi Kanchan (9.2 t/ha). In Cowpea (bush) AVT-II, the best check Kashi Kanchan (12.0 t/ha) out yielded all the test entries.

2.2.4 : Management of plant genetic resources and improvement of leafy and underutilized vegetable crops

(R.S. Pan, A.K. Singh, S. Kumar, J.P. Sharma, Bikash Das and I. Tirkey)

Amaranth

48 diverse germplasm of leaf amaranth (Chinese spinach) were maintained through fresh seed multiplication in muslin cloth covered cages. Among the 24 pulling type germplasm evaluated during summer season, the lines HAAMTH-45 (red leaved; 10.3 t/ha) HAAMTH-20 (green leaved; 10.2 t/ha), HAAMTH-36 (red leaved; 9.3 t/ha) and HAAMTH-47 (green leaved; 9.2 t/ha) were found promising for whole plant harvest. Among the 24 multi-cut type germplasm evaluated during summer season, the lines HAAMTH-13 (deep green leaved; 10.5 t/ha), HAAMTH-17 (green leaved; 9.7 t/ha), HAAMTH-33 (green leaved; 9.7 t/ha) performed better than the red leaved variety Pusa Lal Chaulai (9.4 t/ha).

Drumstick

Twenty germplasm collected from Jharkhand, West Bengal and Karnataka were maintained in the field Gene Bank.

Vegetable soybean

Twenty five germplasm lines were maintained through fresh seed multiplication. The line EC 595824 was found promising for its characteristic basmatic flavour of boiled shelled green grain.

Other minor beans

The germplasm of sword bean (2), jack bean (1), winged bean (10), lima bean (1), velvet bean (2), yam bean (1) and cluster bean (1) were maintained.

Underutilized perennial Cucurbits

Two germplasm of Ivy gourd and 5 female and 2 male lines of spine gourd are being maintained in the field Gene Bank.

2.2.5 : Study on genetic diversity in makhana (*Eurayle ferox*)

(Lokendra Kumar and V. K. Gupta)

(a) Development of pure line varieties of makhana

To exploit the already existing genetic variability in available germplasm in makhana, an extensive pure line development programme has been initiated. In this programme, during *kharif* season of 2009, a number of high yielding and desirable plants (20) have been selected. In the forthcoming season single plant progenies of selected material will be evaluated for development of high yielding varieties.

(b) New germplasm collection of makhana and their evaluation

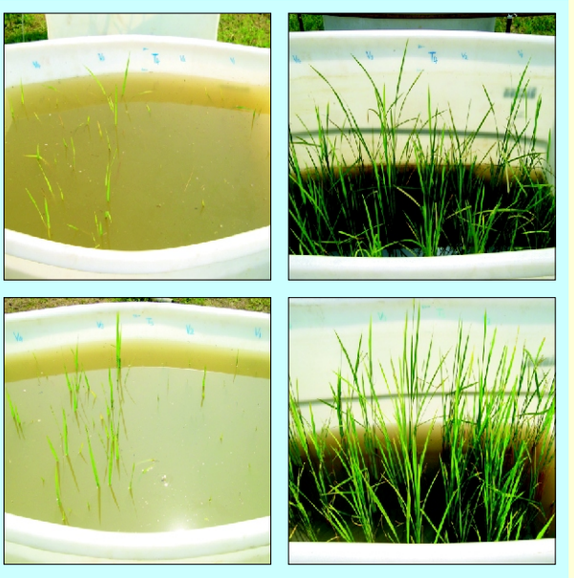
An exploration was undertaken in NEH region- Manipur state in September 2009. In this visit 29 and diverse germplasm of economic importance have been collected from a Imphal East, Imphal West, Bishnupur and Thoubal districts. The collected germplasm has been planted for its evaluation.

Theme 3 : Improved production technologies for field, horticultural and aquatic crops

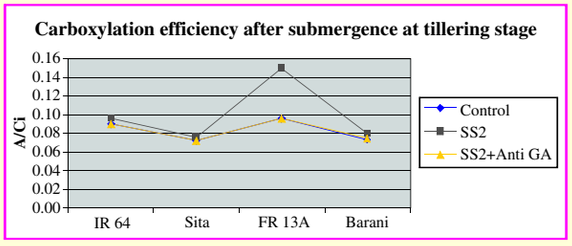
3.1.1 : Physiological management for improved abiotic stress tolerance in rice

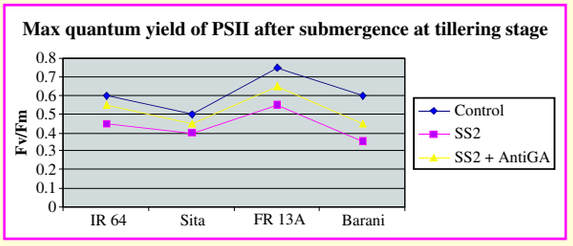
(R. Elanchezhian, A. Abdul Haris and M.K. Meena)

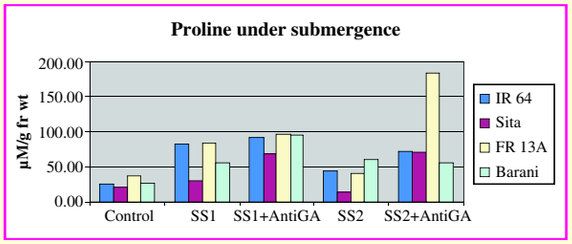
Gas exchange and chlorophyll fluorescence parameters were studied under simulated submergence stress in rice. Four rice varieties viz. Sita, IR64, FR-13A and Bharani were grown in simulated tanks and subjected to submergence stress at seedling and active tillering stages. The effect of submergence stress on gas exchange, chlorophyll fluorescence, proline content and grain yield parameters were measured (Fig. 7). Photosynthesis rate declined in plants subjected to stress under both the stages. Varieties FR-13A and IR 64 recorded maximum photosynthetic rate than Bharani and Sita. Stomatal conductance was also observed to be declining in all four varieties with stress. However, Sita showed lesser decline in conductance with stress than other varieties. Chlorophyll flouresence parameters viz. maximum quantum yield of PSII (Fig.7) electron transport rate, photochemical quenching and non-photochemical quenching were recorded in all four varieties.



Submergence stress to rice varieties under simulation tanks







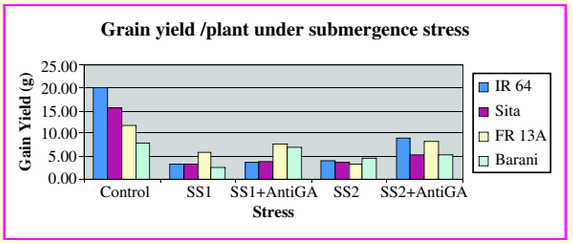


Fig. 7. Carboxylation efficiency, maximum quantum yield, proline content and grain yield of rice under submergence stress

All the parameters except non-photochemical quenching declined with stress at panicle initiation and flowering stage. The decline in yield of PSII, electron transfer rate and photochemical quenching was less in FR 13A followed by Bharani and IR 64. Non-photochemical quenching was higher when stress was imposed among varieties and maximum quenching was observed in Sita. Anti GA application had beneficial effect in maintaining the carboxylation efficiency, quantum yield, proline content and grain yield of plant under submergence stages (Fig. 7) Higher photosynthesis rate coupled with lesser rate of decline in yield of PSII, electron transfer rate and photochemical quenching may have increased the tolerance of variety like FR13 A towards submergence stress.

3.1.2 : Performance of transplanted maize under varying age of seedlings and method of nursery raising

(Sanjeev Kumar, M.K. Meena and R. Elanchezhian)

Transplanting of maize seedlings grown on raised bed, flat bed, sand culture and plastic culture was the main plot treatment, whereas four age of seedling i. e. 4, 5, 6 and 7 weeks were taken as sub-plot treatments.

Low plant mortality, higher plant height, maximum leaf length, and dry matter were recorded in bed sown seedlings which were at par with sand culture. Five weeks old maize seedlings performed better than other aged seedlings (Table 17). Highest yield (5.22 t/ha) was also recorded with sand cultured seedlings, which was at par with raised bed grown seedlings (5.03 t/ha). Five weeks old seedling has given high B: C ratio of 1.97 and 1.93, with sand cultured and raised bed grown seedling, respectively. Maximum B:C ratio (2.22) was on combination of 5 week old maize seedlings with sand culture/ bed sown. Water use efficiency was highest with raised bed grown seedling (176.3 kg/ha/cm) over all other methods of growing seedling while, 5 weeks old seedling had sown highest WUE (173.3 kg/ha/cm). Plastic cultured seedling had performed least due to lesser dry matter accumulation/plant due to weaker seedlings at the time of transplanting.

In the first year it was observed that maize can be easily transplanted by raising its seedlings and if nursery soil is mixed with sand (2:1), resulting less damage to root and higher plant vigour and yield. However, yield of plants grown in raised bed nurseries was at par with that grown in sand culture nurseries. Transplanting 5 week old seedling resulted in maximum grain yield and 22-30 days early maturity over direct sown maize with the same yield level and fits well in the cropping system.

Table 17 : Growth and yield of transplanted maize under seedling raising method and age

Treatments	Mortality %	Plant height (cm) at 90 DAT	Leaf length (cm) at 90 DAT	Dry matter/ plant (g) at Maturity	Days to 50% flowering	Maturity Days	Grain Yield (t/ha)
Seedling Raised method							
Flat bed	9.75	122.3	56.0	380.3	59.17	110	4.71
Raised bed	6.92	129.9	59.2	389.9	57.17	129	5.02
Sand culture	5.75	121.6	59.7	392.8	56.75	135	5.22
Plastic culture	7.67	104.4	47.0	326.9	64.25	144	3.36
C.D.±0.05	1.62	7.7	5.0	96.4	1.15	32.85	-0.43
S.Em.	0.47	2.2	1.5	27.9	0.334	9.52	1.69
Seedling Age							
4 week	7.39	108.8	57.4	361.0	77.24	145	4.50
5 week	6.10	129.9	55.4	473.9	61.33	137	5.72
6 week	8.10	112.6	53.6	354.6	58.25	133	4.49
7 week	8.50	126.9	54.8	290.4	40.50	103	3.60
C.D. .±0.05	2.38	9.3	5.2	56.3	1.57	25.63	0.6
S.Em.	0.82	3.2	1.8	19.3	0.547	8.81	2.1

3.1.3 : Development of sustainable production and utilisation in fruits and ornamental crops

(R.V. Singh, Bikash Das and I. Tirkey)

Horti-silvi-pastoral system for uplands

Under mango based cropping system for uplands of sub-humid regions of eastern Indian plateau, the maximum yield of mango (12.35 kg/plant) was recorded with intercropping of paddy. The yield of guava as

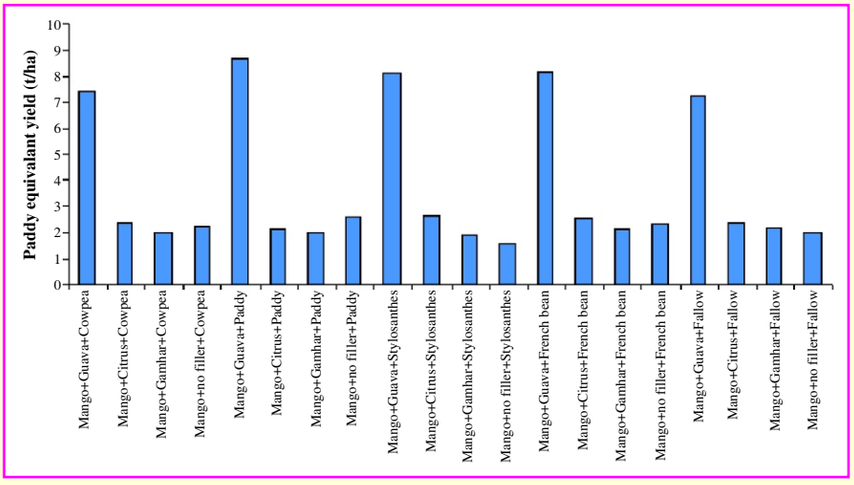


Fig. 8. Paddy equivalent yield under different mango-based multitier cropping systems

filler crop was maximum (18.6 kg/plant) in case of no inter cropping. The performance of test intercrops was recorded to be very poor due to thick shade arising due to overcrowding of canopy of main and filler crops. Low rainfall during June-July and heavy rainfall during the month of September and October also affected the intercrops adversely. In 0-30 cm layer, maximum content of soil organic carbon (0.76) was recorded in case of inter cropping of paddy. During the 11th year, the maximum paddy equivalent yield (8.61 t/ha) was recorded in case of Mango+Guava+Paddy (Fig. 8). However, it is suggested to create open space by pruning of filler plants for growing inter crops profitably or shift to shade loving intercrops for improving profitability of mango based multitier cropping system.

3.1.4 : Regulation of growth and development and nursery management of fruit crops

(Bikash Das, B.R. Jana, S. Kumar, I. Tirkey, A.K. Singh and R.S. Pan)

Standardization of rejuvenation of unproductive mango plants of cv. Amrapali

The experiment is being undertaken since December, 2005 to standardize height of pruning and length of primary and secondary shoot to be maintained for rejuvenation of mango cv. Amrapali planted at a spacing of 5 m x 5 m. Initiation of bearing was recorded in all the treatments during 3rd year of rejuvenation pruning and the number of panicles per plant ranged between 149.5 to 427. The average yield among all the treatments was 41.93 kg/plant, whereas the maximum yield (61.79 kg/plant) was recorded in case of plants with rejuvenation pruning at a height of 2.0 m without maintenance of length of primary and secondary shoots emerged after rejuvenation pruning. Significantly lower yield was recorded in case of rejuvenation pruning at a height of 1.0 m. Rejuvenation pruning at 1.5m with 120 cm length of primary shoot and 60 cm length of secondary shoot resulted in most effective sunlight distribution inside the canopy (an average of 38.04% of light of open space with standard deviation of 12.94 among different parts of the tree canopy).

Heavy bearing in rejuvenated mango plants during 3rd year of rejuvenation

Standardization of GA_3 application for enhanced runner production in strawberry cultivar Douglas

It was observed that none of the treatments resulted in significant increase in number of runners per plant. In general decline in the runner production could be recorded (6.60/plant) than that recorded during

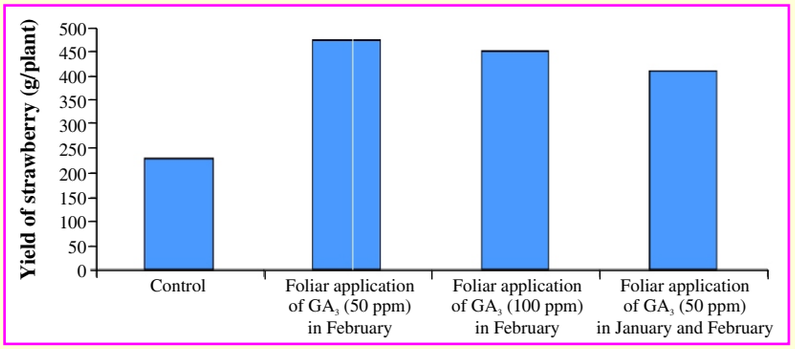


Fig. 9. Effect of GA_3 application on fruit yield of strawberry cv. Douglas

the previous years. This can be attributed to low rainfall during June and July which coincided with peak period of runner production. Foliar spray of 50 ppm and 100 ppm GA_3 in February resulted in significant increase in number of fruits and total yield per plant than that of control (Fig. 9). Hence, it can be concluded that foliar application of 50 ppm or 100 ppm GA_3 during February can increase the fruit yield of strawberry cultivar Douglas.

Standardization of pruning in guava

The experiment is being undertaken to standardize the time of pruning, the length of shoot removal and per cent of plant canopy for increasing the yield of winter crop of guava cv. Sardar under the eastern plateau and hill conditions. None of the treatments resulted in significant increase in the yield of rainy season crop and total yield over that of control. However, significant effect of different treatments was recorded with respect to yield of winter season crop and total income per plant. Pruning 75cm of shoot in 100 percent of canopy on 10th May resulted in the maximum yield (23.25 kg/plant) of winter season crop (Fig. 10). With respect to gross income per plant, pruning 25 cm of shoot in 100 percent of canopy on 20th April (Rs. 858.3) resulted in significant increase over that of control (Rs. 627.5). Hence, yield of winter season crop and gross income per plant, shoot pruning on 20th April was found to be most promising.

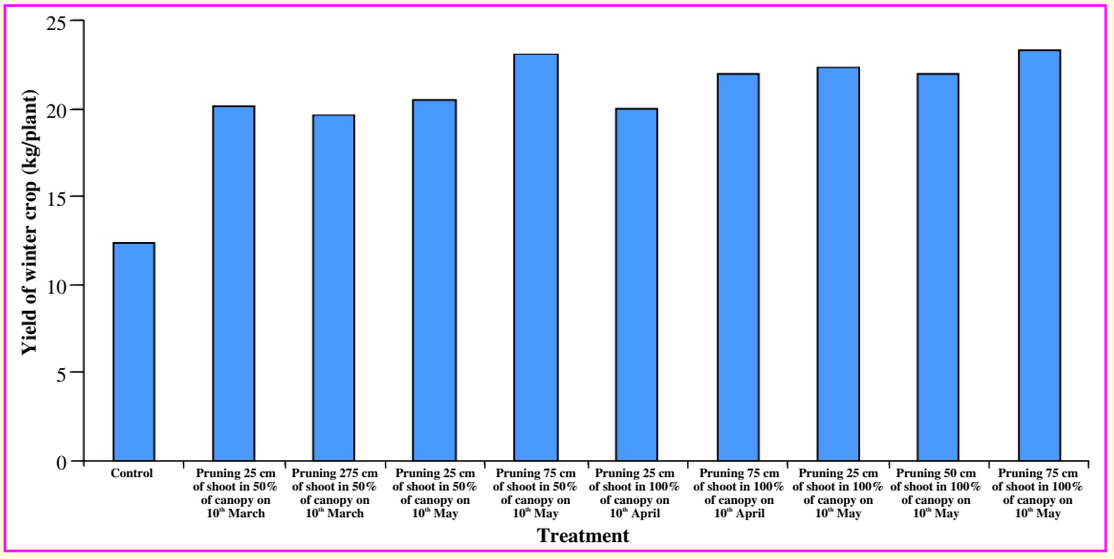


Fig. 10. Effect of pruning on yield of winter season crop of guava *cv. Sardar*

3.1.5 : Development of sustainable production and utilization technology in vegetable crops

(Ranvir Singh and I. Tirkey in collaboration with P. Mahapatra, BAU, Ranchi)

Spacing and fertilization trial on pointed gourd cv. *Swarna Alaukik*

Influence of spacing

Varying intra-row spacing between 50 cm and 150 cm showed significant influence on cumulative yield of fruit in pointed gourd. The highest cumulative yield of 66.81 t/ha was recorded with 50 cm intra-row

spacing which was significantly higher over 100 and 150 cm plant spacings (Fig.11). Increasing the intra-row spacing to 100 cm and 150 cm resulted in reduced yields by 24.44 and 25.36 per cent, respectively. The quality of fruit as well as number of primary branches and diameter of main stem in plant did not show any significant effect of varying plant spacing.

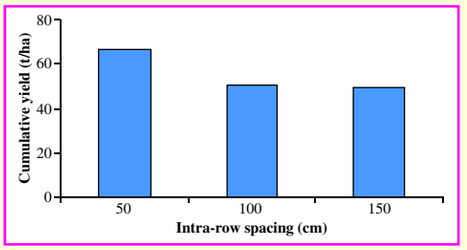


Fig. 11. Effect of spacing on cumulative yield (2006-07 to 2009-10) of pointed gourd cv. *Swarna Alaukik*

Influence of nitrogen

Increasing nitrogen levels between 40 and 160 kg per hectare significantly improved the cumulative yield of fruits (4 years) in pointed gourd. Accordingly, the maximum cumulative yield of 66.40 t/ha was recorded with the application of 160 kg N/ha (Fig.12). Similarly, the maximum cumulative number of fruits (281.6) and yield (6.07 kg) per plant were recorded with the highest level of nitrogen application (160 kg / ha). The quality characteristics of fruit as well as number of primary branches and diameter of main stem in plant did not show any significant effect of graded levels of nitrogen. Analysis of soil properties after three years of experimentation indicated significant decline in pH and improvement in available potassium with increasing doses of nitrogen application. No significant effects of the treatments was observed in case of soil organic carbon, available P, exchangeable Ca, exchangeable Mg, Ca/Mg ratio, available S and HWS-Boron.

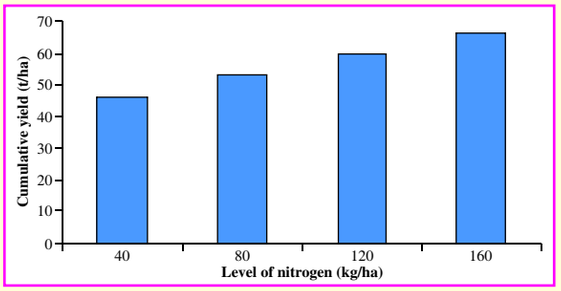


Fig. 12. Effect of nitrogen fertilization on cumulative yield (2006-07, 2007-08 and 2008-09) of pointed gourd cv. *Swarna Alaukik*

Influence of phosphorus

Application of increasing levels of phosphorus between 30 and 90 kg P_2O_5 per hectare did not show any positive effect on cumulative yield of fruits (4 years) in pointed gourd. Accordingly, the maximum yield of fruit (60.23 t/ha) was recorded with 30 kg P_2O_5/ha (Fig.13). Similar effects of phosphorus application were observed with cumulative number and yield of fruit per plant. The quality of fruit as well as number of primary branches and diameter of main stem in plant did not show any significant influence of graded levels of phosphorus application. Analysis of soil properties after three years of experimentation indicated significant decline in pH, EC, available potassium, exchangeable Ca and improvement in content of boron with increasing doses of phosphorus application. No significant effect of the treatments could be observed in case of soil organic carbon, available P, Ca/Mg ratio, available S (Table.18).

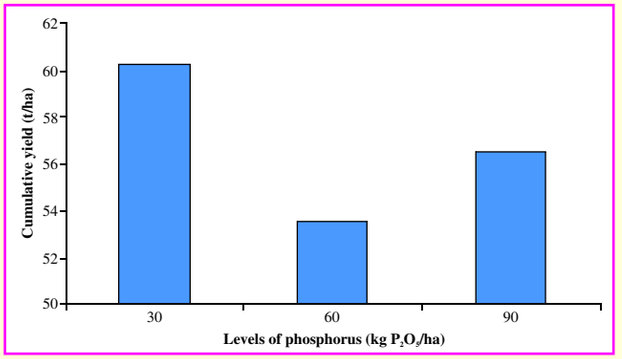


Fig. 13. Effect of phosphorus fertilization on cumulative yield (2006-07, 2007-08 and 2008-09) of pointed gourd cv. *Swarna Alaukik*

Table. 18 : Cumulative effect of three years of phusphorus application on soil properties in pointed gourd cv. *Swarna Alaukik*

Levels of P_2O_5 (kg/ ha)	pH	EC (dSm-1)	Organic carbon (%)	Available P (kg/ha)	Available K(kg/ha)	Exchan-gable Ca (meq/ 100)	Exchan-gable Mg (meq/ 100)	Ca/ Mg ratio	Avaiable S (ppm)	HWS Boron (ppm)
30	6.09	0.04	0.59	65.34	152.53	1.57	0.43	3.96	7.55	0.5
60	6.05	0.04	0.59	128.06	145.41	1.59	0.49	3.76	7.37	0.58
90	5.75	0.03	0.55	105.19	122.81	1.45	0.33	5.56	7.33	0.76
C.D. at 5%	0.17	0.01	NS	NS	25.76	NS	0.12	NS	NS	0.26

AICRP (vegetable crops) trial

1. Studies on vegetable based cropping sequences

The trial comprising seven cropping sequences *viz.* cucumber- paddy- wheat, bitter gourd- paddy-pea, cowpea-chilli-wheat, sponge gourd-okra-potato, bottle gourd-cowpea- tomato, cowpea-onion-wheat and cowpea-okra-pea, was carried out during 2009-10. In summer season, cultivation of cowpea in cowpea-okra- pea cropping sequence recorded the maximum paddy-equivalent yield of 37.36 t/ha which was followed by bitter gourd (31.42 t/ha) in bitter gourd-paddy-pea cropping sequence. The highest paddy-equivalent yield of 41.97 t/ha in rainy season was recorded with chilli in cowpea-chilli-wheat cropping sequence. In winter season, cultivation of pea with different treatments out yielded all other crops grown (65.12 and 79.52 t/ha paddy-equivalent yield). Cultivation of tomato in winter was adjudged to be the next best treatment (57.85 t/ha). The highest total paddy-equivalent yield of 116.89 t/ha was realized with cowpea- okra- pea cropping sequence which was significantly higher than the equivalent yields recorded with all other cropping sequences (Table 19).

Table 19 : Performance of different vegetable based cropping sequences

Treatment	Paddy-equivalent yield (t/ha)			
	Summer	Rainy season	Winter season	Total
Cucumber-paddy-wheat	21.47	4.58	14.51	40.56
Bitter gourd-paddy-pea	31.43	5.19	65.12	101.74
Cowpea-chilli-wheat	12.50	41.98	13.43	67.90
Sponge gourd-okra-potato	15.07	0	56.17	71.24
Bottle gourd-cowpea-tomato	21.89	9.67	57.86	89.41
Cowpea-onion-wheat	14.63	6.48	11.96	33.07
Cowpea-okra-pea	37.36	0	79.53	116.89
S. Em+	-	-	-	0. 98
C. D. at 5%	-	-	-	3.03

3.1.6 : Development of ultra-high density orcharding in guava under Jharkhand conditions (NABARD Funded)

(Bikash Das, Santosh,S. Mali and B.R. Jana)

Pruning in May resulting in profuse flowering of winter season crop

During the third year of orchard establishment of ultra high density guava cultivar Sardar and Allahabad Safeda significant effect of different treatments could be recorded on plant growth, yield of summer season, rainy season and winter season crop and gross income per ha. During winter season, the maximum yield of 12.71 t/ha was recorded in case of pruning to 60 percent of canopy in May, irrigation 20 percent PE, 80 per cent of recommended dose of nutrient + soil application of 2 kg FYM + 50g *Trichoderma* + 50g *Azotobacter* + 50g *Mycorrhizae* + foliar spray of ZnSO4 (0.1%) and boric acid (0.3%). An average yield of 24.04 t/ha could be recorded during the third year of plantation. Pruning three times a year (March, May and October) + irrigation 60 percent PE + application of 100 percent of recommended dose of nutrients + soil application of 2 kg FYM + 50 g *Trichoderma* + 50g *Azotobacter* + 50g *Mycorrhizae* + foliar application of ZnSO4 (0.1%) and boric acid (0.3%) resulted in significantly higher gross income over that of control (Fg. 14).

In case of guava cv. Allahabad Safeda, significant effect of different treatments was recorded on plant growth, yield of rainy and winter season crops, total yield and gross income. However, significant increase in total yield and gross income over that of control was recorded in case of winter season crop. Pruning to 80 per cent of canopy in May, irrigation 20 percent PE, application of recommended dose of nutrient + soil application of 2 kg FYM + 50 g Trichoderma + 50 g Azotobacter + 50 g Mycorrhizae + foliar application of ZnSO4 (0.1%) and boric acid (0.3%) resulted in maximum yield of winter season crop (11.42 t/ha) and total yield (16.35 t/ha). The same treatment also resulted in significant increase in gross income (Rs. 2.1 lakh/ha) over that of control.

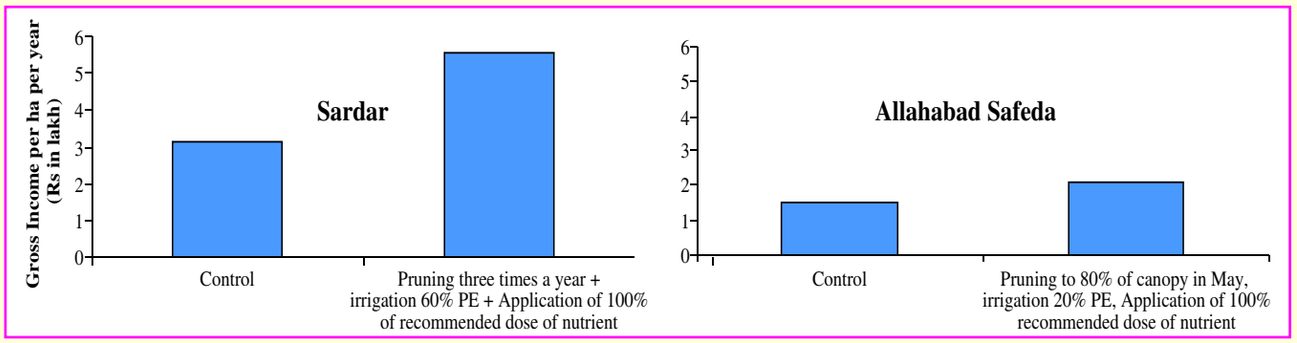


Fig. 14: Gross income from ultra high density orchard of guava cv. Sardar and Allahabad Safeda

3.1.7 : Evaluation of substrates and assessment of water requirement for commercial production of oyster mushroom

(J.P.Sharma and Santosh,S., Mali)

The detailed observetions revealed that water use efficiency in *Pleurotus florida* (PF) was found to be 0.2 to 0.24 kg /litre and 0.18 to 0.24kg/litre in blue oyster mushroom (*Hypsyzigus ulmarius*) (HU) production . These results indicated that 4.16 to 5.0 litre water is required for one kg of *Pleurotus florida* mushroom production and 4.16 to 5.5 litre water is required for one kg blue oyster mushroom (*Hypsyzigus ulmarius*) production. The biological efficiency of *Pleurotus florida* on paddy straw substrate was found to be 84.5 to 89.4 % whereas BE% of blue oyster (*Hypsyzigus ulmarius*) mushroom was 82.7 to 93.3% when spawned in the month of October November (Table 20).

Table 20 : Water use efficiency (kg/litre) in oyster (*Pleurotus florida*) and blue oyster (*Hypsyzigus ulmarius*) mushroom cultivation during 2009-10 on paddy straw substrate

SN	Particulars		Unit 1	Unit 2	Unit 3
1	Temperature (^{0}C)	Max	20.26	20.26	20.26
		Min	14.63	14.63	14.63
2	Humidity (%)	10.0. am	97.2	94.81	93.41
		4.0 pm	97.1	92.1	90.29
3	Fogging time (hours) per unit (T)		3.78	3.65	4.4
4	No of fogger per unit		4	4	4
5	Quantity of water used by fogger (litre)		423.36	408.8	492.8
6	Water used by hand spray (litre)		5.0	0	0
7	Total water used per unit (litre)		428.36	408.8	492.8
8	Yield (kg/unit)	PF	69.299	96.362	67.947
		HU	24.262	0	26.479
9	No of bag /unit	PF	82	108	76
		HU	26	0	32
10	Biological Efficiency (%)	PF	84.51	89.22	89.40
		HU	93.31	0	82.74
11	Total bag /unit		108	108	108
12	Water used per bag (litre)		3.966	3.785	4.563
13	Water used for cultivation (litre)	PF	325.24	408.80	346.79
		HU	103.12	0.00	146.01
14	Water use efficiency (kg/litre)	PF	0.21	0.24	0.20
		HU	0.24	0.00	0.18
15	Quantity of water required for one kg oyster mushroom production (litre)	PF	4.76	4.16	5
		HU	4.16	0	5.5

3.1.7 : AICRP (Mushroom)

(J.P.Sharma)

Strainal evaluation of oyster mushroom (*Pleurotus sajor caju* and *Pleurotus florida*)

Out of five strains of *Pleurotus sajor caju* only two strains viz. PSC3 and PSC 4 resulted in 486.3 g and 616.4 g yield per kg dry straw respectively. In case of *Pleurotus florida, the* strain viz; PF1 (BE 136.2 %), PF4 (BE 124.3%) and PF5 (BE 155.3%) were recorded to be high yielders.

Dehydration of *Calocybe indica and Pleurotus florida*

Dehydration of CI 6 strain of milky mushroom (*Calocybe indica)* revealed that all the five treatments were effective (Fig. 15). The moisture percentage reduced quickly in blanched mushrooms on 2nd day followed by oven drying at 60°C. Their weight was found to remain constant up to 7% after 4th day while sun drying took 5 days (Fig.16). In case of *Pleurotus florida* same treatment were applied and result showed that blanching took less time to dry**.** Blanching (0.2% salt +0.1% citric acid for 2 minutes) and sun drying were found to be best method for drying of milky and oyster mushroom**.**

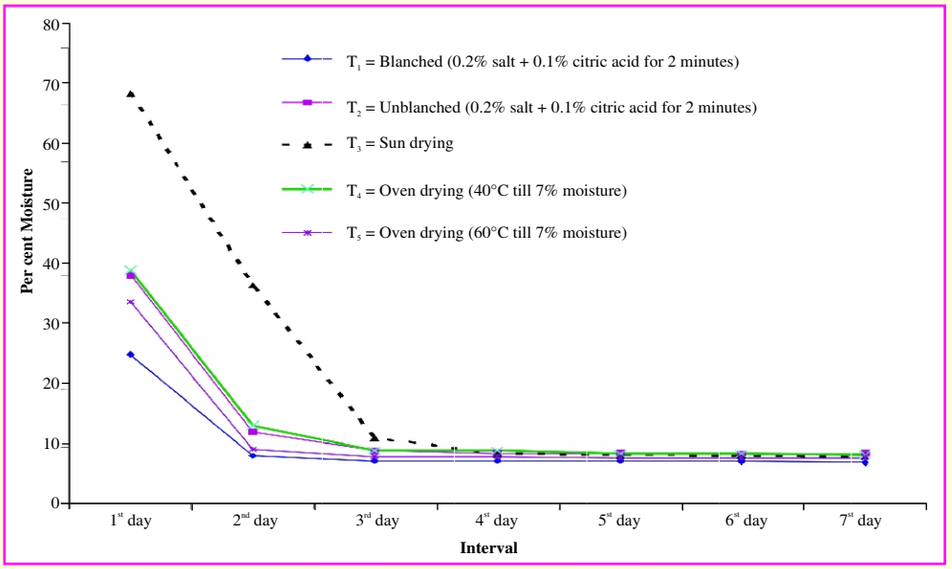


Fig. 15. Effect of dehydration of milky mushroom (str CI-6)with different treatments during 2009

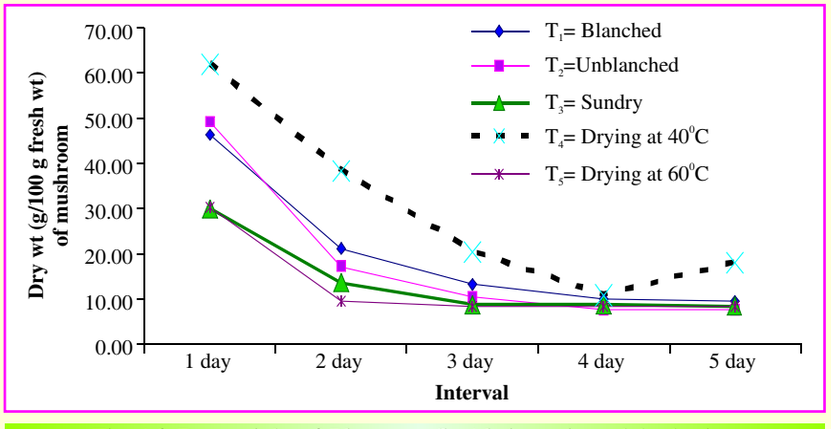


Fig. 16. Dry weight of *Pleurotus florida* in various dehydration treatments during 2009-10

Dried samples of *Calocybe indica*

3.2.1 : Nutrient management in rice lentil cropping system

(A.K. Singh, M.K. Meena and R.C. Bharati)

Four levels of sulphur ($S_1 = 0$, $S_2 = 20$, $S_3 = 30$, $S_4 = 40$ kg/ha) and zinc ($Zn_1 = 0$, $Zn_2 = 4$, $Zn_3 = 5$, $Zn_4 = 6$ kg/ha) were applied to the rice crop and their residual effect on lentil was investigated under rice-lentil cropping system. The texture of soil of experimental area is silty clay loam with mean pH value of 6.8, electrical conductivity 0.16 dS/m organic carbon 0.68 per cent, available nitrogen 244.7 kg/ha, available phosphorus 28.7 kg/ha, available potash 187.8 kg/ha, sulphur 8.3 kg/ha and zinc 0.8kg/ha.

Rice crops under nutrient management in rice-lentil cropping system

Table. 21 : Mean Effects of sulphur and Zinc nutrition on growth, yield attributes and yield of lentil during 2008-09

Treatment	Plant height (cm)	Pod / plant	Grain/ pod	1000 seed weight (g)	Grain yield (t/ha)	Harvest index
Sulphur (kg/ha)						
0 (S_1)	28.7	37.9	1.3	24.7	0.83	0.44
20 (S_2)	30.2	44.8	1.4	24.7	0.87	0.47
30 (S_3)	31.4	47.9	1.4	24.8	0.93	0.48
40 (S_4)	34.6	52.7	1.4	25.0	0.96	0.48
CD at (5%)	4.2	8.2	NS	NS	0.87	NS
Zinc (kg/ha)						
0 (Zn_1)	27.4	38.3	1.3	24.7	0.81	0.44
4 (Zn_2)	30.3	46.1	1.4	24.7	0.87	0.46
5 (Zn_3)	33.6	48.7	1.4	24.9	0.92	0.48
6 (Zn_4)	33.1	50.4	1.4	24.9	0.94	0.48
CD at (5%)	4.2	8.2	NS	NS	0.87	NS

Effects of sulphur and zinc on lentil (Crop season 2008-09)

It was observed that the plant height of lentil was significantly influenced by different levels of Zn and S. The maximum (34.7 cm) and minimum (27.4 cm) plant height at the time of harvesting was recorded in case of Zn_1 treatment and S_4 treatment, respectively. The maximum number of pods per plant were recorded in case of S_4 (52.7) and minimum (37.9) with Zn_1 treatment (Table 21).

Maximum lentil seed yield of 0.96 t/ha was recorded with S_4 treatment whereas lowest yield of 0.82 t/ha was with Zn_1 treatment.

Effects of sulphur and zinc on rice (Crop season 2009)

The plant height of rice was significantly influenced by sulphur as well as zinc. Application of sulphur @ 30 kg/ha (S_3) recorded higher plant height over S_1 and S_2 but was at par with S_4 level of sulphur application. Similar type of response was also recorded in case of zinc application. Application of 5 kg zinc (Zn_3) recorded significantly higher plant height over control (Zn_1). The maximum plant height of 133.6 cm was recorded with Zn_4, whereas minimum (123.3cm) was with S_1 (Table 22). Maximum (7.32) and minimum (5.16) leaf area index was obtained with Zn_4 and S_1, respectively. Treatment Zn_3 produced significantly higher LAI over Zn_1 and Zn_2, but was at par with Zn_4. Application of sulphur @ 20 kg/ha produced significantly higher LAI (6.10) over S_1 and at par with other levels of sulphur.

Lentil crop under Nutrient management in rice lentil cropping system

Number of panicle per square metre, which contributes to the yield, was significantly influenced with each factor. Application of sulphur @ 30 kg/ha (S_3) recorded significantly higher number of panicle/m^2 (349.4) over S_1 and S_2 and was at par with S_4 application. Similar trend was also recorded in case of Zinc application. Maximum and minimum panicle/m^2 was recorded with Zn_4 (358.5) and with S_1 (312.7), respectively.

Minimum and maximum rice yield/ha was obtained with S_1 (6.08 t/ha) and Zn_4 (6.60 t/ha), respectively. Application of sulphur @ 30 kg/ha (S_3) produced 6.46 t/ha rice which was significantly higher than S1 and S_2 but was at par with S_4. In case of zinc, application Zn_3 resulted in significantly higher grain yield over Zn_1 and Zn_2 but at par with Zn_4 level.

Table. 22 : Mean effects of sulphur and zinc on growth, yield attributes and yields of rice during 2009

Treatment	Plant height (cm)	LAI	No. of Panicle / m²	Grain yield (kg/ha)	Harvest index	1000 seed weight
Sulphur (kg/ha)						
0 (S1)	123.3	5.16	312	6080	0.38	15.8
20 (S2)	127.3	6.10	331	6304	0.39	15.9
30 (S3)	130.1	6.65	349	6467	0.38	16.1
40 (S4)	131.6	7.17	345	6534	0.38	15.9
CD at (5%)	2.7	0.62	18	141	NS	NS
Zinc (kg/ha)						
0 (Zn1)	125.6	5.44	315	6105	0.38	15.8
4 (Zn2)	129.2	6.20	335	6341	0.38	15.9
5 (Zn3)	131.6	6.78	354	6497	0.40	16.0
6 (Zn4)	133.6	7.32	358	6602	0.38	16.1
CD at (5%)	2.7	0.62	18	141	NS	0.8

3.2.2 : Crop and resource management practices for sustainable future cereal based systems (CSISA 2, Platform Research)

(S.S. Singh, A.R. Khan, Mohd. Idris and Atul Kumar Singh)

Under Cereal Systems Initiative for South Asia (CSISA), Platform Research has been initiated at Patna for strategic experimental research for future cereal systems with focus on rice-wheat system, its intensification and future diversification for high cereal production with sustainable natural resource management.

Four scenarios of cropping with different residue crop health and nutrient management practices has been sown in three replications having large (1,900 m^2) each plot size (Table 23).

Table 23 : Crop production scenarios and management practices

Scen-arios	Drivers of change	Crop rota-tions (CM)	Crop Management	Tillage in system	Residue management	Crop health	Nutrient management
1	Business as usual	Rice-wheat (current)	Farmers practice	CT-CT	Removal	As usual	As usual
2	Increasing food Demand	Rice-wheat-mungbean	Best Available	CT-ZT-CT	Anchored-removal-incorporation	Best Available	Best Available
3	Increasing food demand, degrading natural Resource senergy, and labor crises	Rice-wheat-mungbean	Conservation Agriculture	ZT-ZT-ZT	Retention-anchored-retention	Best manage-ment	SSNM Based
4	Food nutritional security, intensification and diversifi-cation, farm Profitability	Rice-potato+ maize-mungbean	Best practice	ZT-CT-ZT	Retention-anchored-retention	Best manage-ment	SSNM Based

After harvest of rice and before Laser leveling, soil samples were collected up to 200 cm depth on the basis of EM survey for physico-chemical and microbial studies. Cover crop rice yield varied from 3.0 to 5.0 t/ha under different cropping situation (Table 24).

Table 24 : Crop variety and tillage practices

Tillage	Rice variety	Yield (t/ha)
Puddle transplanted	Sugandha 5	5.0
Puddle transplanted	HUBR 2- 21	3.6
Direct seeded (late)	Abhishek	3.0

In each four scenarios, three levels of crop health management practices (primitive, actual and attainable) have been employed to study its effect on crop growth, incidence of weed, disease and insect pest incidence, yield loss modeling. Major nutrient (NPK) omission plots have been kept in all four crop production scenarios to determine their use efficiency. All inputs (nutrient, irrigation water, chemicals and manpower) are considered to monitor the economics in all scenarios.

Laser leveling

Bed planted wheat

Maize + Potato

Experimental Platform Meeting

3.2.3 : Cultivation of organic rice in makhana-rice cropping system

(*Lokendra Kumar and V. K. Gupta*)

To study the suitability of organic rice production under makhana rice cropping system, an experiment was conducted in post-harvest makhana field and normal field conditions with three popular rice varieties namely Pusa Basmati-1, Pusa Sugandha-5 and PNK-381, planted on 28 July 2009. The comparative performance of these varieties indicates average 35% higher seed yield over the control (Table 25). The result suggest that cultivation of organic rice can be done successfully in makhanarice cropping system.

Table 25 : Comparative performance of seed yield of rice varieties

S.N.	Variety	Seed yield of organic rice in makhana post-harvest field (t/ha)	Seed yield of organic rice in non makhana field (t/ha)	Superiority over control in %
1.	Pusa basmati 1	3.75	2.53	32.6
2.	Pusa Sugandha-5	4.03	2.29	43.2
3.	PNR-381	3.28	2.31	29.5

3.3.1 : Survey and surveillance of insect-pests of rice and wheat cropping system of Patna district of Bihar

(Mohd. Idris and Janardan Jee)

It was observed that the incidence of insect-pests in 2009 was less as compared to 2007 and 2008 in rice (Fig. 17). The mealy bug (*Brevennia rehi*) infestation was observed to the tune of 10-15% in patches at Sabjpura farm. The severe incidence of cutworm was observed at Sabajpura as well as central research farm (CR). Some of the experimental plots were completely damaged at vegetative stage at CR farm. Since the damage was caused at vegetative stage, the crop recuperated at later stage. Due to scarcity of rain in July (av. 4.43 mm) and August (av.12.46 mm), 2009, termite (*Odontotermes sp*) incidence was observed at CR farm in BPT-5204 at vegetative stage. 5-7%. tiller damage was observed at peripheral region of the field. The incidence of gundhi bug (*Leptocorisa oratorias*) was observed above ETL (1-2 bug/hill) at flowering (2.7bug/hill) and milking stages in Satyam, 2.5/hill at milking stage in MTU- 7029 and 1.6 and 1.8 /hill at flowering and milking stages in Rajendra sweta variety at CR farm. However, at Sabjpura the average density (0.9/hill) of bug was in Abhishek. Maximum average d rity at CR farm. Leaf folder (*Cnaphalocr* 29 at maturity. The incidence of yellow s ved.

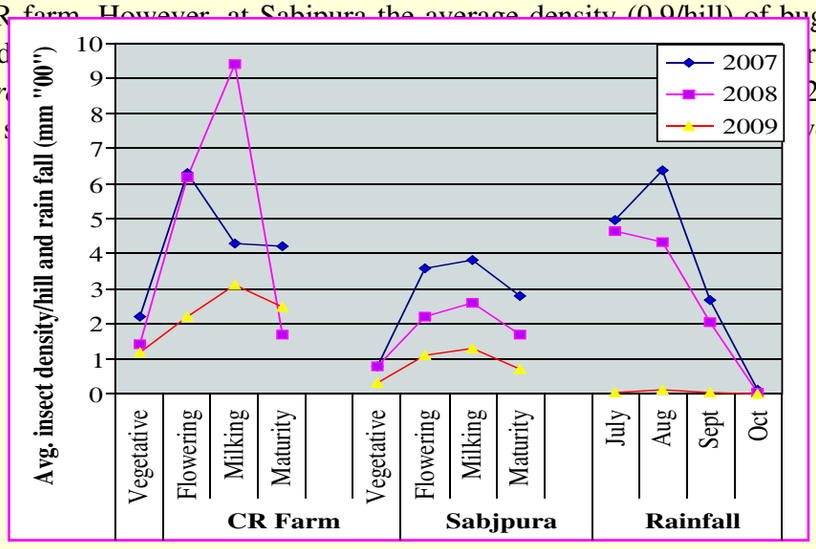


Fig. 17. Insect pests density in rice (MTU-7029) during 2007, 2008 and 2009 in relation to rainfall

3.3.2 : Evaluation of IPM practices for hopper insect-pests of rice crop under local conditions

(Mohd. Idris, Janardan Jee and Sanjeev Kumar)

Seven management practices were evaluated for hopper viz; T_1 Control, T_2 Use of Neem oil spray at the time of appearance of hoppers, T_3 Use of Neem cake at the time of transplanting, T_4 Use of *Beauveria bassiana* (Bb) at the time of appearance of hoppers, T_5 Use of chemical pesticide at the time of appearance of hoppers, T_6 Neem oil + Neem cake, T_7 Neem cake + *Beauveria basiana.* Consecutive long dry periods in July and August resulted in high temperature and low humidity that inhibited the breeding activities of most of the insect-pests of paddy. Brown plant hopper (BPH) and White backed plat hopper (WBPH) were not observed in whole crop season. Green leaf hopper (GLH) population was observed at 90 days after transplantation of the crop in very low number as compared to previous year. Since the population of GLH was below ETL (20 insect/ hill at panicle initiation/booting), no control measure was applied.

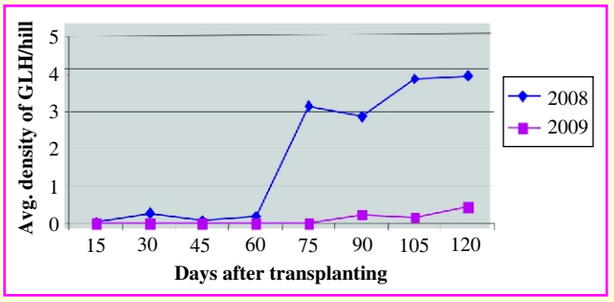


Fig.18. Green leaf hopper population in 2008 - 2009

3.3.3 : Epidemiology and forewarning system of downy mildew disease of cucurbits to develop appropriate IPM strategy (NFBSRAS funded)

(*S. Kumar*)

During 2009 seeds of bitter gourd and ridge gourd were sown on three dates 28 Jan, 12 Feb and 4 Marh in spring season; two dates, 19 June and 17 July during rainy season and ten dates 9, 19, 29 September, 8, 17, 28 October, 7, 17, 27 Novermber and 7 December during autumn winter to monitor the year round population dynamics of cucurbits downy mildew pathogen (*Pseudoperenospora cubensis*) and to assess the inoculum load responsible for the outbreak of the disease. The maximum disease severity (49.25%) was observed on 13 November on 13th leaf of the crop sown on 8 October. Similar severity of disease (48.6%) was also recorded on 08 June on 25th leaf of the crop sown on 12 February. Number of days taken to reach the peak severity varied from 30 to 40 and 09 to 15 days during the rainy season and winter season, respectively.

Conidia and conidiophore of *Pseudoperenospora cubensis*

The susceptibility of bitter gourd was compared with sponge gourd and ridge gourd on crops grown on different dates. The on-station trial on the days taken for the disease initiation was compared in those in on-farm trial. In on-station trial disease initiation was recorded on 25,19 and 14 days after sowing (DAS) as compared to 35,30 and 27 DAS in on-farm trial indicating that initial inoculum load was higher on the farmers fields. It was noted that disease initiated almost at the same time on both the crops and the severity of the disease on the different set of leaves recorded were also same, indicating that both the suscepts respond similarly in disease progression and in epidemics.

Significant number of spore trapping was recorded during 3.00 to 11.00 am. The spore concentration was recorded on 2 mm segments for hourly spore count. The maximum deposition was observed at morning

8.00 am in the months January to March. In the month of December, the maximum spore deposition was observed at morning 9:00 am. After that the spore deposition generally decreased in all dates of observation.

In bitter gourd, the maximum spore concentration of 6.4 x 10^4 / ml of water was observed from leaves collected on 03 December and minimum spore concentration 0.6 x 10^4 / ml of water was found on that collected on 20 March. In ridge gourd, the maximum spore concentration of 7.1 x 10^4 / ml of water was recorded from leaves collected on 03 March and minimum spore concentration 0.5 x 10^4 /ml of water was found from that of collection on 20 March.

3.3.4 : AICRP (VC) trial on evaluation of AVT-II lines of tomato in bacterial wilt sick plot

(J.P.Sharma)

Five elite lines of tomato of AVT-II were tested in bacterial wilt sick plot (Table 26) The data revealed that all the elite lines were resistant to bacterial wilt up to 90 days. The susceptible check (Pusa Ruby) showed the wilting symptom even before 30 day of transplanting and the wilting continued further. Maximum yield was obtained in BMZ-21(24.38 t/ha) followed by US 625 Hybrid tomato (26.64 t/ha) and BT 317 (22.18 t/ha).

Table 26 : Performanc

Entry	Per cent wilt			Yield (t/ha)
	30 day	60 day	90 day	
BMZ-21	0	0	0 (R)	24.38
BT-1	2	2	2 (R)	7.01
BT-317	0	1	1 (R)	22.18
US 625	0	0	0 (R)	26.64
Pusa Ruby	6	42	40 (SC)	4.20
CD(P0.05)				4.20

3.3.5 : AICRP (VC) trial on integrated management of soil borne diseases by use of non-chemicals

(J.P. Sharma)

Incidence of collar rot in French bean (Table 27) was found minimum (7.0%) in soil with application of neem cake (T_4) and also resulted in maximum yield (6.87 t/ha) followed by use of antagonist (T_5).

Treatment	French bean		Tomato	
	% Collar rot	Yield (t/ha)	% wilt at 60 day	Yield (t/ha)
T_1 = Seedling grown in solarized bed	8.7 (16.95)	4.40	88.3 (70.69)	1.29
T_2 = Summer ploughing	10.0 (17.72)	4.93	86.7 (68.66)	4.38
T_3 = Green manure with Black gram	14.7 (21.31)	4.80	88.3 (70.11)	3.25
T_4 = Neem cake @ 10 q/ha	7.0 (14.43)	6.87	80.0 (63.73)	3.81

T_5 = Antagonist (*Trichoderma viride*) seed treatment + soil + seedling dip for 30 min.	7.8 (16.14)	5.33	80.0 (63.54)	3.72
T_6 = Green manure + Antagonist (*Trichoderma viride*)	10.5 (18.45)	5.07	83.3 (66.26)	4.38
T_7 = Green manure +Neem cake @ 10q/ha	8.9 (17.04)	4.93	86.7 (68.66)	3.76
T_8 = Green manure + Neem Cake + Antagonist (*Trichoderma viride*)	14.1 (21.34)	4.93	80.0 (63.54)	6.89
T_9 = Karanj Cake @ 10 q/ha	11.4 (19.73)	5.53	85.0 (67.21)	4.97
T_{10} = Control	14.2 (22.03)	5.20	86.7 (68.85)	2.87
CD (P 0.05)	NS	NS	NS	NS
CV (%)	21.10	19.51	6.48	54.96

Interestingly, green manuring + neem cake with antagonist or without antagonist resulted in enhanced incidence of soil borne disease in French bean as well as in tomato.

Table 27 : Effect of integrated disease management by non-chemical during rainy season 2009

Figures in parenthesis are angular transformed value of percent incidences

3.3.6 : AICRP (VC) trial integrated disease management of bacterial wilt in tomato

(J.P. Sharma)

The experiment was conducted with eleven treatments (Table 28 and Fig. 19) on two varieties viz; Swarna Lalima and Pusa Ruby during summer and rainy seasons of 2009-10. In tomato cv. Swarna Lalima, maximum yield (41.47 t/ha) was obtained in T_9 (combination of all treatments) followed by T_2 (green manuring), T_8 (spent compost) and T_1 (FYM application). The percentage of wilt was recorded to be less than 20 per cent in these plots.

Treatment	Summer Season				Rainy Season			
	Swarna Lalima		Pusa Ruby		Swarna Lalima		Pusa Ruby	
	% wilt *	Yield (t/ha)	% wilt *	Yield (t/ha)	% wilt *	Yield (t/ha)	% wilt *	Yield (t/ha)
T_1 = FYM @ 30 q/ha	15.0	5.69	91.7	0.253	20.0	11.33	58.3	3.33
T_2 = Green manuring	40.0	3.78	88.3	0.167	11.7	22.13	55.0	2.66
T_3 = PGPR @5 kg/ha Soil application	25.0	4.43	85.0	0.420	15.0	5.93	85.0	2.066
T_4 = PGPR (Root diping@1%)	30.0	4.99	78.3	0.307	18.3	4.53	78.3	0.933

T_5 = PGPR (Soil application + drenching)	30.0	3.6	85.0	0.107	10.0	5.47	86.6	0.2
T_6 = Liming @25 q/ha	28.3	4.98	80.0	0.647	11.7	6.13	80.0	0.466
T_7 = Karanj cake @10 q/ha	25.0	3.47	91.7	0.200	13.3	5.8	91.6	0.533
T_8 = Spent compost @10 q/ha	40.0	4.99	81.7	0.233	15.0	12.53	81.6	1.800
T_9 = Combination of all	20.0	6.95	86.7	0.407	0.0	41.47	86.6	4.866
T_{10} = Control	21.7	4.61	83.3	0.233	13.3	6.4	83.3	0.400
T_{11} = Drainage	35.0	5.05	93.3	0.24	25.0	4.6	93.3	0.533
Mean	28.2	4.78				11.48		1.345
CD(P0.05)		NS				4.519		NS

- at 60 days

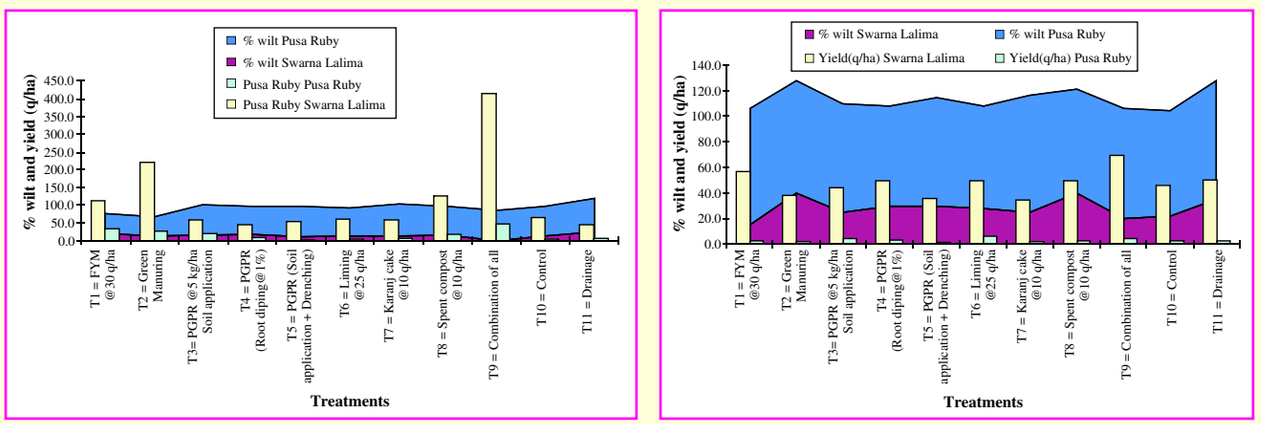


Fig. 19. Effect of integrated management of bacterial wilt in tomato during rainy season 2009

More than 50 per cent wilting was seen in Pusa Ruby variety in both the seasons.

Table 28 : Effect of integrated management of bacterial wilt disease in tomato in summer and rainy season 2009

3.4.1 : Intensification of research on bael (*Aegle marmelos* Correa.) with special reference to medicinal value (in collaboration with National Medicinal Plant Board)

(*B.R. Jana*)

Studies on post harvest management to increase shelf life

Bael samples from cultivar Pant Sujata were harvested and stored at room temperature with four

conditions viz. open crates (T_1), newspaper wrapping (T_2), CFB box packing (T_3) and gunny bag packing (T_4) during 2009-10. It has been found that bael can be stored up to 28 days in ambient temperature without spoilage under all four treatments. Storage life can be extended up to 35 days with 40 percent spoilage with newspaper wrapping and CFB box packing and in both cases 28 % PLW was observed (Table 29).

The maximum TSS of 38.2^{0}B was found with fruit packing in CFB boxes and placed in ambient temperature for 21 days (Table 29). After 21 days of storage, TSS of fruits reduced. Acidity gradually decreased during storage. However, in case of news paper wrapping and CFB box packing, there was slow decrease in acidity. In case of fruit kept in open crates, the acidity was minimum after 35 days of storage. In case of treatment T_2 and T_3 reducing sugar continually increased up to 35 days of storage and it reached up to 8.66 per cent (T_3). In case of treatment T_1 and T_4 reducing sugar content increased till 28 days after storage after which it decreased. Regarding total sugar content, treatment T_2 and T_3 accounted for maximum total sugar content after 28 days of storage after which it decreased. Hence it was concluded that bael can be stor g or CFI ents are

Tab

Storage condition at ambient temperature	7 days after storage	15 days after storage	21 days after storage	28 days after storage	35 days after storage
Open crates	9.56	14.55	19.34	25.78	30.95
Newspaper wrapping	7.94	13.22	17.01	22.96	27.88
CFB box packing	6.90	11.83	15.31	22.04	27.62
Gunny bag packing	8.27	14.11	19.22	27.01	29.01
CD at 5 %	1.12	1.46	2.51	1.05	0.42

Tab

Storage condition at ambient temperature	7 days after storage	15 days after storage	21 days after storage	28 days after storage	35 days after storage
Open crates	36.6	36.9	34.3	30.5	29.8
Newspaper wrapping	36.2	36.7	37.8	34.4	30.5
CFB box packing	36.1	36.8	38.2	34.2	31.6
Gunny bag packing	36.2	36.5	34.5	33.3	29.7
CD at 5 %	NS	NS	0.72	0.45	0.88

CFB box packing of bael fruits and kept in storage for 28 days

Standardization of propagation methods in bael.

Two propagation techniques viz. patch budding and wedge grafting were performed during August 2009 at 1.5 year aged seedlings

collected from forest department at Ranchi. It has been found that wedge grafting accounted for the max... met...

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Treatment	Success (%)	Length of scion (cm)	No. of leaves	Girth of scion(cm)
Patch budding	11.36	2.67	1.75	0.88
Wedge grafting	19.95	2.85	2.51	0.96
LSD ($p \leq 0.05$)	2.34	0.18	NS	NS

3.4.2 : Development of post-harvest processes and machinery for Makhana

(S.N. Jha, Janardan Jee and B.K. Jha)

Makhana seeds roasting and popping unit, one roaster for conditioning and roasting of makhana seeds and other popping unit attached with the roaster for immediate hitting of hot roasted seed for popping having capacity of about 25 kg-conditioned seeds per hour was fabricated. At present the average decortications percentage of makhana seeds was found to be about 68 per cent and the popping percentage ranged from 25 to 28 per cent. Efforts are being made to increase the efficiency of poppal makhana (Table 32).

A series of testing has been done with the help of farmers and processors. The optimum level of moisture content and temperature of roasted makhana seeds were done by conditioning of the seeds by grading to have uniform size in a single batch. The conditioned dry nut having about 20-25 per cent moisture were roasted to reduce the moisture content to 17-18 per cent and pre-tempering the pre roasted seeds for about 30-48 hrs (Table 33)

The desired moisture ranging from 8.1 to 9.6 per cent was observed by weight basis. The barrel tem...

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Sr. No.	Hand arm rpm to feed the makhana seeds	Moisture content of roasted nut (%)
1.	8	9.60
2.	10	9.90
3.	12	10.20
4.	14	10.45
5.	16	10.95

Sr. No.	Impeller rpm	No of seeds fed to popping unit	No. of popped makhana	No. of unpopped kernel	No. of unpopped seeds
1.	1400	141	41	40	60
2.	1400	78	28	22	28
3.	1400	160	34	55	71
4.	1400	143	45	48	50
5.	1400	165	48	43	74

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Sr. No.	Moisture content by weight	No. of seeds	Impeller speed rpm	No. of broken kernel	No. of popped seeds	No. of uncracked seeds
1.	8.6	204	1400	77	36	91
2.	8.6	297	1400	107	35	155
3.	8.7	174	1400	80	26	68
4.	8.1	144	1400	82	7	55
5.	9.6	366	1400	231	9	126
6.	8.0	246	1400	125	32	89
7.	8.2	265	1400	126	19	120

Besides decortification and popping, value added products of makhana were also developed. Particle size of different constituents for formulating the ready-mix of makhana kheer with major parts of makhana were standardized using sensory score of kheer prepared from the developed ready-mix. Mix having sensory scores of 8 or more were selected for shelf life studies in refrigerator and ambient conditions. The mix having moisture content of 14-15 per cent and stored in refrigerators was found to be acceptable with sensory score of more than 6.5 after 3 months of storage in refrigerator, while the same product when stored at ambient it was not acceptable after one month. The microbial loads in the first case were also found to be negligible. The mix having moisture content of about 5-6 per cent showed the same level of acceptability after six months when stored in ambient and about one year in refrigerator. The colour however became darker and time of stirring for preparation of kheer increased from about 0.5 min to about 5 minute in warm water.

Experiments for understanding the kinetics of absorption of milk by whole as well as ground makhana using response surface methodology and factorial designs of experiments, respectively were conducted to optimize the particle size of makhana, total solids and temperature of milk for development of ready to constitute makhana kheer mix. Milk absorption rate by whole popped makhana reduced drastically after about 10 second of absorption. Major dimensions and geometric mean diameters after absorption of milk decreased, which is in contrast with absorption moisture by major agricultural products. Results showed that size of makhana particles between 0.83 to 1.4 mm absorbed milk maximum and is suitable for

Theme 4 : Integrated land and water management

4.1.1 : Development of farmers' friendly Decision Support Tool for selection of beneficial Integrated Farming System components

(*A. Upadhyaya*)

Farmer's friendly "Integrated Farming System Components Selection Model" is useful in taking decision about selection of integrated farming system components based on expected profit under the prevailing constraints and also to suggest beneficial integrated farming system components. The maximum 9 IFS components are categorized for three situations, namely, wet land, mid land, and upland. Situations are displayed components both as farming as well as non-farming based. In farming based components water applied has to be provided in 'cm' whereas in non-farming based it should be provided in 'm^3'. For computing 'Direct' cost of input there is a provision of direct feeding and on double clicking a table having option to calculate total cost of input after taking into account variable cost, fixed cost including interest cost, depreciation cost, and annual rent of building, machinery and facility for farming based and non-farming based.

There is a provision also for computation of three indicators i.e. Benefit-Cost Ratio, Land Productivity (Rs/ha), and Water Productivity (Rs/m^3) from the input data, which seems quite useful in facilitating farmers and other decision makers in exploration and selection of beneficial Integrated Farming System (IFS) components.

4.1.2 : Development of Decision Support Tool for canal operation

(*Adlul Islam, A. Upadhyaya, A. K. Singh and Abdul Haris A.*)

Long term (2000-2007) data at 6 hours intervals on stage and discharge of Ranitalab and Bikram block and daily water release data of three distributaries,Adampur, RPC V and Rewa were collected. Model set up was prepared for the canal network located between Ranitalab and Bikram blocks with discharge hydrographs at the Ranitalab (upstream) and stage hydrograph at Bikram (downstream), and discharge hydrographs at the distrbtatries as boundary conditions. For calibration of the hydraulic simulation model, Manning's roughness coefficient was varied from 0.0225 to 0.0350. Results of simulation showed good agreement between observed and simulated discharges at Bikram block and offtaking points of Adampur, RPC V and Rewa distributary (Fig 20) with 0.025 as Manning's roughness coefficient. The same setup was used for OPTALL model for deciding the optimal release to different distributaries under three different scenarios. Three different scenarios considered were: (i) actual supply from the Ranitalab gate, (ii) design discharge of the Ranitalab gate as the supply from the Ranitalab gate, and (iii) 75% of the design discharge of the Ranitalab gate as the supply from the Ranitalab gate. For estimating crop water requirements, rainfall and evapotranspiration (computed using Penman Monteith method) was estimated at different probability levels and used as input to OPTALL model.

Result of OPTALL simulation using actual release at Ranitalab indicated that there is inequitable distribution of water in different distrbutaries and the actual supply in RPC V is more than the demand. However, in the Adampur and Rewa the actual supply is less than demand in most of the weeks. Simulation results also showed that water can be released equitably and adequately during 11 weeks (23rd-32nd weeks and 33rd week) only in all the three distributaries (Fig. 21). During remaining weeks, though the model allocated water equitably among different distributaries but could not supply water adequately and the supply- demand ratio varied from 0.7 to 0.2.

When simulation is carried out using the design discharge available at the Ranitalab gate, results indicated that water can be released equitably and adequately during 15 weeks (23rd-37th weeks) and during remaining weeks the supply- demand ratio varied from 0.9 to 0.7. When simulation is carried out using 75% of the design discharge at the Ranitalab gate, water can be released equitably and adequately during 11 weeks (23rd-29th 32nd, 34th, 36-37th weeks) and the supply- demand ratio varied from 0.9 to 0.5 during remaining weeks. These results clearly indicate that there is need to develop optimal gate operation schedule for equitable distribution of water among different irrigation schemes (distributaries/ outlets).

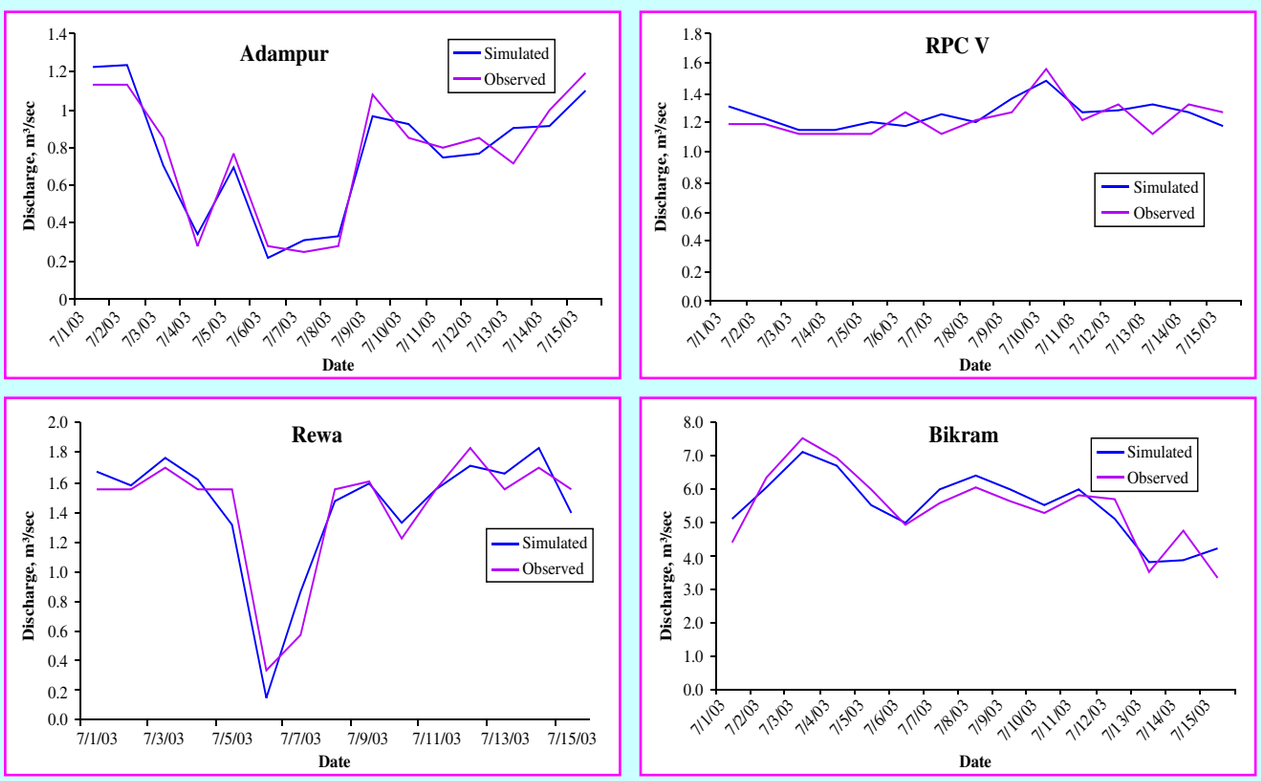


Fig. 20. Simulated and observed flow at different distributaries and Bikram block

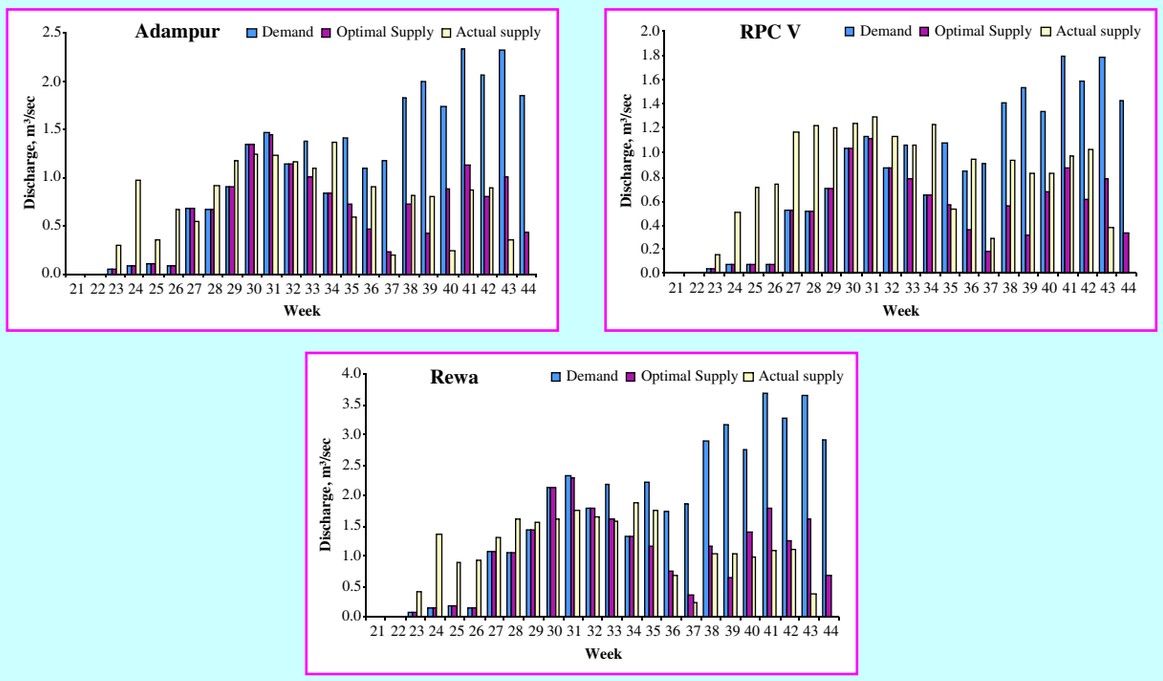


Fig. 21. Comparison of demand, optimal and actual supply during 2003

4.2.1 : Characterization and classification of ground water quality of some parts of Maner block of Patna district of Bihar

(M.K. Meena, B. Saha, A.K. Singh, and Adlul Islam)

Monitoring of ground water quality with special reference to arsenic using water quality index was carried out at selected locations for developing a Decision Support Tool (DST) for the end users. Water samples from different depths ranging from 30 to 120 ft form selected boreholes were collected for analysis of hydrochemistry, especially for arsenic and iron contamination (Fig. 22).

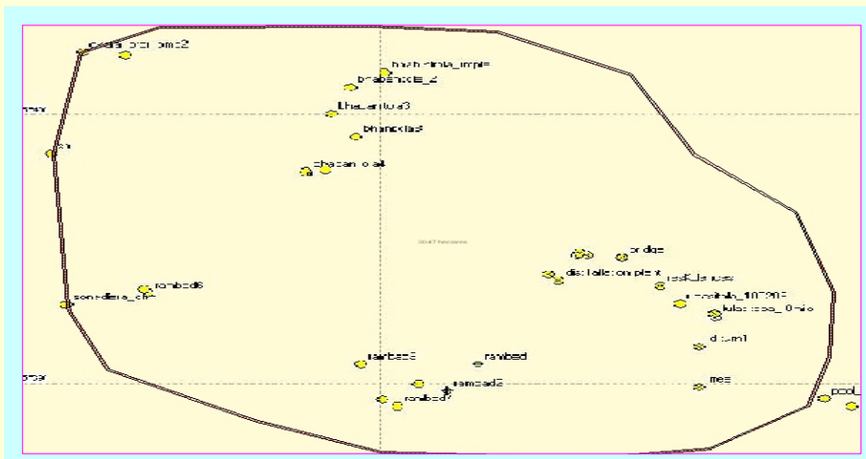
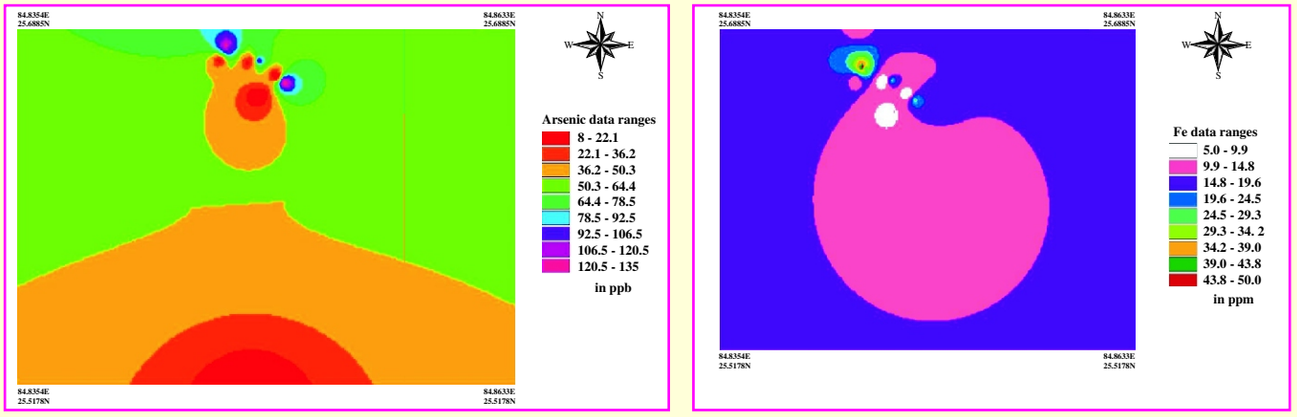


Fig. 22. Study area with GPS Points.

Spatial thematic maps were developed for arsenic and iron content in the ground water used for irrigation to access their spatial distribution in this study area (Fig. 23).



(a) Arsenic (b) Iron

Fig. 23. Spatial distribution of arsenic and iron in the ground water used for irrigation in study area

It was observed that arsenic content was increasing with the depth of soil profile (Fig.24).The arsenic concentration was in the range of 1.65-2.20 ppm in the soil profile near to the river Sone. Further the arsenic concentration in the vegetables and field crops grown in these area, found to be 3.2, 5.0, 3.3, 3.2 and 2.0 ppm of arsenic concentration in potato, mustard, bitter guard, lentil and wheat, respectively.

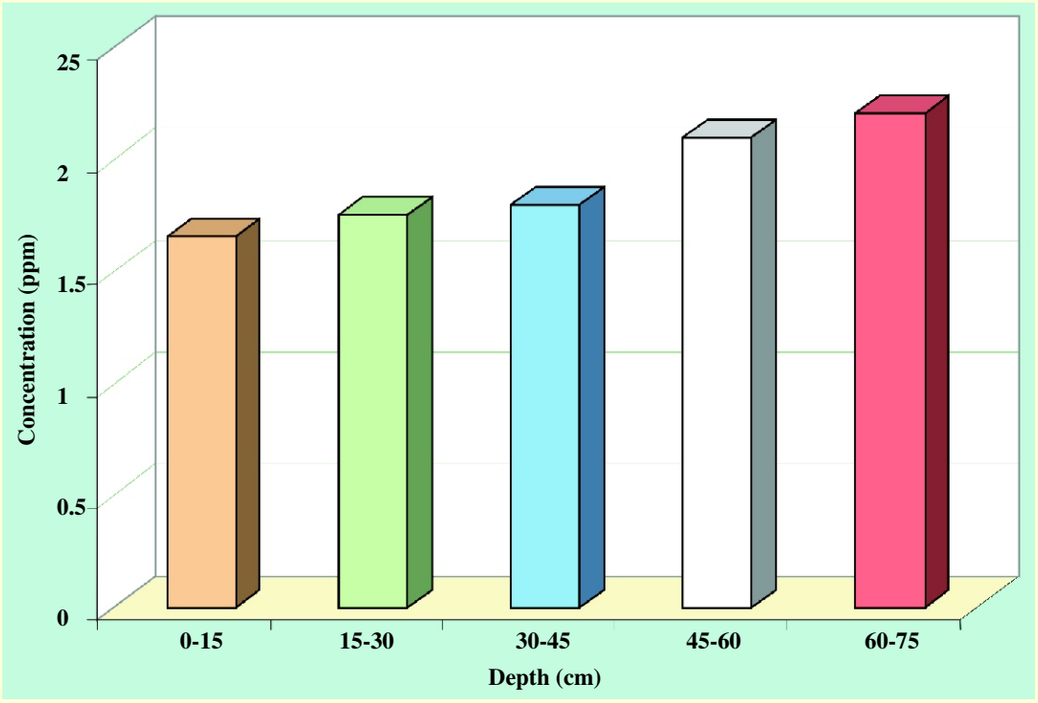


Fig. 24. Depth wise distribution of arsenic in soil profile in study area

4.3.1 : Enhancing and sustaining the land and water productivity through multiple uses of water

(M.A. Khan, Abdul Haris A., A. Upadhayaya, U. Kumar, M.K. Meena , LK. Prasad, P.M.Sherry, D.K. Kaushal and A. Dey)

a) Assessment of land and water productivity under multiple water use systems.

Field experiment was conducted to study water productivity with exchanged water applied to different crop sequences under two doses of fertilizer (100% and 75%) and tubewell water used for irrigating different crop sequences. The following treatments (Table 35) were taken in factorial RBD.

Table 35 : List of different treatments

Treat. levels	Treatments
Crop sequences	
C_1	Rice-wheat-gram
C_2	Rice-potato-onion
C_3	Rice-cabbage-cowpea
Irrigation water with fertilizer dose	
F_1	100% dose of fertilizer with pond water
F_2	75% dose of fertilizer with pond water
F_3	100% dose of fertilizer with Tube-well water

Water productivity of different crop sequences under irrigation from secondary reservoir as well as well tubewell showed that rice-potato-onion sequence recorded significantly higher water productivity (Rs. 7.48/m^3) (Table 36) compared to rice-cabbage-cowpea (Rs. 6.45/m^3) and rice-wheat-green gram (Rs. 6.07/m^3) and different fertilizer doses were not significantly different. Rice equivalent yield was significantly higher with 100 per cent fertilizer application using pond water than 100 per cent fertilizer application with tubewell water.

Table 36 : Rice equivalent yield and Water productivity of different crop sequences

Treatment	Rice Eq. Yield (t/ha)	WP of sequence (kg/m^3)	WP of sequence (Rs/m^3)
C_1 (Rice-wheat-gram)	8.71	0.64	6.07
C_2 (Rice-potato-onion)	16.32	0.78	7.48
C_3 (Rice-cabbage-cowpea)	14.07	0.68	6.45
CD	0.73**	0.069**	0.657**
F_1 (100% Fertilizer with Pond water)	13.62	0.67	6.36
F_2 (75%Fertilizer withPond water)	12.83	0.71	6.79
F_3 (100% Fertilizer with tubewell water)	12.61	0.72	6.85
CD	0.73*	NS	NS

b) Characterization of soil fertility and water quality under multiple use system

Multiple uses of available land and water resources is one of the concept that enhance the overall productivity of the resources by integration of different production systems while keeping one resource as

central theme. The present study is directed towards improving the system productivity by managing and recycling of water within the selected production system and at the same time sustaining the system's resources.

Water quality studies

In-situ water quality of different systems i.e. pond, trench and rice-fish culture was studied periodically (Fig. 25). Temporal water quality variation indicated that there was inverse relationship between oxygen saturation and temperature. The oxygen saturation increases with decrease in temperature during cooler months (8.3 to 9.78 mg/l), while slight increase in pH was observed (7.64-8.35) during winter months.

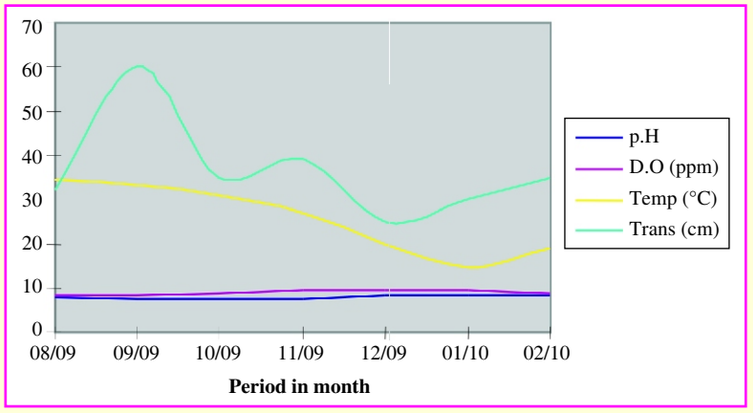


Fig. 25. Temporal variation in water quality in the pond water

Temporal variation in nutrients concentrations was observed in the pond water where recycling of water was done to irrigate the dependant crops in the system. Concentration of ranged from 0.1-0.7, 0.04-0.6 and 2.5 - 4.0 ppm, nitrate, phosphate and potassium, respectively. However no significant change was observed in EC of pond water.

Soil fertility studies

In present study, irrigation water from two sources (tube well and pond) was applied in wheat, cabbage and potato crops with 100 per cent recommended dose of fertilizer. Fertility status of soils under

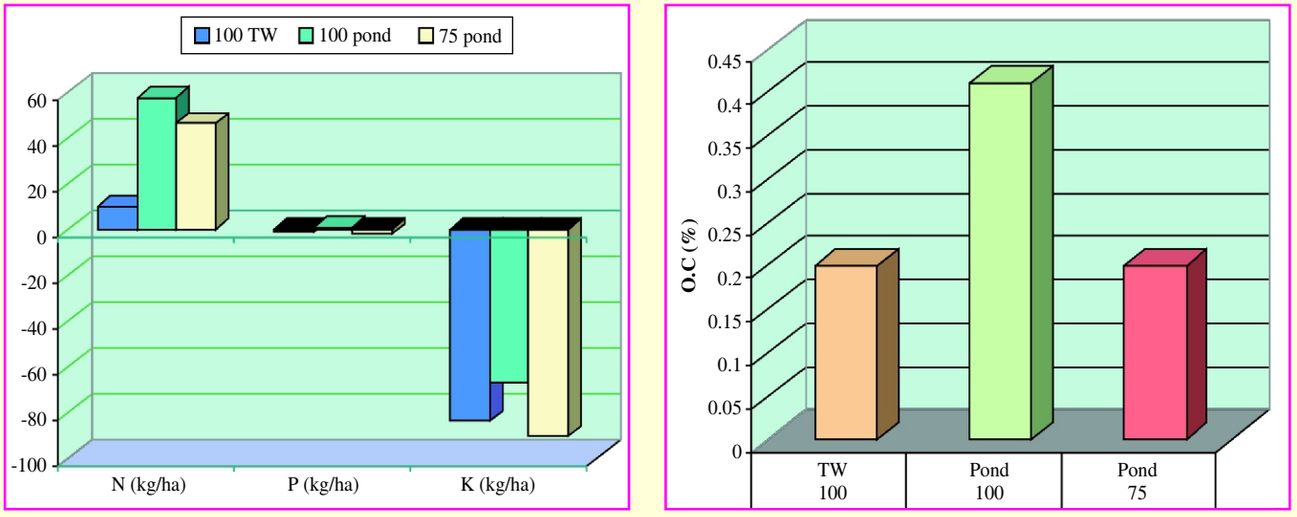


Fig. 26. Change in N, P, K status (kg/ha) and organic carbon (%) content under different irrigation treatment in wheat

irrigation through tube well water as well as pond water (under aquaculture) showed no significant change in pH and electrical conductivity. While per cent organic carbon increased from 0.8 to 1.1 and average available nitrogen content increased by 14 per cent in soils under treatment of 100 per cent fertilizer dose + pond water irrigation. Available phosphorus content slightly increased, but differential reduction (-ΔK) in potassium content was noticed by 8.5, 11.54 and 7.56 per cent in wheat, cabbage and potato plots, respectively irrigated with pond water + 100% fertilizer dose compared to tube well water+ 100 % fertilizer dose. Hence, there is improvement in fertility status of soils under multiple uses of water (recycling of water) in comparison to control (Fig. 26).

c) Monoculture and polyculture of high value shellfish species under multiple water use system

Three experiments were initiated for examining how best the waterlogged areas along the canal command can be utilized for sustaining productivity in order to enhance the livelihood of the people living in proximity.

(i) Service Reservoirs

Monoculture as well as polyculture of prawn (*M. rosenbergii*) in two ponds of 40 x 20 m size was undertaken. PL-20 of *M. rosenbergii* @ 50000/ha were stocked in the ponds in the month of August for monoculture experiment while in case of polyculture the stocking rate was @ 40000/ha. The average weight of PL-20 was 0.5 g. In polyculture, fingerlings @ 7000/ha of silver carp, catla and rohu in the ratio of 1:2:4 were stocked. The scampi PL-20 were fed with Starter-I, 3-4 times in a day @10-6% of body weight while fishes were fed @ 3 per cent of body weight with the feed composed of mustard oil cake and rice bran.

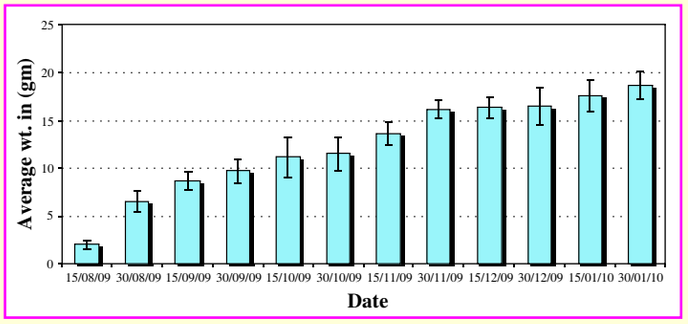


Fig. 27. Growth of prawn in pond (Monoculture)

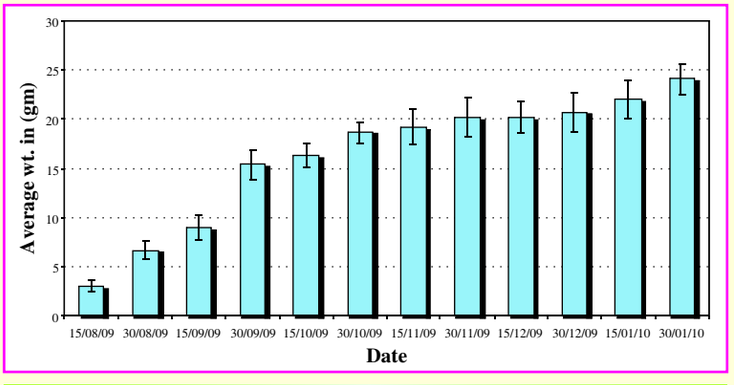


Fig. 28. Growth of prawn in pond (Polyculture)

Prawn after 120 days of rearing in monoculture has attained an average weight of 16.5 gram (Fig. 27). Partial harvesting of prawn yielded a total of 3.25 kg prawn. In Polyculture (Fig. 28) it attained average weight of 21.7g. The better growth of prawn in polyculture could be the result of aeration effect caused due to the movement of the fishes in the pond.

After rearing of fish for 120 days rohu and silver carp indicated better growth with an average weight of 374 g and 410 g, respectively. With prawn polyculture system, Khaki Campbell ducks were integrated @ of 200 ducks per ha of water area. Whole rice grain was fed to all ducks @100 g/ head/ day, with foraging in

the pond for 4 hours per day. Growth rate of ducks was recorded at 12.86 g/day up to 4 months of age after which growth followed reducing trend. Ducks started laying eggs at the age of 25 weeks and on an average a female laid 18.5 eggs per month with an average weight of 61.5 g.

(ii) Fish trenches-cum-raised bed

The fish trenches having (i) running water body and (ii) standing water body covering an area of 440 m^2 each were utilized to grow prawn and fish. PL-20 of *M. rosenbergii* @ 40000/ha were stocked in the trench in the month of August for monoculture experiment while in case of Polyculture the stocking rate of PL-20 was @ 30000/ha. The average weight of PL-20 was 0.5g. In polyculture, fingerlings @ 10000/ha of rohu and catla in the ratio of 2:3 were stocked. After rearing of prawn for 100 days, observations on monoculture revealed that it attained an average weight of 17.5g (Fig. 29) yielding 430 kg/ha while in polyculture it attained an average weight of 18 g (Fig. 30) yielding 347 kg/ha. The survival rate of prawn in monoculture was 68.9% while in polyculture it was 85%.

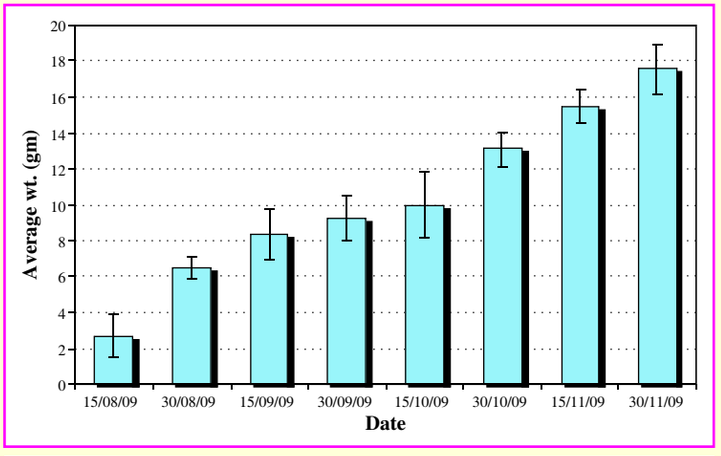


Fig. 29. Growth of prawn in trench (polyculture)

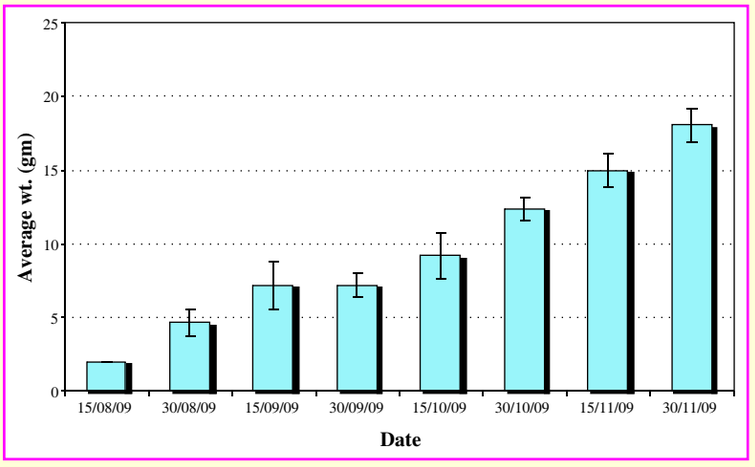


Fig. 30. Growth of prawn in trench (monoculture)

After rearing of fish for 100 days, fish yield was 0.6 t/ha. The growth of fish in trenches was slow as compared to their growth in ponds. It could be due to availability of lesser area and depth of water in trenches. In both the trenches overall dissolved oxygen content was low compared to secondary reservoirs.

(iii) Rice-fish cultivation

Under rice fish integration system seasonally waterlogged / canal seepage affected areas were converted into four rice plots of 50 x 30 m size for undertaking rice cultivation of MTU 7029. Refuge was provided in the centre of the plot covering an area of 150 m^2. Fish fries @20000/ha and 30000/ha of rohu, catla, silver carp, common carp and mrigal in the ratio of 1.5:1.5: 1:3:3 were stocked in the month of August 2009 in two plots. The stunted yearlings @ 9400/ha and 164000/ha in same proportion were also stocked in other refuge of two plots. After rearing the fish for 120 days, the harvesting resulted in an average yield of

1.0 tones/ha. Intermixing of fishes and their escapement from the rice plot could have occurred as was evident from the poor harvesting of fish.

4.5.1 : Water harvesting and better cropping systems for the benefit of small farmers in watersheds of the east India plateau (ACIAR funded)

(*S. Kumar and Adlul Islam*)

One of the objectives of the project is to simulate the impact of watershed management interventions through hydrological modeling for planning and management of watershed development activities. Since, the test watersheds located at Pogro and Amagara, have no historical records of flow/discharge, for upscaling of watershed management interventions in the watersheds of east India plateau, development of regionalized watershed parameters is needed for the application of hydrological models in the ungauged watersheds like Pogro and Amagra. Hence, two river basin (e.g., Damodar River Basin and Brahmani River Basin) located in the eastern India has been selected. From Damodar River basin five subwatersheds (namely, Usri, Hurdag, Nagwan, Olidih and Banikdih) and from Brahamni River basin four subwatersheds (Tilga, Jaraikela, Gomlai, and Jenapur) covering the entire Brahmani basin has been selected for calibration and validation of the hydrological model and developing regionalized parameters. Results of calibration and validation of IHACRES (Identification of unit Hydrograph And Component flows from rainfall, Evaporation and Streamflow data) model for different sub-basins of Brahmani River basin is presented below.

Daily rainfall data from 25 rain gauges located in or near the Brahmani basin were used to estimate areal rainfall for each of the four sub-catchments. Four techniques were explored for estimating the areal rainfall: inverse distance weighting (IDW), Theissen polygons, and both of these methods with rainfall spatially weighted by a long-term average rainfall surface (2000-2009) from the PERSIANN dataset. The PERSIANN satellite-derived rainfall surface was used as there were insufficient gauges to generate a surface using spatial interpolation methods. For best reproduction of observed streamflow, the IDW approach gave the best result indicating that many rainfall events had a large spatial coverage, leading to reduced uncertainty in areal rainfall due to averaging a larger number of stations. For predicting flows at ungauged sites however, the wIDW is more sensitive to errors in the rainfall surface, and hence the wTP approach should generally be preferred.

For calibrating the IHACRES model, different model configuration (e.g., 1-0, 1-1, 2-1, 2-2, 2-0) were run one by one keeping the range of model parameters (e.g., delay, τ_w, f, I, p) and calibration period same for all the model configuration. The drying rate at reference temperature (τ_w) is varied from 0 to 60 with a step of 2, temperature dependence of drying rate (f) is varied from 0 to 4 with a step of 0.2, and the moisture threshold for producing flow (I) is varied from 0 to 50 with a step of 10. Grid search results so generated were then input to "Multi criteria search algorithm" to find the best calibration.

As could be seen from (Table 37), the 2-1 model configuration (i.e., *2 exponential stores in parallel*) is performing better in most of the cases. In case of 2-1 model, the parameter τ_w is found to vary from 40 to 52, with smallest watershed Tilga having lower value (40), followed by Jaraikela (50) and Jenapur (largest watershed among the four) (52). However, the value of τ_w is found to be 42 in case of Jenapur when calibration was performed using the regulated streamflow data- i.e. after operation of Rengali dam/reservoir

(located upstream of Jenapur and downstream of Gomlai) for irrigation during dry periods as well as controlling flow during monsoon season.

Table 37 : Best fit models with calibrated parameters

Watershed	Model	Delay, day	C	Calibrated Model parameters			
				τ_w, (days)	f (°C^{-1})	l (mm)	p
Tilga	2-1	0	0.002048	40.00	0.6	0.00	1
Jaraikela	1-1	0	0.003580	22.00	2.6	0.00	1
Jaraikela	2-1	0	0.000903	50.00	0.8	0.00	1
Gomlai	2-2	1	0.001267	28.00	0.0	10.00	1
Jenapur	2-1	1	0.003171	42.00	1.0	40.00	1
Jenapur-predam	2-1	1	0.001245	52.00	0.2	50.00	1

c= mass balance term; τ_w=drying rate at reference temperature; f=temperature dependence of drying rate; I = moisture threshold for producing flow; p = power on soil moisture; 1-1= Exponential store and instantaneous store in parallel; 2-1=2 exponential store in parallel; 2-2= 2 exponential stores and instantaneous stores in parallel

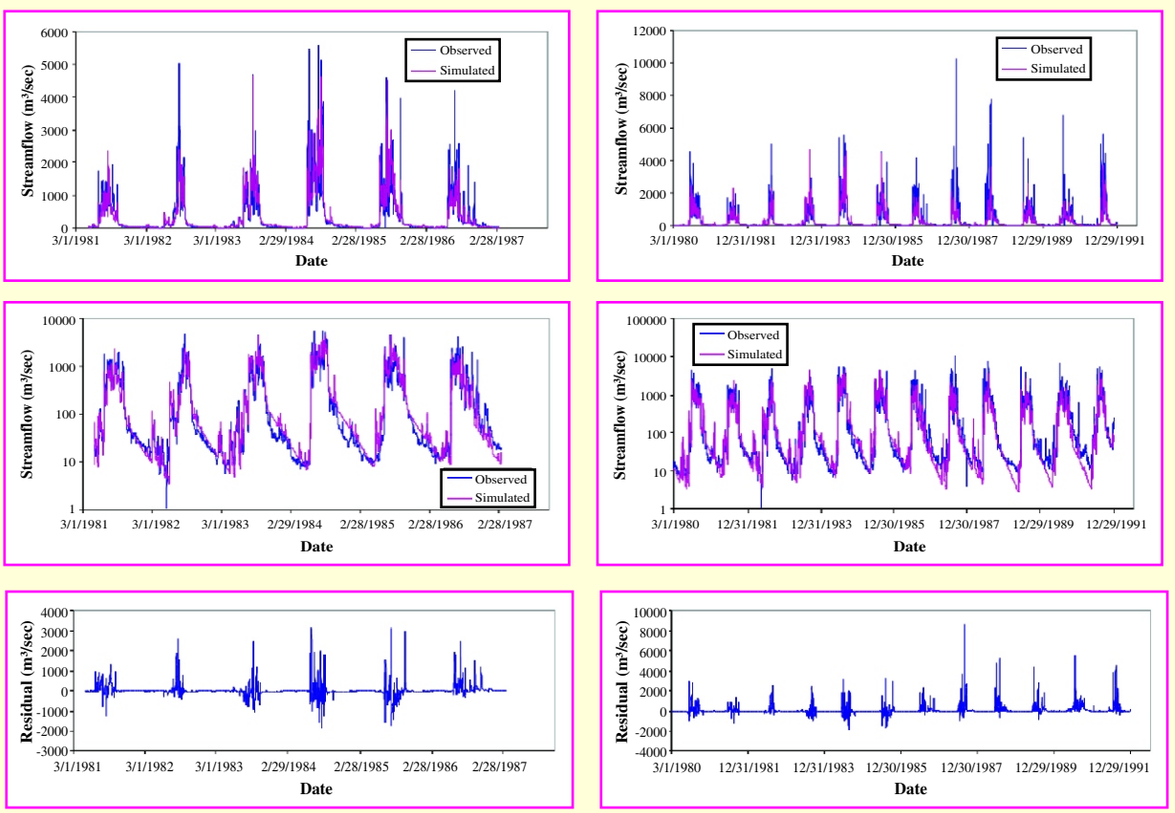


Fig. 31. Observed and IHACRES simulated streamflow at Gomlai sub-catchments of the Brahmani basin.

Temperature modulation factor (f) for 2-1 model for these three watersheds varied between 0.2-0.8. For Gomlai, 2-2 model is performing better than other configuration. In case of Jaraikela, the 2-1 model performs better compared to 1-1 model as indicated by the most of the model performance parameters but fails to capture low flows. Only in case of Jenapur and Gomlai, the parameter I (moisture threshold for producing flow), affected the flow. Fig 31 depicts the observed and simulated streamflow long with residuals for Gomlai sub-watershed of the brahmani basin. The observed and simulated streamflow along with residuals for all the four sub-catchments indicates that IHACRES model performs reasonably well in all the four sub-catchments of Brahmani basin.

4.5.2 : Development of guava + pineapple multistoried cropping system under rainfed conditions

(B.R. Jana, Bikash Das and M.K. Meena)

The project is being conducted since 2008 to standardize nutrient requirement and mulching for guava+pineapple based cropping system under rainfed conditions. It was observed that during 2nd year of plantation, application of 100% fertilizer dose of guava and 50% fertilizer dose of pineapple with mulching of local weed resulted maximum yield of guava (880 kg/ha).

4.6.1 : Design and development of a low pressure sprinkling nozzle

(A. Rahman, A. K. Singh, A. Upadhyaya)

Under this project efforts are being made to develop a low pressure-low cost sprinkling nozzle which can be operated below 1.0 kg/cm^2 pressure. In this direction numbers of prototype nozzles were developed based on reverse turbine model. The developed prototype is a multi arm/prong with multi-outlets, and curved arms were joined with an ellipsoidal drum. The drum was kept ellipsoidal to hold sufficient water in it to maintain the moment of inertia of the device for smooth rotation, and also to minimize air drag and maintain uniformity in jets. The prong or the arms are also given sufficient curvature to develop

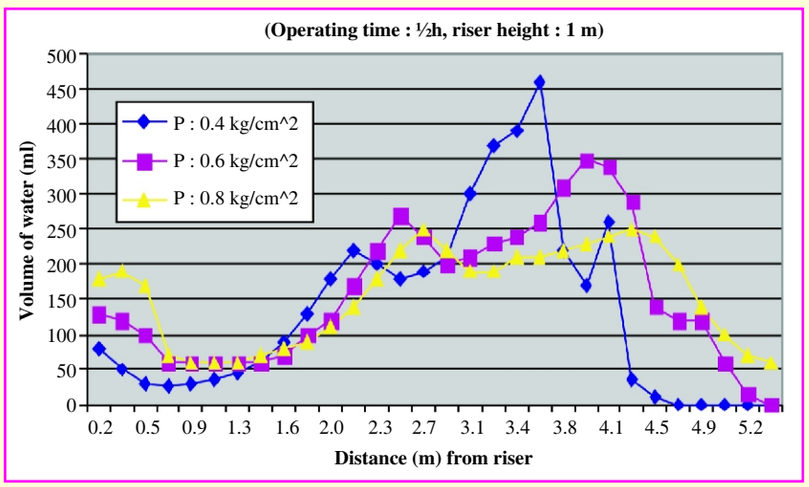


Fig. 32. Water distribution pattern of 8 arm device at various operating pressures

Sufficient torque/ moment of momentum to facilitate rotation. The arms were not joined with the drum in same horizontal plane, but arms were joined with the drum at different angles in vertical plane. This procedure was followed to give various water jets different projectile ranges to maximize water distribution uniformity. The number of arm and size of orifice are determined based on the inlet pressure and the experiences gained from the repeated testing. The different prototypes models with 4, 6 and 8 arms were tested in laboratory over the pressure range of 0.2 to 1.0 kg/cm^2.Testing showed that the 4 arm prototypes did not rotate at all but remains static while the 6 arm prototype did rotate but rotation was uneven. The results from 8 arm device were found quite encouraging with water throw diameter varying from 5.6 m to 12.8m over the pressure range of 0.2 to 1.0 kg/cm^2.The uniformity coefficient was found to vary from 40 to 60 percent over the pressure range of 0.4 to 0.8 kg/cm^2 (Fig.32 & 33). The linear fit curve showed that the variation of water throw diameter with the operating pressure can be represented by the equation D = 1.1667P+ 3.2667 with r^2 = 0.909. Further refinement of the device is still in progress.

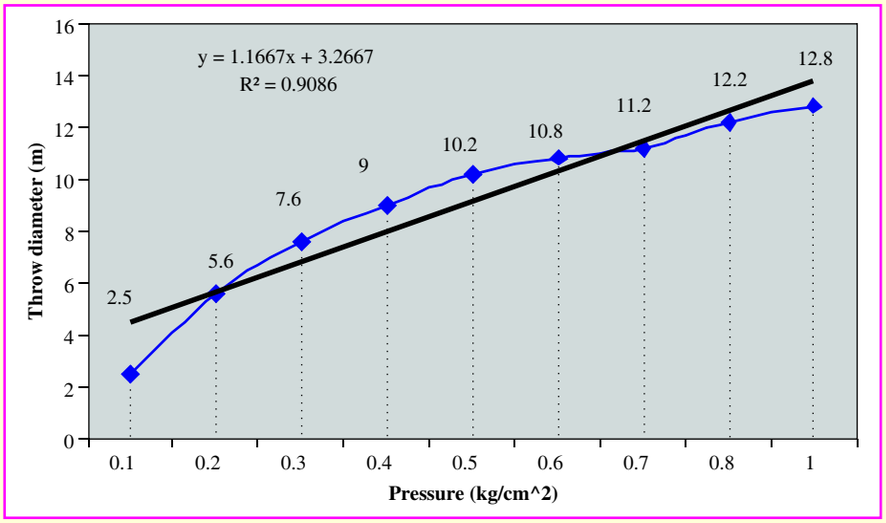


Fig. 33. Operating pressure vs. water throw diameter of 8 arm device

4.6.2 : Development of drip irrigation practices in Okra-potato-mentha system

(S.K. Singh and Chunchun Kumar)

Project on development of drip irrigation was undertaken in July, 2009 to evaluate the water requirement and also to find out the optimum dose of soluble N and K fertilizers for fertigation of Okra-Potato-Mentha system under surface and drip irrigation at Sabajpura farm. The soil texture of the experimental area is silty clay loam with mean value of pH 7.2, electrical conductivity 0.11 dS/m in 1:2.5 soils: water solution, organic carbon 0.81 per cent, available Nitrogen 197.85 kg/ha, Phosphorus 33.15 kg/ha and Potash 153.07 kg/ha, respectively.

Okra at fruiting stage

During rainy season 2009 the performance of okra (Arka Abhay) was compared for surface irrigation (IW : CPE = 0.80 ; 6 cm depth) and rainfed treatments as main plots along with 3 levels of (75,100 and 125%) of soluble N&K as sub-plots with 6 replications. The results revealed (Table.38) that length and girth of pod, pod weight/plant and dry weight of weeds were significantly influenced due to irrigation. However, all the yield components, dry weight of weeds as well as the pod yield were significantly influenced due to different levels of N & K. The highest pod yield of 5.87 t/ha was recorded in surface irrigation, which was 24 percent higher over the rainfed crop (4.72 t/ha).

Table1 38 : Effect of irrigation and N and P levels on yield attributes of okra

Treatment	Length of pod (cm)	Girth of pod (cm)	Pods/ plant	Pod weight / plant (g)	Dry weight of weeds (g/m^2)	Pod yield (t/ha)
Rainfed	9.47	4.00	12.81	88.67	139.17	4.72
Irrigated	11.62	5.31	13.67	107.18	170.89	5.87
SEM (±)	0.086	0.187	0.359	1.145	3.233	0.369
CD at 5 %	0.31	0.680	NS	4.163	11.756	NS
75 % recommended levels of N & K	10.13	4.41	11.30	90.12	139.91	4.29
100 % recommended levels of N & K	10.63	4.68	13.68	99.37	159.49	5.70
125 % recommended levels of N & K	10.87	4.86	14.74	104.29	165.70	5.89
SEm (±)	0.051	0.010	0.095	0.737	0.691	0.183
C.D. at 5%	0.153	0.031	0.282	2.175	2.039	0.541

4.6.3 : Development of drip irrigation practices for litchi in eastern plateau region

(Santosh, S. Mali and Bikash Das)

In order to evaluate the efficacy of drip irrigation system for litchi production in eastern plateau region, an experiment was conducted with 25 years old well established and healthy adult bearing litchi orchard. Three levels of irrigation A_1, A_2, and A_3 (30%, 20% and 10% of PE respectively) under drip irrigation and two levels irrigation B_1 and B_2 (30 % and 50 % of PE respectively) under ring basin irrigation were imposed. A treatment having only rain fed crops (B_1) was also imposed to compare the irrigated and non irrigated crop yields. To keep the same irrigation time for all levels of irrigation under drip system, the discharge for three levels of irrigation was modified by adopting specially designed and manufactured micro tube (1 mm ?) based low cost water application system. The three designs A_1, A_2 and A_3 applied water at desired uniformity at eight places under the tree canopy. The irrigation interval under drip irrigation was alternate day for the months of February and March and daily for the months of April and May while for basin irrigation it was 7 days throughout. In order to study the effect of starting time of the irrigation on the yield of litchi, treatments on start of irrigation were also imposed with irrigations starting from 1st Feb, 1st March and 1st April.

Moisture content

Volumetric moisture content from four depths at 5, 15, 30 and 45 cm was determined for drip and basin irrigation treatment combinations. The distribution of moisture in the root zone shows that moisture content is higher in case of A_1 followed by A_2 and A_3 (Fig 34). Distribution of moisture in the root zone was almost uniform for A_1, while it showed increasing trend with depth for irrigation levels A_2 and A_3.

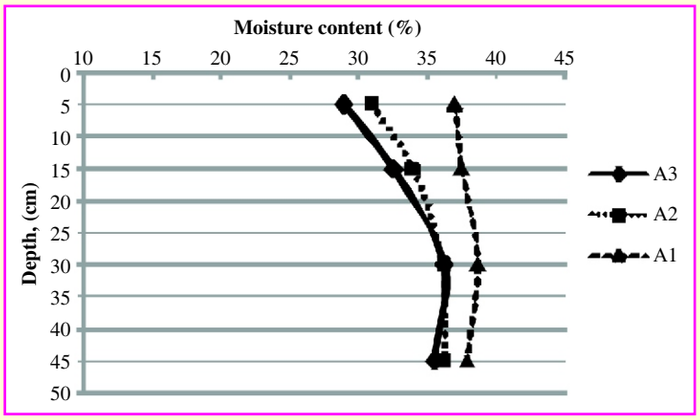


Fig. 34. Volumetric moisture content for drip irrigation

Depth wise moisture content data for basins (Fig 35 and 36) showed that moisture content was near to saturation and was almost constant throughout the root zone on first day of irrigation. Thereafter it started decreasing with time at all depths. On fifth day moisture content at 5 cm depth was 23.9 and 25.8 percent for B_2 and B_3 respectively, while that at 45 cm depth it was 29.2 and 30.1 percent for B_2 and B_3 respectively. In general moisture levels were more for B_3 than B_2. On fourth and fifth day moisture content was higher at 15 cm than 30 cm because of presence of organic matter at this depth which increases the water holding capacity of soil.

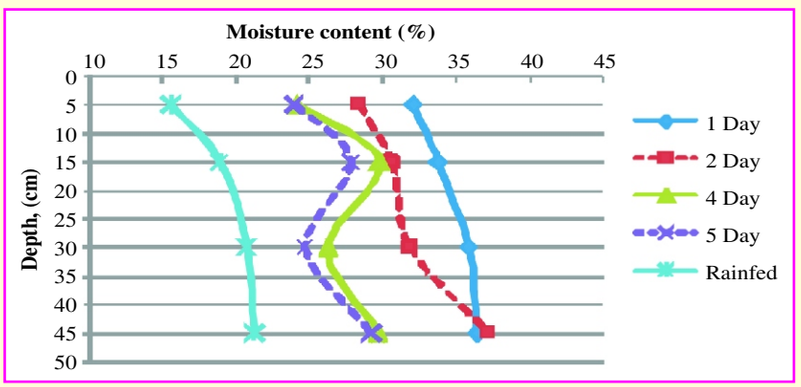


Fig. 35. Daily soil moisture data for B_2 (30 % PE) and rainfed treatment

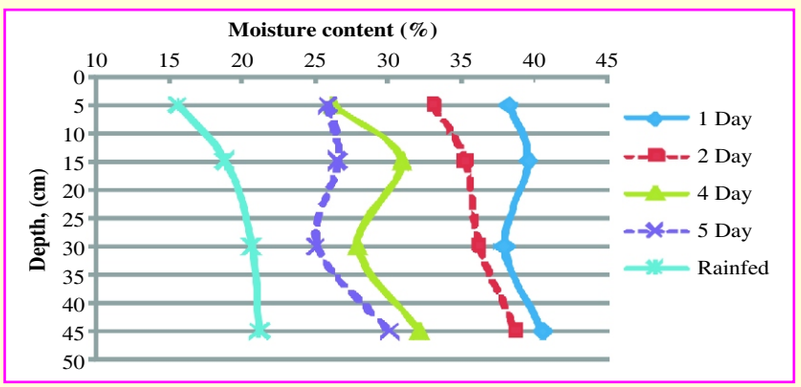


Fig. 36. Daily moisture data for B_3 (50% PE) and rainfed treatment

Effect of treatments on yield and physio-chemical parameters

During the first year of experimentation, significant effects of the different treatment could not be observed on yield, fruit drop, fruit cracking and physico-chemical parameters of fruits. Significantly by better response was observed in case of reducing sugar content in the fruit which ranged from 8.1 per cent (Flood irrigation as per schedule of drip with V=30% PE, application from 1st February) to 10.3 per cent (Drip irrigation V = 30% PE, application from 1st March) (Fig. 37). However, none of the treatments resulted in significant change in the content of reducing sugar in the fruit from that in case of plants grown under rain fed condition. During second year significant difference was observed only for percent potassium content in leafs. Fig. 38 depicts that the potassium content in leafs ranged from 0.7 (Flood irrigation with V = 30% PE, application starting from 1st February) to 1.06 (Flood irrigation with V =30% PE, application starting from 1st April).

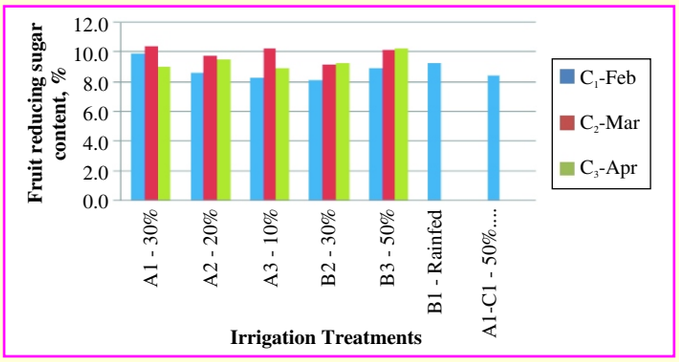


Fig. 37. Effect of different irrigation treatments on reducing sugar content

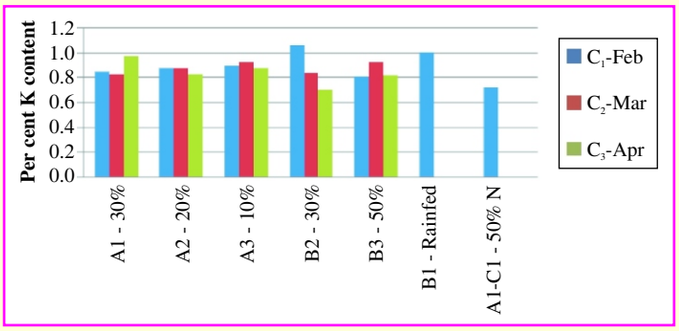


Fig. 38. Effect of different irrigation treatments on K content in leaf (%)

Throughout the period of experimentation none of the treatment showed significant difference on fruit yields. The plants under rainfed treatments also gave comparable yields as that under drip and basin irrigation. This can be attributed to the fact that over the years (for last 25 years) the litchi plants under the experiment were irrigated during flowering to harvesting (Feb to mid May) using flood irrigation system. The root system has been developed in larger area and to deeper depths that can extract water form deeper soil profiles and even at greater soil water potentials. So installing drip irrigation system in adult litchi plants may not necessarily increase the yield, however, it can be viewed as a convenient way of water application which reduces the drudgery of irrigation.

During the first year of experiment effect of deficit irrigation through drip as well basin irrigation was not observed on litchi yield. The statistical analysis done using *t-test* has not showed significant difference in yield in any of the treatments. However, the maximum yield was observed in case of 20 per cent PE level of irrigation with irrigation starting from 1st February.

4.6.4 : Gravity subsurface drip and fertigation for cucurbits in sandy loam soils of eastern plateau region

(Santosh S Mali and Ranvir Singh)

An experiment was conducted to assess the response of cucumber (*Cucumis sativus*) crop to subsurface placement of drip laterals and under various levels of fertilizer application. Four depths of lateral

placement *viz.* D_1 (0 cm-on surface), D_2 (5 cm), D_3 (10 cm) and D_4 (15 cm below soil surface) and four levels of fertilizer doses *viz.* F_1 (50:30:30), F_2 (100:60:60), F_3 (150:90:90) and F_4 (200:120:120) of NPK were considered for evaluation. Split plot experimental design was selected for the experiment. The cucumber crop was irrigated as per the irrigation schedule based on pan evaporation data. Fertilizer was applied through fertigation twice a week using ventury system. Fertilizer application rate was varied throughout the season, for initial two weeks it was kept low, it was increased as per the growth stages and decreased at the end of the season.

Data on lateral and vertical advance of waterfront at different time intervals was recorded for all depths of lateral placements and is presented in (Fig. 39). The crossing point [origin (0, 0)] of x and y axis represents the position of lateral placement. Placing the lateral on surface showed maximum lateral movement and water moved laterally up to 27 cm from the water source after 3.5 hr. However, lateral movement was restricted to 15 cm on both sides in case of placement of laterals at 10 cm and 15 cm below ground level. The quick upward waterfront advance due to capillary action was observed in 5 cm and 10 cm lateral placement depths with water emerging on surface after 10 minutes and 1 hr, respectively. In case of 15 cm depth of lateral placement water emerged on surface after the period of observation (approximately 24 hours) but the surface wetting area was considerably smaller than that in other lateral depths (Picture 1). This fact supports the hypothesis that subsurface placement of laterals reduces the evaporation loss from soil surface. At the end of 3.5 hr maximum total wetting depth of 28.5 cm was observed in case of 15 cm depth of lateral placement followed by 26.5 cm in case of 10 cm lateral placement depth. This illustrates that subsurface placement of laterals at 10 cm and 15 cm gives better wetting pattern and more wetting volume in the root zone.

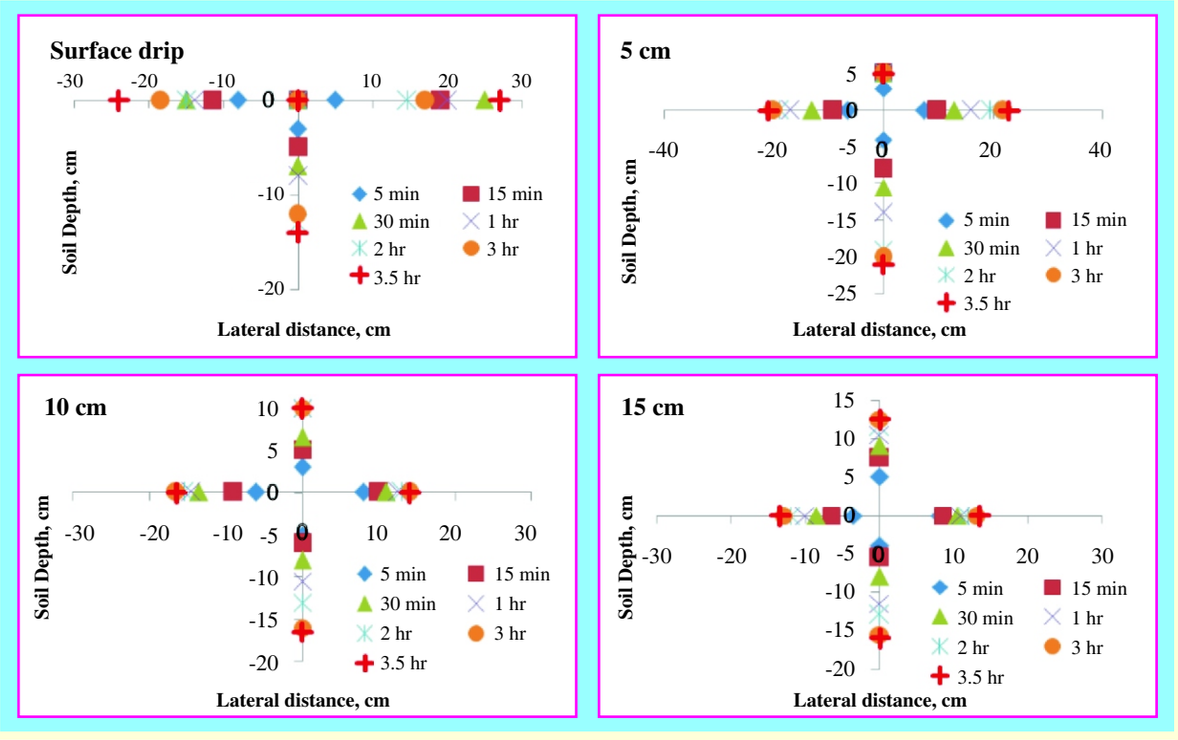


Fig. 39. Advancement of water front under surface and subsurface drip irrigation at various time intervals

(a) Surface Drip

(b) SDI with lateral at 5 cm depth

(c) SDI with lateral at 10 cm depth

(d) SDI with lateral at 15 cm depth

Surface wetting pattern observed for various depths of lateral placement after 24 hrs of 1st irrigation

Vine length data was recorded at 30, 45, 60, 75 and 90 days after sowing. The analysis of plant growth data at 90 days after sowing showed that vine lengths in fertilizer treatment F_3 were significantly better than vine length in treatment F_1 (Table 39). Placing the sub surface lateral at 10 cm depth resulted in higher vine lengths indicating proper plant growth. Higher vine lengths of 2.24 m and 2.20 m were observed in 10 cm and 15 cm depths of lateral placement respectively in fertilizer treatment F_3. The difference in vine lengths as visible from the field plots is shown picture 2.

Table 39 : Vine length (m) 90 days after sowing

Depth of lateral placement	Fertilizer dose			
	F_1	F_2	F_3	F_4
D_1	1.30	1.60	1.90	1.68
D_2	1.41	1.67	2.01	1.80
D_3	1.55	1.87	2.24*	2.01
D_4	1.82	1.77	2.20*	2.10

* Significantly better at $t_{0.05}$ s = 2.44

The fresh market yield of the cucumber under various treatments is presented in (Table 38). It may be observed that the yield of cucumber was increased due to subsurface placement of the laterals. The one way analysis of variance (ANOVA) performed on yield data indicated significant effect of placement depths of laterals on yield.

Fertilizer dose	Depth of lateral placement			
	Surface, 0 cm	5 cm SDI	10 cm SDI	15 cm SDI
F_4				
F_3				
F_1				

Differences in vine lengths at 60 DAS as observed in experimental plots

Table 40 : Yield (t/ha) of cucumber in different fertilizer and depths of lateral placement treatments

Depth of lateral placement	Fertilizer dose			
	F_1	F_2	F_3	F_4
D_1	12.0	17.6	16.4	15.6
D_2	12.7	18.2	23.8	21.3
D_3	17.1	25.6	28.2*	18.4
D_4	18.7	21.1	29.7*	25.3

* Significantly better at $t_{0.05}$ s = 2.44

In all the four fertilizer treatments, sub surface drip showed higher yields than surface drip. Analysis of data using t-test showed that significantly better yields were obtained under 10 cm and 15 cm depths of

lateral placement in fertilizer treatment F_3. However, maximum yield was recorded under 15 cm depth of lateral placement. The yields obtained under 10 cm depth of lateral placement are considerably higher than 5 cm depth of lateral placement but are slightly lower than 15 cm placement depth. The higher yield under SDI may be attributed to uniform moisture distribution in root zone and availability of water and fertilizer directly in the root zone. Also, placing the laterals below soil surface reduced the loss of water due to evaporation which increases the water availability to plants under SDI.

In case of 0.15 m lateral placement depth the yield under fertilizer treatment F_3 was 29.7 ton/ha while that under F_4 was 25.3 ton/ha. Similarly, in case of 0.1 m depth of lateral placement fertilizer treatment F_3 recorded yield of 28.2 ton/ha which is higher than 25.6 ton/ha and 18.4 ton/ha in F_2 and F_4 respectively. Based on this analysis it may be interpreted that fertilizer dose of 120 kg N, 90 kg P_2O_5, and 90 kg K_2O (F_3) will give higher cucumber yields in soils of plateau region. These results, however, needs to be tested for at least one more year.

Water use efficiency

The water use efficiency (yield per unit of water used) was calculated based on average yields observed under different treatments and the quantity of water used. The depth of water applied throughout the growing season was 33.79 cm in surface and 0.05 m, 0.10 m SDI treatments while that in 0.15 m SDI treatment it was 34.19 cm. The increase in depth at 0.15 m lateral plots was due the extra hand watering done during the time of germination.

It may be observed that highest water use efficiency has been obtained in fertilizer treatment F3 under 0.15 m SDI treatment (Table 39). The second highest water use efficiency was observed under the same fertilizer treatment under 0.1 m depth of lateral placement.

Table 41 : Water use efficiency (ton $ha^{-1}m^{-1}$) under different placement depths of laterals

Fertilizer Dose	Depth of Lateral placement (m)			
	0.00	0.05	0.10	0.15
F_1	35.5	37.6	50.6	54.7
F_2	52.1	53.9	75.8	61.7
F_3	48.5	70.4	83.5	86.9
F_4	46.2	63.0	54.5	74.0

4.7.1 : Impact assessment of climate change on water resources and their productivity

(Abdul Haris, A., Adlul Islam and R.Elanchezhian)

(a) Assessment of impact, adaptation and mitigation of climate change on major crops of Bihar

To study the impacts and necessary adaptation measures to overcome the effects of climate change on the important cereal and pulse crops grown in Bihar, four representative centers namely Pusa (Zone I), Madhepura (Zone II), Patna (Zone IIIA) and Sabour (Zone IIIB) were selected. The meteorological, soil and crop data collected and modified into model usable form. The historical meteorological data was analyzed to identify the long-term changes in temperature and rainfall. The available weather data was divided into two

time slots baseline (1961-90) and post 1990 (1991-2005). Baseline and post 90s showed an increasing trend in annual rainfall for all stations except Madhepura, where there is decreasing trend for the baseline. Annual maximum temperature showed decreasing trend while annual minimum temperature showed increasing trend for all stations, post 1990. However, for baseline, a mixed trend was observed for maximum as well as minimum temperature. The HADCM3 generated mean rainfall (mm/day) and temperature (°C) 2020, 2050, and 2080 were extracted from nearest grid points covering the study area. The INFOCROP model was calibrated and validated for wheat, rice and maize crops. Field experiment to identify the effects of different dates of sowing on three different varieties (varying in maturity duration) of rice was carried out at ICAR-RCER experimental farm.

Simulation studies conducted with PRECIS RCM data for Pusa during 2080 predicted less decrease in medium and long duration varieties of rice from baseline as compared to the simulation studies done with GCM data, for the rest of the crops the simulation studies suggest that the decrease in yield was more as compared to GCM based simulation.

Adaptation strategies : For rice and wheat crops different adaptation measures were tried, like shifting of sowing dates and varying the amount of fertilizer, keeping in mind the warmer temperatures and shortage of water in the expected climate change scenarios. Simulation studies were carried out by advancing sowing dates of rice and wheat crops by 7, 14 and 21 days.

Rice : Advanced sowing for rice of short duration variety (Saket 4) by 14 days, increased the production of rice for all agro-ecological zones of Bihar. Similarly, for medium duration variety (Sita), an increase in yield was predicted with the advancement of sowing date by 14 days during 2080s, except at zone III B. Advancing the sowing of long duration variety (Radha) by 14 days was beneficial for 2020 and 2050 scenarios but resulted in marginal loss or no change for 2080 scenario except for Madhepura, where the yield increased slightly (Fig. 40).

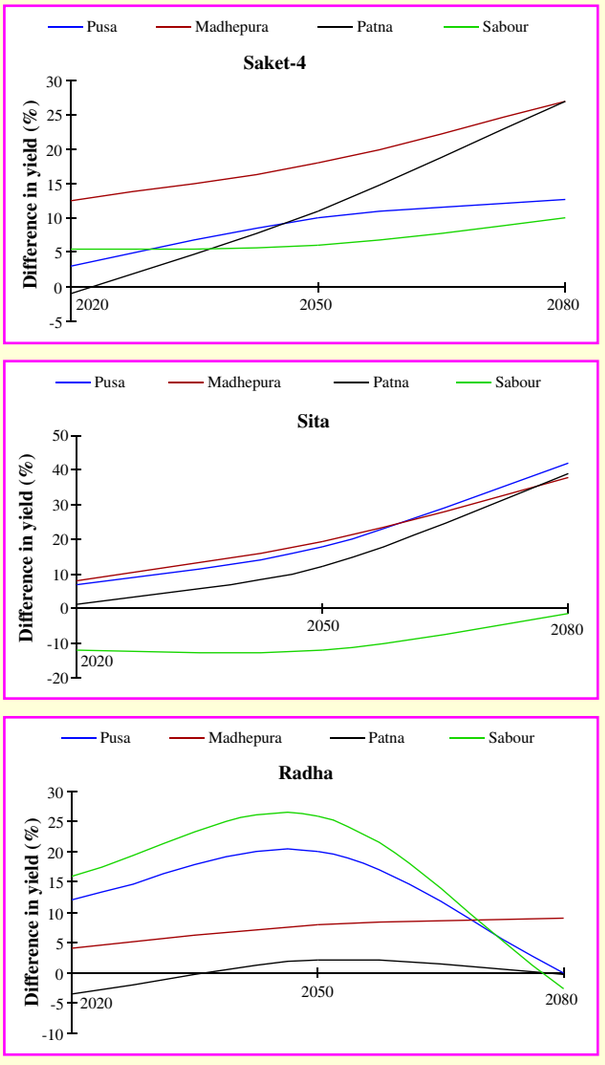


Fig. 40. Difference in yield (percentage change) of rice between advanced and normal sowing

Wheat : In wheat, 7 days advanced sowing as compared to 14 days advancement with higher dose of nitrogen was beneficial at all stations except Patna, where no change was observed (Fig. 41).

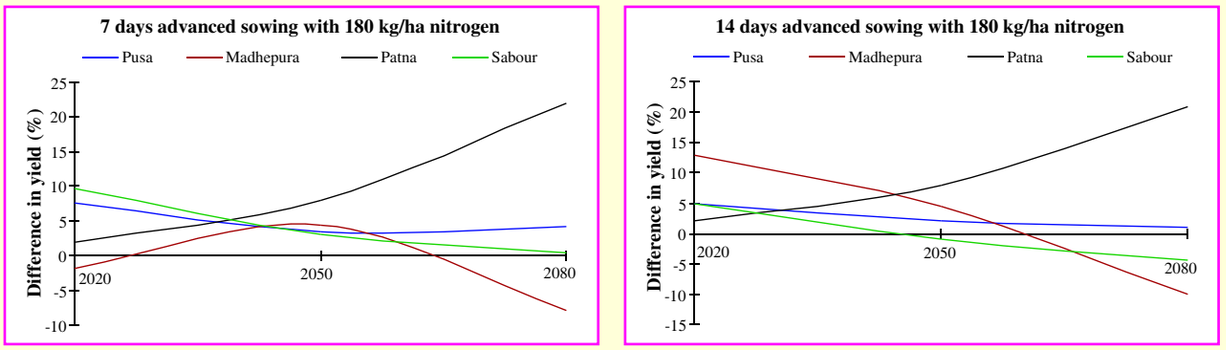


Fig. 41. Difference in yield (percentage change) of wheat between advanced and normal sowing

(b) Hydrological Modeling for Assessing Climate Change Impact in Bhawani Basin

The Bhavani basin, lying upstream of the Bhavanisagar Reservoir, was selected for assessing the climate change impact on hydrology and water resources availability in the basin. For hydrological modeling basin is delineated into Upper and Moyar sub-basins in GIS environment. The Upper Bhavani sub-basin is having total catchment area of 1494.10 km^2 with streamflow gauging station located at Nellithurai. The elevation of the basin varied from 382.80 to 2230.25 m (HRU 24) and slope varied from 4.85 to 63.16%. This sub-basin is dominated by forest land (78%) followed by agricultural (14%) and grassland (8%) area.

For assessing the impact of climate change on streamflow, Had CM3 generated mean rainfall for the period 1980, 2020, 2050, and 2080 were extracted from four grid points covering the entire Bhavani basin and interpolated using Inverse Distance method, and mean rainfall for 16 rain gauge stations, considered for hydrological modeling, was extracted. There is decrease in rainfall in most of the months in the basin under A2a as well as B2a scenarios. Maximum decrease of 45.20 and 51.90% was observed in the month of February 2020 under A2a and B2a scenario, respectively. During the month of July and August there is increase (though less than 10%) in rainfall under both A2a and B2a emission scenario.

For hydrological modeling, IHACRES (Identification of Unit Hydrograph and Component Flows from Rainfall, Evaporation and Streamflow data) model was calibrated and validated using the observed streamflow data of Nellithurai gauging station. During calibration period the Coeff of Determination and Nash-Sutcliffe Coeff. was found as 0.80 and 0.78, respectively. The model was found to perform satisfactorily during validation phase with Coeff of Determination and Nash-Sutcliffe Coeff. of 0.79 and 0.76, respectively.

Simulation studies using HadCM3 predicted changes in rainfall and temperature under A2a and B2a emission scenarios indicated increase in annual streamflow during 2020 under both the emission scenarios (Fig 42), where as there is decrease in annual streamflow during 2050 under both the emission scenarios. Under B2a emission scenario, there is decrease in streamflow during monsoon season in all the three periods (2020, 2050 and 2080) whereas there is increase in streamflow during pre-monsoon season. Similar results were found in case of A2a emission scenario, except during 2050 monsoon and 2020 pre-monsoon seasons.

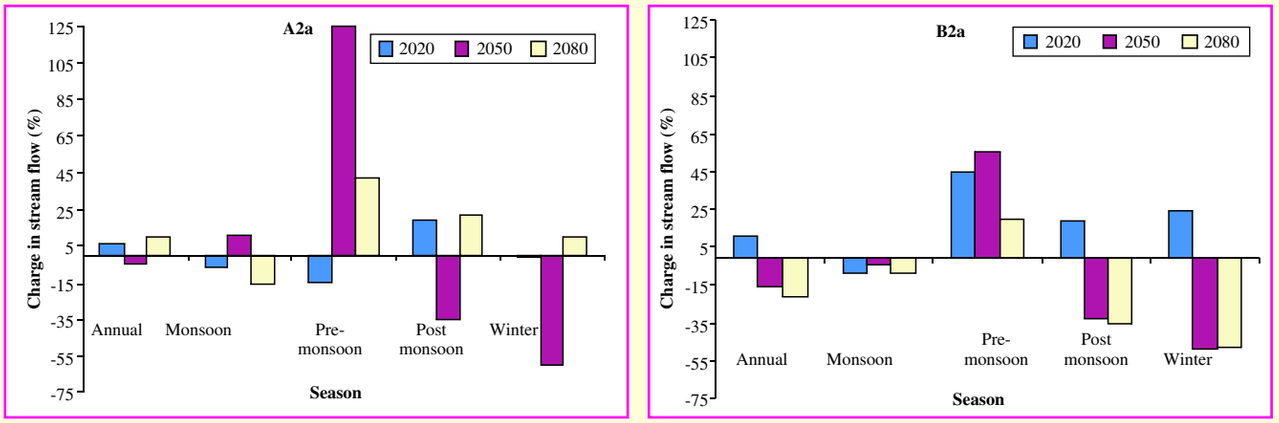


Fig. 42. Changes in seasonal and annual streamflow

4.8.2 : Effect of organic amendments on Soil Microbial Biomass Carbon (SMBC) in Rice-Wheat Cropping System.

(Chunchun. Kumar, T.K. Srivastava and K. Rajan)

Field experiment was conducted at institute farm in randomized block design in rice-wheat cropping system to assess the increment in microbial Biomass Carbon (SMBC) due to application of organic amendments. The trial comprising of eight treatments, T_1 control (No nutrient application), T_2 Recommended dose of N, P, K through fertilizers, T_3 FYM @ 20 ton/ha, T_4 FYM @ 10 ton/ha, T_5 Crop Residue (30 %),T_6 Crop Residue (15%),T_7 GM (*Sesbania* after 40 days) and T_8 GM (*Sesbania* co-culture) were conducted. The initial soil parameters as pH 7.24, EC 0.12 dSm^{-1} (1:2.5 soil water ratio), organic carbon 0.64%, available N, P and exchangeable K as 218.4, 19.46 and 174 kg / ha, respectively. The SMBC of initial soil sample was 77 mg $C\text{-}Co_2 kg^{-1}$ soil 10 $days^{-1}$. The highest paddy grain yield 7.58 t/ha was recorded in T_7 followed by T_3 (7.33 t/ha) and T_4 (7.25 t/ha) the two paddy yield of 7.0 t/ha was recorded in treatment T_2.

Soil studies after 30 days of transplanting indicated that there was an increasing trend in SMBC (35-87% change over initial) which was highest in T_7 with 143 mg $C\text{-}Co_2 kg^{-1}$ soil 10 $days^{-1}$ and lowest in control with 104 mg $C\text{-}Co_2 kg^{-1}$ soil 10 $days^{-1}$ which further increased after 60 days of transplanting (25-96% change over initial) highest in T_5 crop Residue(30%) with 151 mg $C\text{-}Co_2 kg^{-1}$ soil 10 $days^{-1}$ and lowest in control with 96 mg $C\text{-}Co_2 kg^{-1}$ soil 10 $days^{-1}$.

Theme 5 : Livestock & fisheries improvement and management

5.1 : Fish seed, feed and management of fishponds

5.1.2 : Performance potential of integrated aqua-culture having mono-culture of Indian magur and polyculture of carps with special reference to Jayanti rohu

(A. K. Jain, T. K. Srivastava, N.Chandra and P. K. Ray)

Two ponds measuring 0.32 ha (P_1) and 0.07 ha (P_2) along with 250 m^2 land adjacent to pond-P_2 were taken for the project. Pond P_1 was stocked with early fry of catla (0.087 g and 1.2 cm), rohu (0.018 g and 1.3 cm), mrigal (0.179 g and 1.4 cm), grass carp (0.206 g and 2.6 cm) and silver carp (0.169 g and 2.76 cm). Besides, 200 nos. of Jayanti rohu fry (5-10 g) were stocked. Fish stock was fed with supplementary feed comprised of rice bran and mustard oil cake.

Growth data of the fishes have shown highest growth rate in catla followed by silver carp. Growth rate of Jayanti rohu was significantly higher than that of rohu. Pond bunds and area earmarked for horticulture was used for growing seasonal vegetables and various fruit bearing plant saplings (banana, papaya, guava and lemon).Two lactating cows were integrated with the fish and horticulture production system. Cow dung was used in fishpond and as organic manure for crop on land.

5.3 : Development of technologies for improving livestock and poultry health and production

5.3.1 : Formulation of poultry broiler and goat feed using makhana by-products

(A. Dey, B. P. S. Yadav and P. K. Ray)

Makhana bran as an ingredient for broiler poultry diets was tested under the project. 300 days old broiler chicks were divided into 5 groups of 60 birds in each group following Completely Randomized Design. Each group had 3 replicates having 20 birds in each replicate. Five iso-nitrogenous and iso-caloric diets were prepared using makhana bran as one of the ingredients replacing rice bran at 0, 25, 50, 75 and 100 percent level. Separate starter and finisher diets were prepared following methods of Bureau of Indian Standards (1992). One group of chicks was fed with one diet for 42 days after which a 4 day metabolism trial was conducted to study the nutrients digestibility. Individual body weights and feed intake were recorded weekly. Dry matter intake and digestibility did not differ significantly up to 50% of replacement of rice bran. Feed conversion efficiency of birds also did not change significantly up to 50% replacement groups (Fig. 43). Weekly body weight did not differ significantly among groups up to 4 weeks of age of birds but reduced significantly thereafter in 75% and 100% replacement groups in comparison to control group (Fig. 44).

Feeding of Makhana based diet to poultry

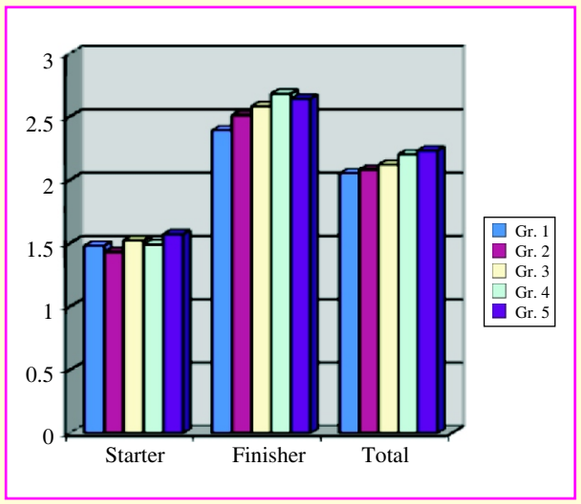


Fig. 43. Feed conversion efficiency of different groups of poultry

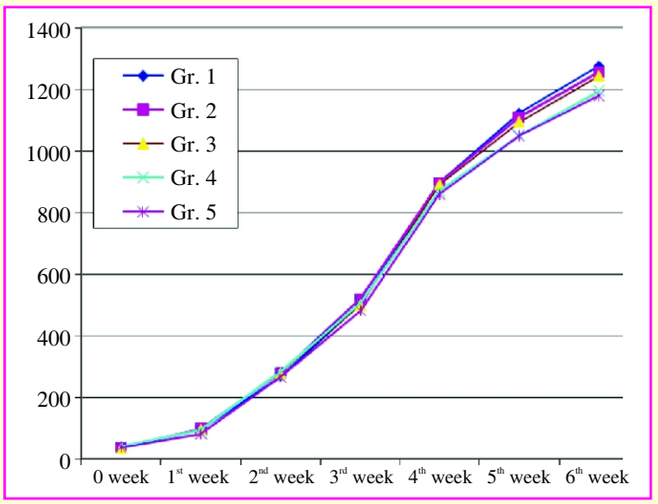


Fig. 44. Weekly body weight of different groups of poultry

5.3.2 : Improvement of Black Bengal breed of goats by selective breeding through artificial insemination

(P. C. Chandran, S. J. Pandian and P. K. Ray)

The initial survey conducted on Black Bengal goats in 15 villages of Patna district of Bihar revealed that the average adult body weight of female goats were 16.47 ± 0.28 kg. The body weights at different ages are presented in the (Fig. 45). The height (42.20± 0.87 cm) and body length (43.70±0.76) at 3 months of age were lesser than chest girth (48.14±0.75 cm). The breed is most popular for kidding percentage. The survey revealed that twinning and triplets from 3rd kidding accounted for 85 per cent.

Artificial insemination in Black Bengal goats

The wide variation in the growth rate provides an opportunity for taking up selective breeding tool to improve the production and reproduction traits. Semen was collected from genetically superior Black Bengal bucks using Artificial Vagina method. Later, semen was subjected to macroscopic examination and the quality was assured before diluting it with goat milk extender. The microscopic analysis was carried out for individual sperm mortality, sperm abnormality and live and dead count. After dilution, semen was preserved in the refrigeration temperature till 6 days. The does in the estrum were artificially inseminated.

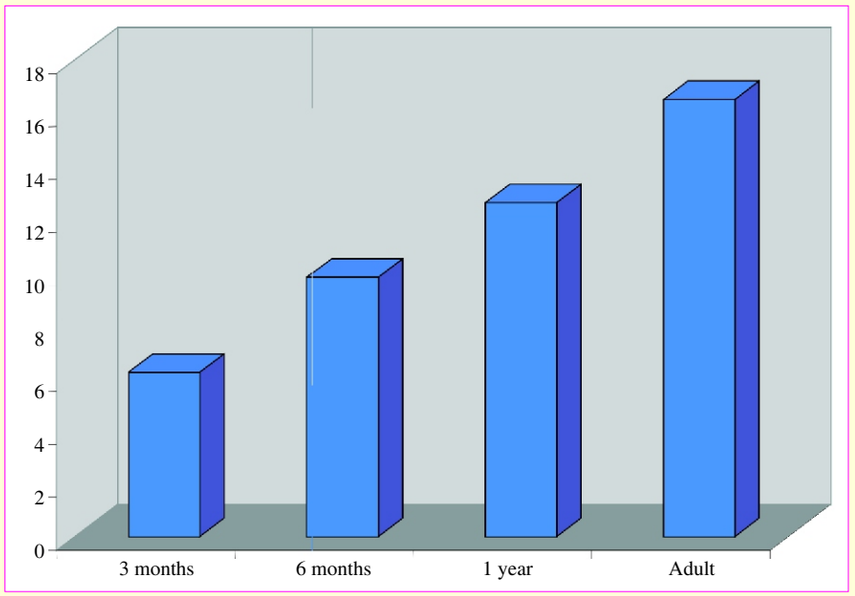


Fig.45: Body weight (kg.) at different ages

5.3.3 : Studies on reproductive diseases of cattle under field conditions of Bihar

(S.J. Pandian, P.K.Ray, P.C.Chandran and Manoj Kumar)

Seroprevalence of Brucellosis, Leptospirosis, Infectious Bovine Rhinotracheitits-Infectious Pustular Vulvovaginitis (IBR-IPV) and Bovine Virus Diarrhoea (BVD) was studied to ascertain the infectious cause of infertility and in order to arrive at a conclusion regarding the status of these diseases and their coexistence in the cattle population of Bihar. Three hundred serum samples from various districts viz. Patna, Katihar, Purnia, Gaya and East Champaran districts of Bihar were collected. Besides, serum samples were collected from organized dairy farms of ICAR RCER, Bihar Veterinary College and Rajendra Agricultural University Farm, Pusa. Samples were preserved under deep refrigeration (-20°C). Avidin-Biotin ELISA kit for Brucellosis and IBR has been acquired from Bangalore and ELISA procedure has been standardized. Laboratory standards for haematological parameters have been tested for cattle in Animal Health Laboratory (Table 42).

Rectal examination prior to sample collection

Table 42 : Hematological parameters of cattle

Parameters	Hb (g %)	PCV (%)	RBC (Millions/ µl)	WBC (per µl)	MCV (fl)	MCH (pg)	MCHC (g/dl)
Observed range	6.2-12.4	33-49	4.55-7.56	5400-9900	57.66-76.92	10.32-19.19	15.92-26.06
Observed average	8.4	38.9	5.60	7700	68.46	14.19	20.84

5.3.4 : Studies of Peste des Petits Ruminants (PPR) and Blue Tongue in goats and sheep in Bihar

(P. K. Ray, S.J.Pandian and Manoj Kumar)

PPR and Blue Tongue are the major threats to 200 million small ruminant population of the country. In view of the heavy economic losses to goat and sheep population due to these important diseases, it is pertinent to have a proper monitoring system which identifies the diseases in farmer herds. The study envisages an investigation of suspected cases of PPR & Blue Tongue in various districts of Bihar. The sera samples were collected randomly from the goats and sheep and also from the suspected cases based on the clinical signs and gross pathology. The sera samples are being analyzed for the presence of antibodies against PPR virus and Blue Tongue virus by competitive ELISA and indirect ELISA, respectively. The tissue sample collected from the dead animals is being used for detection of PPR viral antigens by sandwich ELISA. The concurrent prevalence of PPR and Blue Tongue are being determined based on this study.

Severe enlargement of mesenteric lymph nodes with congestion of intestinal wall

Severe enteritis of intestinal with congestion of intestinal wall, congested intestinal mucosa (inset)

5.4 : Crop-livestock integration through dairy and goat based enterprises

5.4.1 : Development of crop-livestock farming system models Crop-dairy based farming system under irrigated condition

(B.P.S. Yadav, A. Dey, P. C. Chandran, S. J. Pandian, S. K. Singh and R. C. Bharti)

Rice-wheat cropping system is commonly practiced in irrigated condition of farming to enhance farm income. The project was undertaken in two acre area to develop dairy based integrated system model in intensified crop-livestock production system in irrigated area. Four crossbred dairy cows were integrated in the system and compared with farmer's practice models simulated with one cattle in the system. The crop, fodder yield and performance of cows are presented below in tabular form (Table 43).

Fodder production under irrigated system

Table 43 : Crop and livestock production in 1 acre model

Attribute	Farmer's practice (control)	Intensified dairy based production system
Total land	1 Acre	1 Acre
Food crop area	0.9 Acre	0.6 Acre
Fodder area & animal shelter	0.1 Acre	0.4 Acre
Crop Production		
Wheat yield	7.28 Quintal	5.92 Quintal
Wheat straw yield	9.50 Quintal	6.34 Quintal
Rice yield	15.34 Quintal	10.42 Quintal
Rice straw	18.36 Quintal	12.24 Quintal
Fodder yield		
Kharif maize	862 kg	1735 kg
Berseem	140 kg(1st cut)	2918 kg (upto 2nd cut)
Oat (up to 2 cuts)	-	683 kg
Lactation yield	939.8 kg	2193.12 kg
Total dung produced	5.11 Tonnes	32.12 tonnes

Agro forestry - goat based integrated farming system under rainfed condition

Two acres of land was undertaken in rainfed condition to develop two models of 1-acre each, where in model I, cereal/legumes-crops were incorporated as practiced by farmers in rainfed condition and in model II, goats were introduced along with grasses and fodder crops. Jamunapari goats were reared under the system in semi intensive system of management.

Model I

During *kharif*, maize, arhar and upland paddy were sown. Rice crop failed due to scanty rain. However, local maize grain yield was recorded at 2.5 qt/ha. In *rabi* season, lentil crop was sown and yield was recorded at 3 qt/ha. Arhar crop is standing and yield is yet to be recorded.

Model II

Analysis of data revealed that average live weight of goat increased from 3.26 ± 0.87 kg at birth to 22.3 ± 0.65 kg at one year of age. The average growth rate (g/day) was recorded at 50.2 ± 1.20. Reproductive performance of doe indicated that age of first kidding was 512 ± 1.28 days where as kidding interval was recorded at 290.6 ± 0.78 days and gestation period as 151.8 ± 0.23 days during the period.

Jamnapari goats under rainfed condition

Health management

In the project, the disease occurrence pattern was recorded in dairy herd of crossbred cows and Jamunapari flock from the month of June'09 to February'10. With the experience gained from this farming system model, prophylactic calendars for dairy animals and goats were developed.

In dairy animals the following cases were sporadically reported and treated in the year. Joint ill, Abscessation, Bloat, Mastitis; Repeat breeding, Anoestrus, Ketosis associated with Mastitis, Udder edema and Femoral fracture. In Jamunapari kids, Strongylosis and bacterial enteritis were encountered occasionally.

Prophylactic calendar for cattle

Month	Season	Deworming	Vaccination	Tick bath	Susceptibility
January	Winter,	Regular	FMD*		Respiratory infections and Digestive disorders
February	Winter, dry			*	Respiratory infections and Digestive disorders
March	Hot, Humid			*	Ectoparasitism and Blood protozoan infections
April	Hot, Humid	Regular		*	Ectoparasitism and Blood protozoan infections
May	Hot, Humid	Broad spectrum	Anthrax		Ectoparasitism, Blood protozoan infections and Ephemeral fever
June	Pre-monsoon, Monsoon				Ephemeral fever, Feet ailments, Endoparasitisism, and Coccidiosis
July	Monsoon	Flukicide			Prone for Endoparasitism, Feet ailments, Coccidiosis
August	Monsoon				Prone for Endoparasitism, Feet ailments, Coccidiosis
September	Hot, Humid	Broad spectrum		*	Prone for Endoparasitism, Blood protozoan infections
October	Hot, Humid	Regular		*	Prone for Endoparasitism, Blood protozoan infections
November	Pre-winter		Hemorrhagic septicemia & Black Quarter		Metabolic disorders, Deficiency diseases
December	Winter				Metabolic disorders, Deficiency diseases

5.5.2 : Improving water productivity, reducing poverty and enhancing equity in mixed crop-livestock systems in the IGB (Challenge Programme Project)

(M. A. Khan and A. Dey)

A Challenge Programme project was undertaken in collaboration with International Water Management Institute and International Livestock Research Institute to assess the water productivity of livestock in Indo-Gangetic Plains (IGP), India particularly in water scarced areas of the basin.

Burning of straw in Hisar Haryana

For the study of the crop-livestock interactions, water availability and social and institutional roles, 3 sites in Indo-Gangetic Plains namely Bankurs district in lower IGP, Etawah district in upper IGP and Hisar district in Trans IGP have been selected based on the rainfall gradient. In each district, 2 villages have been selected for collection of primary data. Stakeholders and focus group meetings in all the villages were organized. Risks and constraints to livelihood in all the villages have been identifed based on the interview of stakeholders and key questionnaires. Districtwise data on livestock population, livestock products, cropping pattern, area under different crops, crop yield and availability of irrigation facilities have been collected. A benchmark document on livestock production in IGP has been prepared. A baseline survey regarding resource availability, cropping pattern, livestock population and production has been undertaken and role of different institutions in crop-livestock-water nexus in all the villages have been studied. Districtwise population of cattle and buffalo in Indo-Gangetic Plains has been presented in (Fig. 46 and 47), respectively.

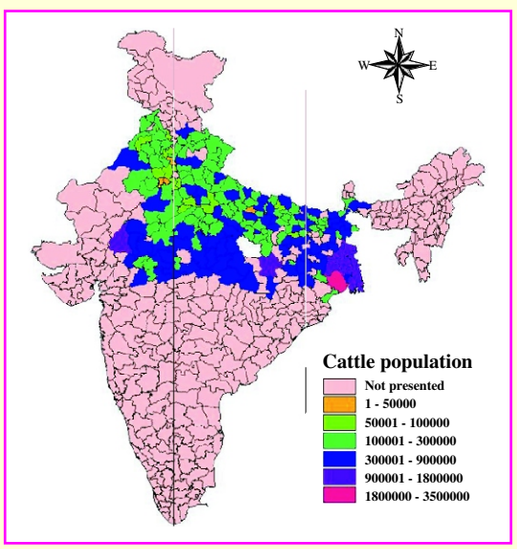


Fig. 46. District wise cattle population in IGP

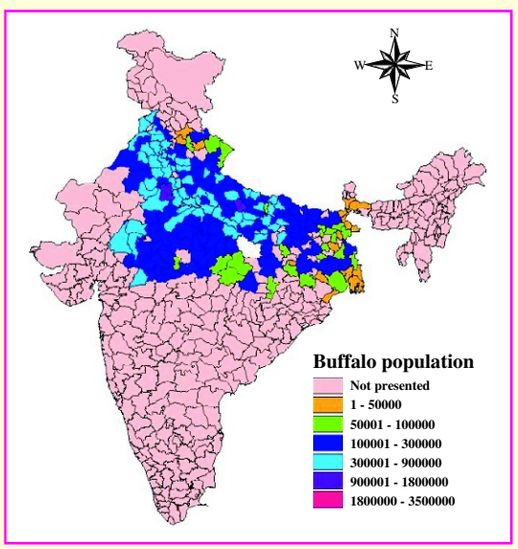


Fig. 47. District wise buffalo population in IGP

Theme 6 : Development of need based farming system models for different eco-systems

6.2.1 : Studies on irrigation and nutrient requirement of diversified cropping system in irrigated eco-system of central Bihar

(R.D. Singh, Shivani and L.K. Prasad)

A field experiment was conducted in split-split plot design with three replications allotting cropping systems in main plot, levels of irrigation in sub plot and levels of nutrients in sub-sub plot at main campus farm during *kharif* 2008, to find out the irrigation and nutrient requirement of different crops under diversified cropping systems. Five cropping systems viz. C_1 (Rice-tomato-bottle gourd), C_2 (Rice-potato-onion), C_3 (Rice-mustard-tomato), C_4 (Rice-coriander-lady's finger) and C_5 (Rice-carrot-cowpea) awere tested at two levels of irrigations viz. I_1-Optimum level, I_2- Sub-optimum level and two levels of nutrients viz. F_1-Recommeded level and F_2-50 per cent of recommended level, respectively. Soil samples were collected from the experimental plots and analyzed for physical and chemical properties. The texture of the soil was silt clay loam with mean value of pH 6.5, electrical conductivity 0.11 dS/m in 1:2 soils: water solution, organic carbon 1.05 percent, available nitrogen 281 kg N/ha, available phosphorus 23.6 kg P/ha and available potash 180 kg K/ha, respectively.

Results of paddy yield equivalence revealed that during first year of experimentation, there were significant variations among cropping systems, levels of irrigation and nutrients and its interaction. Among the cropping systems, maximum yield equivalence (40.49 t/ha) was recorded in rice-tomato-bottle gourd followed by rice-potato- onion (33.45 t/ha), rice-carrot-cowpea (21.91 t/ha), rice-coriander-ladies finger (19.73 t/ha) and rice-mustard-tomato (10.84 t/ha), respectively. Among the levels of irrigation, maximum yield equivalence (25.83 t/ha) was recorded at optimum level followed by sub-optimum level (24.74 t/ha). Among levels of nutrient, maximum yield equivalence (26.09 t/ha) was recorded at recommended level followed by 50 per cent of recommended level of fertilizer. Maximum net profit (Table 44 and 45) was recorded in rice-tomato-bottle gourd (Rs.1, 52,904/ha) followed by rice-potato-onion (Rs. 1, 04,402 /ha) and rice carrot cowpea (Rs, 75,652/ha), respectively. Similar trend was observed in benefit cost ratio (2.70, 2.08 and 1.94), respectively. Among levels of irrigation, maximum net profit was recorded at optimum level of irrigation (Rs. 79,328/ha) over sub-optimum level (Rs. 74,465/ha). Among levels of nutrient, maximum net profit was recorded at recommended level (Rs. 77,212/ha) followed by 50% of recommended level (Rs. 73,652/ha), respectively.

Soil studies indicated that there was significant variation in pH, EC, organic carbon available nitrogen, phosphorus and potash after first crop cycle. It has been observed that in all the systems there was increase in pH and phosphorus, but reduction in EC, organic carbon, available nitrogen, and potash from initial status of the nutrient. This may be attributed to exhaustive cropping. There was decreasing trend in organic carbon, available nitrogen and potassium in all the systems from initial status of the soil but variations among cropping systems, levels of irrigation and nutrient were found significant. This may be because of vegetable dominated crops in the system, whose nitrogen and the potassium requirement is quite higher than other crops in the system (Table 46). Higher nutrient status after completion of first crop cycle indicated that application of higher level of irrigation and nutrient has increased the available nutrient status in the soil.


$C_1 I_1F_1$ (Rice-tomato-bottlegourd)


$C_1 I_1F_2$ (Rice-tomato-bottlegourd)

$C_2 I_1F_1$ (Rice-potato-onion)


$C_2 I_1F_2$ (Rice-potato-onion)

During second year (2009) of experimentation only rice crop has been taken. Growth and yield parameters were recorded and analyzed. Results revealed that there was significant variation in number

of grain/ panicle, grain and straw yield but most of the growth and development characters were found non-significant in all crop cropping systems, levels of irrigation and nutrients.

Table 44 : Effect of levels of irrigation and nutrient on yield equivalence (t/ha) in terms of paddy (2008-09)

Cropping system	Irrigation		Mean	Fertilizer Mean		
	I_1	I_2		F_1	F_2	
C_1 - Rice-tomato-bottle Gourd	40.71	40.26	40.49	41.94	39.04	40.49
C_2 - Rice-potato-onion	34.42	32.48	33.45	34.61	32.29	33.45
C_3 - Rice-mustard-tomato	10.95	10.73	10.84	10.86	10.83	10.84
C_4 - Rice-coriander-lady's finger	20.41	19.05	19.73	20.23	19.23	19.73
C_5 - Rice -carrot cowpea	22.65	21.17	21.91	22.79	21.04	21.91
Mean	25.83	24.74	-	26.09	24.48	-
		Factors				
	C	I	F	C x I	C x F	I x F
SE(m) ±	0.54	0.12	0.13	0.28	0.28	0.18
C.D. at 5 %	1.76	0.38	0.38	0.88	0.88	0.53

Cost of rice : Rs. 6600/t taken for converting yield of different crops to the paddy yield equivalence.

Table 45 : Yield equivalence in terms of paddy, net-return, cost of production and benefit cost ratio in different cropping systems (2008-09)

Cropping system	Yield equivalence of different crops t/ha			Paddy yield equiv-alence (t/ha)	Gross return (Rs. /ha)	Cost of culti-vation (Rs./ ha)	Net return (Rs./ /ha)	Benefit cost ratio
	Kharif 2008	Rabi 2008-09	Sum-mer 2009					
Rice- tomato bottle Gourd (C_1)	5.70	28.78	6.00	40.49	242940	90032	152904	2.70
Rice potato onion (C_2)	5.99	12.17	15.28	33.45	200700	96298	104402	2.08
Rice mustard tomato (C_3)	5.84	5.00	--	10.84	65040	63980	1060	1.02
Rice-coriander-lady's finger (C_4)	5.70	5.73	8.30	19.73	118380	67553	50827	1.75
Rice carrot cowpea (C_5)	5.96	10.72	5.23	21.91	131460	67897	63563	1.94
SE m (±)	0.12	0.56	0.18	0.54	-	-	-	-
CD at 5%	NS	1.82	0.59	1.76	-	-	-	-
Level of irrigation (I)								
I_1	5.86	12.65	7.34	25.86	154980	79328	75652	1.95
I_2	5.83	12.31	6.64	24.74	148440	74975	73465	1.98
SE m (±)	0.87	0.09	0.00	0.12	-	-	-	-
CD at 5%	NS	0.28	0.16	0.38	-	-	-	-
Level of Nutrient (N)								
F_1	5.89	13.00	7.20	26.09	156540	79328	77212	1.97
F_2	5.80	11.96	6.72	24.48	146880	73228	73652	2.01
SE m (±)	0.73	0.09	0.04	0.13	-	-	-	-
CD at 5%	NS	0.27	0.12	0.38	-	-	-	-

Table 46 : Effect of levels of irrigation and nutrient on chemical status of soil after first crop cycle in diversified cropping system (2008-09)

Treatment	pH	EC	Organic Carbon (g/kg)	Available Nitrogen (kg/ha)	Available Phosphorus (kg/ha)	Available Potash (kg/ha)
Initial status of nutrients in the soil of experimental site	6.50	0.110	10.50	281.00	23.56	193.20
Average nutrient status after first crop cycle (2008-09)	7.08	0.100	8.52	247.62	24.17	151.01
Rice- tomato-bottle Gourd (C_1)	7.16	0.104	8.40	259.54	25.54	149.93
Rice potato-onion (C_2)	7.01	0.107	8.80	248.33	24.33	153.54
Rice mustard-tomato (C_3)	6.85	0.094	7.90	224.54	22.74	149.85
Rice-coriander-lady's. finger (C_4)	6.92	0.080	8.60	248.57	24.71	155.46
Rice carrot cowpea(C_5)	6.89	0.088	8.90	257.12	23.56	146.27
SE m (±)	0.04	0.005	0.13	3.29	0.62	1.27
CD at 5%	0.13	0.016	0.40	10.73	2.02	4.14
Level of Irrigation (I)						
I_1	7.02	0.10	9.10	258.89	25.43	153.09
I_2	6.91	0.09	8.00	236.35	22.93	148.93
SE m (±)	0.03	0.002	0.21	1.53	0.24	0.78
CD at 5%	0.09	NS	0.70	4.82	0.76	2.46
Level of Nutrient (N)						
F_1	7.00	0.096	8.80	255.49	25.45	155.10
F_2	6.93	0.094	8.30	239.45	22.91	146.92
SE m (±)	0.03	0.004	0.13	1.36	0.32	0.85
CD at 5%	NS	NS	0.40	4.01	0.94	2.51
C.V%	2.66	22.04	8.58	3.02	7.17	3.08

6.2.2 : Development of vegetable based Integrated Farming system for marginal farmers of irrigated upland

(Shivani, R. D. Singh, K. Rajan and P. K. Ray)

In one-acre vegetable based integrated farming system model, cereal, seasonal vegetable, fodder crop and goatry have been taken as main component and vermicomposting as secondary component. Crop enterprises have been established on 76 per cent, having cereal and pulses in 24 per cent and seasonal vegetables in 52 per cent area. Area allocated for other enterprises are fodder crop (12.5 percent), bunds (4 percent), goatry (5 percent) and vermicomposting pits (2.5 per cent). Six cropping systems including cereal, pulses and vegetable crops have been taken in the field to identify suitable cropping system for this module. These cropping systems are: rice-wheat-green gram (C_1), rice-potato-green gram (C_2), lady's finger- potato-onion (C_3), bitter gourd- tomato- bottle gourd (C_4), lady's finger-coriander-sponge gourd (C_5), and brinjal-carrot-cowpea (C_6) with two levels of fertilizer viz. F_1- recommended level (RDF), F_2- 50 percent of recommended level of fertilizer + goat manure & vermicompost. Analysis of soil samples collected from the experimental plots revealed that the soil is silt clay loam with pH 6.6, electrical conductivity 0.14dS/m, organic carbon 1.20 per cent, available nitrogen 313 kg/ha, available phosphorous 38.5 kg/ha and available potash 259 kg/ha.

The experiment was initiated in *rabi* season. All rabi, summer and *kharif* crops were grown only with recommended dose of fertilizer. Oat + berseem, cowpea and M.P.Chari were grown as fodder crops during rabi, summer and *kharif* season, respectively. A total of 6.5 t green biomass was produced throughout the year. This green biomass generated an income of Rs. 12,951. Yield of all crops were converted into Lady's finger yield equivalence. Based on the results of two seasons, maximum yield equivalence was recorded in bitter gourd-tomato-bottle gourd (17.2 t/0.4 ha) followed by lady's finger-potato- onion (16.0 t/0.4 ha) and rice-potato-green gram (11.3 t/0.4 ha). Similar trend was observed in net return and benefit cost ratio (Table 47). Vermicompost is being prepared and along with goat manure has been recycled within the system from *kharif* 2009.

Table 47 : Yield equivalence in terms of lady's finger and economics of the crop components

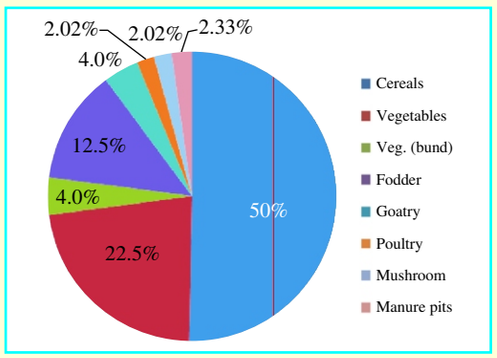
Cropping system	Lady's finger yield equivalence (t/0.4 ha)				Gross income (Rs. /0.4 ha)	Net Return (Rs. /0.4 ha)	B:C ratio
	Kharif	Rabi	Summer	Total			
Rice-wheat-greengram	----	3.65	2.64	6.29	31450	16971	2.17
Rice-potato-green gram	----	7.98	3.28	11.26	56300	36293	2.81
Lady's finger-potato-onion	----	7.94	8.09	16.03	80150	52415	2.89
Bitter gourd-tomato-bottle gourd	----	12.65	4.52	17.17	85850	61334	3.50
Lady's finger-coriander-sponge gourd	----	4.60	2.80	7.40	37000	22756	2.60
Brinjal-carrot-cowpea	----	2.35	3.18	5.53	27650	11788	1.74

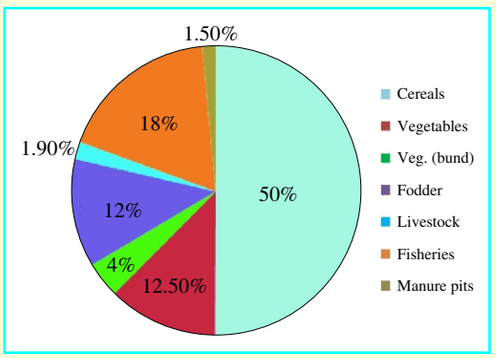
Note : Cost of lady's finger @ Rs. 5000/t was taken for converting yield of different crops to the lady's finger yield equivalence.

6.2.3 : Integrated Farming System for irrigated ecosystem

(Sanjeev Kumar, P. M. Sherry, U. Kumar, A. K. Singh, S.S. Singh, N. Chandra, M.K. Meena, P.K. Ray and Md. Idris)

At Patna main research farm IFS models, one acre for irrigated upland and two acres for irrigated lowland, have been demonstrated. The area under different components has been allocated as per need and in view of nutrient recycling within the system. In one-acre model, goatry, poultry, mushroom, and vermicomposting have been integrated with the crop components. Under crop components, rice-wheat and rice-maize, cowpea-cauliflower-tomato, okra-pea-cabbage and cucurbits- cabbage-brinjal cropping systems were followed and nutrient recycling from the system was studied. Cowpea-cauliflower-tomato cropping system along with poultry + mushroom + goatry gave the highest net income of Rs. 1,09,672 in comparison with other cropping system in a farming system mode which was about four times more than rice wheat cropping system in isolation. In addition 1.5 tonnes of vermicompost and 3.2 tonnes of goat manure were also produced by the system which were recycled within the system and thus, resulting saving of 100 kg Urea, 170 kg SSP and 40 kg of MOP and decrease in cost of cultivation .





In two-acre IFS model, livestock (3 cows + 3 calves), fisheries, duckery, and vegetables and fruits were integrated with prevalent rice-wheat crop system. Different enterprises were evaluated with the same cropping system (rice-wheat) for their economic return and employment within different farming systems. It was found that rice-wheat + vegetables + livestock + fisheries + duckery IFS model gave the maximum return per 2 acre area (Rs. 1,68,865) with 406 man days additional employment opportunity. In addition 2.0 t of vermicompost and 24 t of cow dung were also produced by the system which were used within the system and thus, 200 kg urea, 400 kg SSP and 100 kg of MOP were saved and the cost of cultivation was reduced (Table 48 & 49). Fruit crops were also planted in both the IFS model.

Integration of fish, duck and vegetable with crops two acre IFS for irrigated low land

Mushroom, poultry and vegetable integration in one acre IFS for irrigated upland

IFS models for irrigated ecosystem

Table 48 : Component wise net return (Rs.) from 1 acre IFS model

Cropping system	Crop	Poultry	Mushroom	Goatry	Total	% increase over rice-wheat system
Rice-wheat alone (0.4 ha)	24,478 (13,668)	---	---	---	24,478 (13,668)	----
Rice-wheat (0.3 ha)	18,358 (10,251)	18,625 (9,270)	20,000 (6,580)	38,423 (24,814)	95,406 (50,915)	289
Rice-maize (0.3 ha)	20, 839 (9,970)	18,625 (9,270)	20,000 (6,580)	38,423 (24,814)	97,880 (50,634)	300
Rice-wheat-green fodder (0.3 ha)	20,455 (9,838)	18,625 (9,270)	20,000 (6,580)	38,423 (24,814)	97,503 (50,500)	298
Okra-pea-cabbage (0.3 ha)	26,835 (18,240)	18,625 (9,270)	20,000 (6,580)	38,423 (24,814)	1,03,883 (58,904)	324
Cowpea-cauliflower-tomato (0.3 ha)	32,624 (18,240)	18,625 (9,270)	20,000 (6,580)	38,423 (24,814)	1,09,672 (58,904)	348
Cucurbits-cabbage brinjal (0.3 ha)	28,491 (18,240)	18,625 (9,270)	20,000 (6,580)	38,423 (24,814)	1,05,539 (58,904)	331

Table 49 : Component wise net income and employment generation from 2acre IFS model

Farming system	Net income (Rs. /2 acre/year)				Employment generation (Man days /2 acre/year)		
	Crop	Fishery and /or Duckery	Livestock	Total	Crop	Fishery and/ or Duckery/ Livestock	Total
Rice-wheat alone (0.8 ha)	46,122 (27,336)	----	----	46,122 (27,336)	402	----	402
Rice-wheat (0.76 ha) + livestock	43,815 (25,970)	----	42,290 (50,216)	86,105 (76,486)	390	160	550
Rice-wheat (0.64ha) + livestock + fishery	38,050 (21,868)	22,500 (7,225)	42,290 (50,216)	1,02,840 (79,309)	378	202	580
Rice-wheat (0.64ha) + livestock + fishery + duckery	38,050 (21,868)	40,500 (18,215)	42,290 (50,216)	1,20,840 (90,299)	378	272	660
Rice-wheat + Veg (0.76 ha) + livestock	91,840 (32,814)	----	42,290 (50,216)	1,34,130 (83,030)	526	160	638
Rice-wheat + vegetables (0.64 ha) + livestock + fisheries	86,075 (27,632)	22,500 (7,225)	42,290 (50,216)	1,50,865 (85,073)	478	202	680
Rice-wheat + vegetables (0.64) + livestock + fisheries +duckery	86,075 (27,632)	40,500 (18,215)	42,290 (50,216)	1,68,865 (97,063)	526	272	808

Note : Figures in parenthesis denotes cost of production

6.2.4 : Formulation, development and assessment of a pollen substitute meeting the nutritional needs of honey bees (*Apis mellifera*)

(Janardan Jee)

Under this project a small experimental bee keeping unit with four bee boxes containing 8 frames each was established in the Complex premises. Bee colony with healthy Queen Bee and workers were introduced and acclimatized. Four treatments with one control (only sugar syrup) were tried for assessing the suitability of artificial diet of the honey bee (*Apis mellifera*). Pollen substitute combinations with fatless soybean flour, gram flour, sorghum flour, makhana flour and potato flour and skimmed milk powder, defatted milk, yeast dried, honey and sugar were prepared and given in the different proportion during pollen scarcity period (Sept-Oct). It was observed that honey bee preferred the soybean flour over the other combinations. Gur (jaggery) was the most preferred nectar substitute for the bees. More brood development was reported from soybean flour and sugar feeding colonies. It was also observed that mortality rate of the bees was significantly higher during severe winter.

Theme 7 : Socio-economics, technology transfer and HRD

7.1.1 : Performance and status of SHGs in disadvantaged districts of Bihar

(M. S. Meena, K. M. Singh, P. K. Thakur, Abhay Kumar and Ujjwal Kumar)

Demographic Characteristics : Most of the self help groups (SHGs) members belonged to 27 to 45 years of age. Nearly fifty per cent of members had primary standard of education. About one-fifth of the members in these groups were illiterate followed by those with matric standard (12%). Few members (15%) were educated higher than matric. Most of them had rural background (94 %). Members were mostly contributing up to Rs. 50 per month. Earnings per member from SHG activities ranged from Rs. 400 to Rs.1891. Most of the farmers (61%) had up to 6 years experience while 39 percent farmers had experience of more than 6 years in SHG activities. SHG members (61%) had agriculture as main occupation, followed by household work and manual labour work.

Attitude of group members : Attitude statements were broadly classified as (i) socio-economic upliftment; (ii) education and training; (iii) marketing and entrepreneurship qualities; (iv) technology adoption and participatory research; and (v) banking/credit aspect. A positive attitude was observed on all the mentioned aspects. Overall it was clearly observed that most of the SHG members (91%) had favourable attitude towards the activities taken up by the SHGs.

Change in behaviour of group members : Study revealed that 62 percent SHG members felt moderately changed in their behaviour, followed by highly changed (21%) and slightly changed (17 %).

7.1.2 : Value chain study of selected commodities: case of milk and vegetables in Bihar

(K.M.Singh, N.Chandra, M. S. Meena, R.C.Bharati and Abhay Kumar)

The study has been undertaken with the objectives: (i) to study the market structure of milk and vegetables (ii) to examine marketing cost, margins and price spread of milk and vegetables and factors affecting them and (iii) to identify different marketing channels and constraints to milk and vegetable marketing. Review of literature on Rural-urban linkage, food value chain system, credit facilities for food value chain, marketing and share of consumer, role of globalization and liberalization, various marketing channels/disjointed in food chain supply system etc was done. Schedules are being prepared for detailed field study.

7.1.3 : Socio-economic analysis of access to farm credit in Patna and Vaishali districts of Bihar

(N. Chandra, R.C. Bharati, M. S. Meena and Manibhusan)

Based on stratified random sampling technique, 75 borrower farmers consisting of small (< 1 ha), medium (1-2 ha) and large (> 2 ha) categories of farmers based on their size of holding from two villages i.e. Bedauli (Naubatpur block) and Sangrampur (Vikram block) of Patna were interviewed on various parameters of access to credit with the help of pre-structured schedule.

The average amount of credit per ha of cropped land obtained by sample farmers in Patna district was Rs. 22285. Out of this, average institutional credit was Rs. 12362 and non-institutional credit was Rs. 9923.

This institutional credit was found to be more than non-institutional credit. The same was found to be Rs. 6774, Rs. 7806 and Rs. 7705 for small, medium and large farmers, respectively. It was observed that both total credit as well as institutional credit obtained increased with the farm size, while reverse was the trend with non-institutional credit. The examination of purpose wise credit off take indicated that Kishan Credit Card (KCC) was the most predominant form of credit, followed by livestock and machinery/ equipment. However, in case of small farm, livestock credit uptake was more dominant. The examination of loan repayment by sample farmers indicated that most of the farmer borrowers repaid the loan. Only 24 percent of borrowers could not repay. There was no lump sum repayment.

Crop failure was found to be the most important reason for non/irregular repayment of borrowed fund, followed by low crop yield, lack of irrigation and low price of the produce. As regards constraints to borrowing expressed by respondents, it was observed that non-cooperation by bankers, ignorance / illiteracy and unwillingness to borrow by farmers themselves were major constraints to borrowing. Constraints to lending in Patna (Banker's perspective) were (1) borrower's unclear enterprise, (2) borrower's unclear intention, (3) loan waiver scheme: the greatest hurdle in lending, (4) the project not being well prepared leading to its unviability, and (5) some borrowers being known for non-repayment (willful defaulters). To overcome access to credit bankers should be borrowers friendly, fair and transparent and should consider to and organize loan mela in villages. Loan-waiver scheme is not good for sincere and regular repayers and discourages repayment of loans resulting into credit defaults. Also farmers should be sensitized to banking, its procedures, importance of borrowing and timely repayment, adverse consequences of non-repayment, and also entrepreneurship through various formal/informal training.

7.1.4: Farmers Participatory Action Research Programme (FPARP) MoWS

7.1.4.1: Multiple uses in canal command area for improved livelihood

(Ujjwal Kumar, Abdul Haris and A. Dey)

Multi tier-multi species cropping system

Main crop like mango/aonla was sown in 10 m x 10 m spacing, filler crop like guava and citrus were sown in 5 m x 5 m or 2.5 m x 2.5 m spacing and crops like cereals or pulses or turmeric or vegetable was grown as inter-crop depending upon the season. This intensive cropping system started giving income from the first year itself.

Secondary reservoir- cum-horticulture and vegetable production system

Medium deep waterlogged lands (0.5 1.0 m) can be modified in the form of a reservoir that can be used for multiple uses. The excavated soil is spread around the periphery to form a bund with crest level at least 50 cm above the highest water level to ensure that water do not overtop the bunds. High value horticultural/vegetable production on bunds utilizing seepage water with little supplementary water can produce good profit for the land, which was otherwise poorly utilized. In conjunction, good fish production can be achieved with water quality management through water routing for irrigation purpose. The routed water containing good amount of nutrients provides opportunity for applying water to the fields in correct amount and at appropriate time, which enhances yield and quality of agricultural produce.

Improving economic returns from citrus orchards through better management and nursery development

It is observed that farmers do not properly prune the citrus orchard and left over space in the orchard is not utilized. With proper pruning of citrus plant and sowing of turmeric as intercrop provided Rs. 40,797 additional return which is 68 % higher than the farmers practice having no pruning and intercrop.

Trenches-cum-raised bed system for fishery and horticulture

Lands having water stagnation of more than 1.0 m, are not much beneficial for rice-fish culture. Trenches in such areas were excavated in such a way that excavated soil was filled in alternate strips to make bunds. Similarly, waterlogged areas having water stagnation between 0.3 1.0 m could be utilized for effective fish culture by further digging in the form of trenches and raising a portion above highest flood level using excavated soil to cultivate vegetable or horticultural crops**.**

Trenches-cum-raised bed system for fishery and horticulture in village Beerpur of Patna district

Rice -Fish System

Rice-fish system is useful in productive utilization of seasonally waterlogged lands in canal command. Side refuse was made by allotting 10 % area for fish shelter. By adopting this technology farmers harvested 0.25 tonnes fishes and 4 tonnes of rice in the 1 ha area. Net saving of Rs. 35,900/ha was reported through rice fish system which is 14% higher than net return reported from rice alone (Table 50).

Table 50 : Relative returns of different multiple use system in farmers' field in canal command, Patna, Bihar

S. No.	Multiple use system	Gross income (Rs/ha)	Cost of cultivation (Rs/ha)	Net income (Rs/ha)	B:C ratio
1	Rice + fallow	46600	20100	26500	2.32
2	Rice -fish in water logged area	63000	27100	35900 (35)*	2.25
3	Fish in sunken trenches, horticulture on raised beds	89250	43000	46250 (75)*	2.76
4	Secondary reservoir + horticulture & vegetable on dykes	111000	54580	56420 (113)*	2.34

* Value indicate % increase over traditional rice production

Small-scale duck farming for alternate income generation

Fish culture with improved duck breed was demonstrated in three sites of Patna district. Duck improves aeration in pond, which in turn improves fish growth in low input fish culture system in villages. Moreover, duck droppings are used as fish feed. Khaki Campbell ducks start laying eggs at the age of 22-26.

weeks, which is 8 weeks earlier than deshi breed. During one year, a bird can lay around 200-250 eggs. Average production of egg per bird was 211 / yr with profit of 544/bird per year

7.1.4.2 : Enhancement of water productivity through multiple uses for livelihood of small holders (FPARP)

(D.K. Kaushal, A.K. Singh, S.K. Singh and Ujjwal Kumar)

Under Farmer Participatory Action Research Programme (FPARP) seven normal demonstrations could be undertaken, as severe drought conditions due to prolonged summer and inadequate rains during monsoon resulting in non-availability of sufficient water, prevented undertaking of some of the interventions in Kaincha chaur covering an area of 60 acres of chaur land, in Jandha block, district Vaishali. The total household beneficiaries were 19 families.

Technology demonstrated/ to be demonstrated

S. No.	Description of Technology (ies)
1.	Fish culture in trench (1 No)
2.	Rice fish culture in seasonal waterlogged areas (3 Nos).
3.	Horticulture - vegetable and livestock production in fish pond system (2 Nos).
4.	Establishing low cost eco-hatchery for raising fish seed (1 No).

(i) Fish trenches-cum-raised bed

The fish trench having standing water body covering an area of 940 m^2 was constructed to grow fish. Spawn, 14 lakhs of mrigal and rohu produced on 7-9-2009 by the operation of eco-hatchery was stocked in the trench for rearing the same for creating seed bank. After 100 days of rearing, fries attained size varying between 50-80 cm.

Fish trench

(ii) Rice-Fish culture

Rice-fish culture, useful in productive utilization of seasonally waterlogged lands was undertaken to grow fish in the rice fields with lateral pond type fish refuge. Three demonstrations with constructions of lateral refuge were initiated. However, the stocking of fish could not be undertaken due to unavailability of water in the refuge because of severe drought. Thirty five days old rice seedlings (cv.IR 6444) were transplanted in the 1st week of August. Harvesting of rice gave a yield of 6 t/ha of rice grain and 6.5 t/ha of straw.

(iii) Horticulture-Vegetable and livestock production in fish pond system

To enhance the water productivity, two ponds were reconstructed. Limited efforts could be made to produce vegetables on the embankments. Combined culture of indigenous major carps and exotic carps

were undertaken in ponds. A duck house was also constructed and 30 Khaki Cambell were integrated in the system during March, 2009. Ducks started laying eggs in the month of June when their average weight was around 1.5 kg. Bottle gourd on bunds gave production of 20.0 t/ha. The fish yield was 1.5 t /ha.

Duck-cum-fish farming

(iv) Establishing low cost eco-hatchery for raising fish seed

Portable carp hatchery for raising fish seeds was established. This hatchery is useful in producing fish seed at farmer's field. The transportation of seed from different far off places to the farm site involving substantial cost is getting reduced by introduction of this hatchery. In one run, it has the capacity to produce 1.0-1.2 million spawn. The hatchery operation demonstrated to farmers resulted in production of 80 lakhs spawn.

Such a low costing hatchery can easily be procured by group of farmers. Farmers were advised to make SHG and by pooling their resources, the hatchery could be procured. This offers scope for its wide adoption in rural India. This will definitely enhance the fish seed availability.

Eco-hathery

Responses of the farmers on the adaptability of the various technologies explained to them have been encouraging.

(i) Fish culture in cages (floating) provided an opportunity for a low cost and confined environment in Chaur to farmers enabling them to enhance quality fish production from flood pain wetlands resulting in improvement in livelihood of the stakeholders.

(ii) Fish culture in Pens provided a way forward to protect the escapement of fishes from the chaur by fencing its periphery with pens.

(iii) Before operation of the project, farmers had the constraints with regard to the availability of seed/fish fingerlings. However, operation of eco-hatchery helped the farmers to learn the technology of producing fish seed and they were encouraged to adopt the technology at various fields. Fish seed packaging was also demonstrated to farmers enabling them to export the fish seed.

Fish Seed packing

(iv) More than 200 farmers from the adjacent areas visited the project area and have been benefited with the demonstrations of various interventions of IFS modules.

Feild day with farmers

7.1.4.3 : Water Saving Technologies (FPARP)

(A. Upadhyaya, S.S. Singh and A.K. Singh)

Four Water Saving Technologies (WSTs) under Farmers' Participatory Action Research Programme (FPARP) funded by Ministry of Water Resources, Govt. of India, were demonstrated during *rabi* season in year 2008-09 and six WSTs during *kharif* 2009. During *rabi* season, WSTs were: (i) software demonstration for promotion of conjunctive use in canal command,(ii) zero tillage in wheat and surface seeding in lentil, (iii) balance use of nutrients, (iv) Low Energy Water Application (LEWA) in wheat. In *kharif* season WSTs were (i) raising bund height to improve rain water utilization efficiency, (ii) optimization of rice transplanting time, (iii) software demonstration for promotion of conjunctive use in canal command, (iv) zero tillage and direct seeding of rice, (v) balance use of nutrients, and (vi) Low Energy Water Application (LEWA) in rice. These technologies were demonstrated to 62 farmers in 47 acre land in Amarpura village in the command area of Khajuri distributray and Nisarpura village in the command area of Manjhauli distributary under Patna Main Canal in Sone Command Area. The details of technologies and observations are presented below.

Software demonstration for promotion of conjunctive use in canal command

In order to promote conjunctive use of tubewell and canal water for timely application of first irrigation to wheat at CRI stage and timely transplantation of rice seedling, a software already developed in Hindi using Visual Basic Platform was demonstrated to farmers during both the seasons. This software facilitated farmers to understand the threshold value of desired yield increase, which can compensate the additional cost involved in irrigation through tubewell. Due to conjunctive use practice the wheat yield was 3.72 t/ha as compared to 3.10 t/ha due to canal water irrigation alone. In *kharif* season, the practice of conjunctive use by raising rice seedling using ground water and its timely transplanting using rain/canal/ground water were found to increase yield of rice by 40 per cent from 3.5 t/ha in farmers' practice to 4.9 t/ha under conjunctive use practice. The farmers could easily compensate the additional cost involved in irrigation through tubewell water.

Zero tillage in wheat and surface seeding in lentil

Zero tillage/surface seeding in gram/lentil and wheat in combination with residual effect of Laser land leveling was demonstrated for water saving and yield gain. In wheat, there was yield gain of about 0.3 t/ha due to ZT, which was more gainful (0.5 t/ha) in combination with fields Laser leveled last year. In gram and lentil, there was no yield reduction due to ZT or surface seeding over farmers' practice and yield ranged between 1.5 to 1.6 t/ha. This saved the cost of tillage and uniform availability of soil moisture.

Balance use of nutrients in crops

Use of recommended doze of fertilizer, both in wheat (NPK/ ha 120:60:40) and in rice (NPK 100:60:40) gave better results. Better root development due to phosphorus and bold grains due to potash application was observed. An excess amount of Rs. 2,000/ha due to balanced use of nutrient was accrued which resulted in significantly higher yield of both rice and wheat (0.6-0.7 t/ha).

Raising bund height to improve rain water utilization efficiency

Based on last year's experience and ongoing drought during transplanting period, farmers were advised to increase the bund height around rice fields up to 20-25 cm in order to utilize maximum rainfall by the crop and its conservation through recharge. All 62 farmers raised the height of bunds as suggested. It was found that around 90% rain water could be stored in the fields. This stored water reduced irrigation requirement (2-3 no. i.e. 15-22.5 cm) of rice and runoff from fields. Even prolonged dry spell due to inadequate rainfall during crop growth period and less available canal water, available rain/canal water could be utilized more productively. This practice not only saved the crop but also reduced the ground water pumping cost and proved to be most economical and adoptable.

Raising bund height around rice fields

Optimization of rice transplanting time

Where irrigation through ground water was possible, farmers were encouraged to raise rice seedling in time and utilize ground water for its' timely transplanting under drought situation and delayed canal water supply. One heavy irrigation for land puddling (16 hours) and 4 irrigations (8 hours) were applied in 10 per cent area (0.1 ha) ouder nursery, which cost Rs. 1440/- @Rs. 60/hour for 5 H. P. pumpset and yield increase was 1.0 t/ha over farmer practice. This saved 1-2 numbers of irrigations at reproductive stage in absence of canal water. The subsequent wheat crop could also be sown in time i.e. last week of November, owing to timely rice harvest leading to improvement in yield of rice-wheat crop sequence.

Zero till direct seeding in rice

Zero till direct seeded rice (ZTDSR) saved irrigation water for nursery raising (3.6 ha-cm) as well as water saving of 12-15 ha-cm by curtailment of puddling for transplanting. Less requirement of irrigation water (20 hours per ha through 5 hp pump) in standing crop was observed in ZTDSR as compared to puddle transplanted (30 hours per ha). Due to dry spell, 8 ha-cm water was used as irrigation for direct seeding in June. Therefore, net saving was around 7-8 hacm water in crop establishment. Timely rice establishment in direct seeding facilitated effective rain water use in July and irrigation water saving in October at reproductive stage due to early maturity of crop. Less cracking was observed in soil under un-puddled condition at dry spell and hence the irrigation water was required at later time (15-18 days after disappearance) as compared to puddled transplanted (5-7 days). Total 3-4 irrigations were saved under

ZTDSR. Under puddled condition, soil compactness restricted root penetration to deeper layer, while under un-puddled condition plant remained greener due to continuous moisture supply in rice through deeper root system, which reduced critical water requirement for crop survival at dry spell.

There was saving of inputs under nursery raising, puddling, transplanting, irrigation and plant protection. Although higher expenditure (Rs. 3,500/ha) was required for proper weed management in ZTDSR before and after sowing of crop but other savings compensated this extra expenditure. Under ZTDSR, the yield of rice was either same or higher over farmers' practice besides timely vacation of field for sowing of winter crops.

Low Energy Water Application (LEWA) in rice and wheat

In order to demonstrate and promote Low Energy Water Application (LEWA) in wheat during *rabi* 2008-09 and rice during *kharif* 2009, two sets of LEWA were installed in farmers' fields in Amarpura and Nisarpura villages and their installation, operation and water application as well as time saving, money saving, energy saving and water saving aspects were demonstrated to farmers in their fields. Farmers appreciated the LEWA device and were quite convinced with the performance of LEWA system during dry spells.

7.1.4.4 : Farmers Participatory Action Research Program for demonstration of water harvesting technology (MoWR)

(*Santosh S. Mali, and S. Kumar*)

In order to cater to the water needs of newly established orchards in uplands and midlands during non monsoon period, a new technology of water harvesting was invented at ICAR-RCER, R C, Ranchi. The technology was named as *Doba.* It is a small storage tank of size 3.0 x 1.5 x 1.0 m dug into the ground and is lined with 200 micron thick black polythene and is covered from above with thatch (roof) prepared from locally available material like straw and bamboo frame. To give proper anchorage to polythene it is buried in shallow trenches dug on four sides. *Doba* collects direct falling rainfall and no runoff is allowed to enter in it to avoid silting. One *Doba* collects and stores 4500 litres of water which is sufficient to give life saving irrigation to ten plants. Life of *Doba* structures is three years which ensures the availability of water during the months of water stress.

This type of water harvesting technology is much cheaper which, according to the farmers is an attractive feature of the technology. The structure requires about 1.5 man days for digging which costs about Rs.140/- and the cost of polythene is Rs. 510/- (6 kg @ Rs.85 per kg) and thatch (roof) may be prepared from field waste free of cost or else it will cost about Rs.100/- for paddy straw and bamboo. The total cost of one such *Doba* comes out to be Rs.750/. If farmer is having an acre area under fruits planted at 5 x 5 m, the total number of plants will be 160 and 16 such *Doba*s will be required and the total cost for one acre will be Rs.12000/-.

This *Doba* technology was demonstrated in farmers' fields through active participation of farmers. During the visits to villages, village meetings were arranged and the farmers were motivated to adopt the *Doba* technology. Farmers were trained for construction, maintenance and necessary precautions to be taken for the *Doba* in field. The plan for each field was worked out and work of construction of *Dobas* was completed by the farmers.

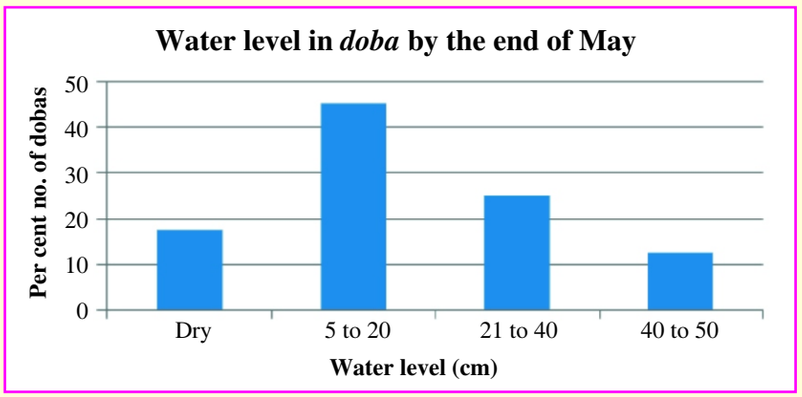


Fig. 48. Water levels in *Doba* at the end of May 2009

In Gumla district, farmers were planning to convert the low productive land into orchards. Realizing the need of water for these newly established orchards, ICAR-RCER, Ranchi Centre selected Toto village for the demonstration of *Doba*. Twenty seven potential farmers from *Roshani*, *Juhi* and *Saraswati* mahila mandals adopted *Doba* technology in 6.53 ha area. In Adeldih village of Purulia district in Pogro watershed, five mango growers readily accepted and installed this technology on their farms. A field survey was carried out at the end of the May 2009 and water levels were recorded in *Doba* (Fig. 48).

During the year 2009 the technology was demonstrated in the fields of 89 farmers covering 12 villages in Lapung block of Ranchi district and Bero block of Khunti district covering a total of 35 ha area (Table 51). In these villages the *Doba* technology was incorporated in the orchards establish under NABARD's 'WADI" programme. The technology of water harvesting using polythene lined ponds was demonstrated in farmers' field in Namkum block of Ranchi district.

Table 51 : Villages where the demonstrations have been completed during 2009

Technology	**Block/ District**	**Village**	**No. of farmers**
Demonstration of direct rainfall collection technology (*Doba)*	Bero	Kokde	22
		Nagri	9
		Bair Toli	1
		Jamni	2
		Danr Kandaria	3
		Harhanji	5
		Ghagra	3
		Childri Tangra Toli	12
	Lapung	Balandu Chupa Toli	14
		Latratu	6
		Sarsa	5
		Balandu	7
Demonstration of rainwater harvesting pond for multiple uses to support livelihood	Namkum	Churu	1
	Total		**89**

Water harvesting pond in farmers' field at Namkum started getting water right from first rains.

The *Doba*, The mango and the happy family in Purulia district

Farmers actively participating in digging of *Doba* and placement of polythene in Danr Kandaria village

Irrigation from harvested water not only saved the life of mango plants but fresh leaf emergence and vigour is also prominently visible.

The action research conducted at farmers' field revealed that water remains in the structure up to end of May. This makes it possible to provide life saving irrigation to the newly established orchards. Life saving irrigations from *Doba* showed 100 % plant survival and better growth of plants. Mango plants grown using this technology, showed new leaves emergence even in the month of April and May. This promising technology, if adopted on regional scale, can help farmers to increase their income and also to diversify the crops to meet their nutritional requirements.

7.1.5 : Scaling up of water productivity in agriculture for livelihood through teaching-cum-demonstration, training of trainers and farmers.

(*K. M. Singh*)

7.1.5.1 : Capacity building of farmers and trainers for scaling up of water productivity

(*M. S. Meena, Abhay Kumar and Ujjwal Kumar*)

The project was undertaken to study demographic attributes, knowledge level, water management skills and to conduct and evaluate training programmes. Under project, review of literature for updating

research status on various aspects of scaling up of water productivity was done. Training programmes were planned and knowledge test was standardized to evaluate the impact of trainings on *Scaling-up of Water Productivity in Agriculture for Livelihoods of Farmers*. Schedules were developed on demographic attributes of farmers, experience in agriculture, training imparted, information seeking pattern, management skills, etc., A total of 14 trainings were conducted this collaborations of Krishi Vigyan Kendra, Bihar Veterinary College, Patna, non-governmental organizations, etc. In these, 700 farmers were trained and evaluated to observe impact of trainings imparted (Table 52).

Training in progress

Table 50 : Trainings organized under project "scaling-up of water productivity in agriculture for livelihoods of farmers"

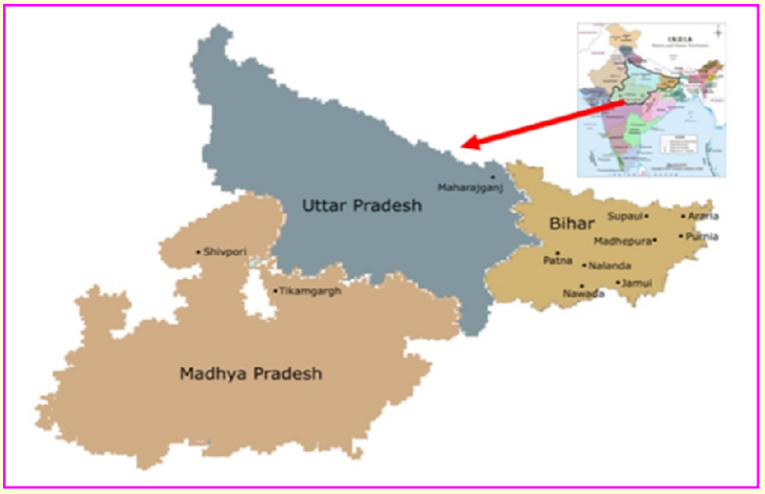
Sl. No.	Collaborative Institutions	Duration (7 days)
1	KVK, Jahanabad	04-10 Sep. 2009
2	KVK, Jamui	05-11 Sep. 2009
3	KVK, Vaishali	07-13 Sep. 2009
4	KVK, Barh	11-17 Sep. 2009
5	BVC, Patna	08-14 Oct. 2009
6	KVK, Buxar	18-24 Nov. 2009
7	KVK, Harnaut (Nalanda)	26 Nov.- 2 Dec. 2009
8	KVK, Nawada	15-21 Dec. 2009
9	KVK, Vaishali	17-23 Dec. 2009
10	KVK, Buxar	18-24 Jan. 2010
11	KVK, Aurangabad	19-25 Jan. 2010
12	KVK, Jamui	19-25 Jan. 2010
13	BVC, Patna	15-21 Feb. 2010
14	ICAR RCER RC, Darbhanga	17-23 Feb. 2010

7.1.5.2 : Promoting sustainable livelihood development (rojiroti) (www.rojiroti.org)

(M.A. Khan, S.S. Singh, Atul Kumar Singh and Ujjwal Kumar)

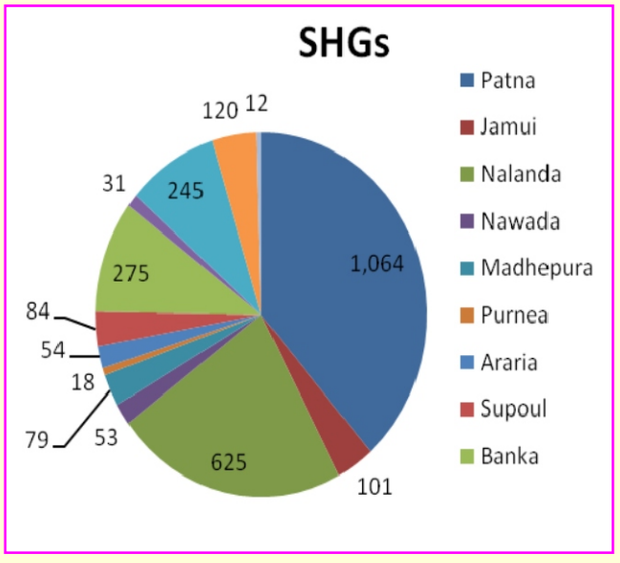
Project is funded by the 'Research into Use Programme', a major initiative of DFID that aims to improve access to knowledge and technology for poor people whose livelihoods depend on natural resources. Main objectives of the project include significant use of renewable natural resource support system and other natural resources, research outputs for the poverty reduction (direct/ indirect) of poor men

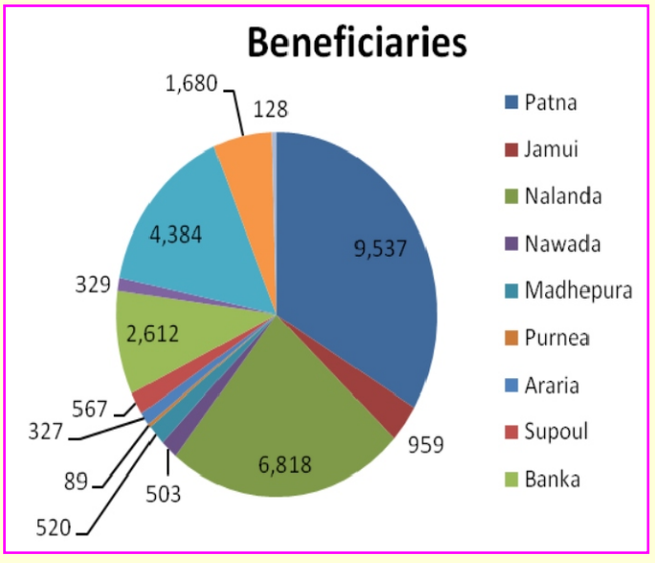
and women in diverse contexts. It is focused on the livelihood improvement of resource poor rural families around natural resources through formation of SHGs, microfinance, income generating agricultural activities and convergence with social welfare developmental schemes. There are three main partners of this project - GY Associates, U.K., Centre for Promoting Sustainable Livelihood, Bihar (CPSL) and ICAR Research Complex for Eastern Region, Patna. The project is operational in 11 districts of three states viz- Bihar, M.P. and eastern U.P. There are three major activities of this project (i) non-deterministic, dialectic approach to support community level institutions (SHGs) and provide lead to livelihood improvement for substantially increased number of the poor and the socially disadvantaged who depend upon renewable natural resources, (ii) improving service delivery enabling significantly number of RNR dependent poor to benefit from and access to agricultural services, and (iii) engagement by coalition partners in project findings leads to uptake of the dialectic approach.



SHGs formation and beneficiaries covered

Total 2,868 SHGs have been formed which cover 29,951 beneficiaries in three states. Major coverage is in Bihar, particularly Patna and Banka districts.

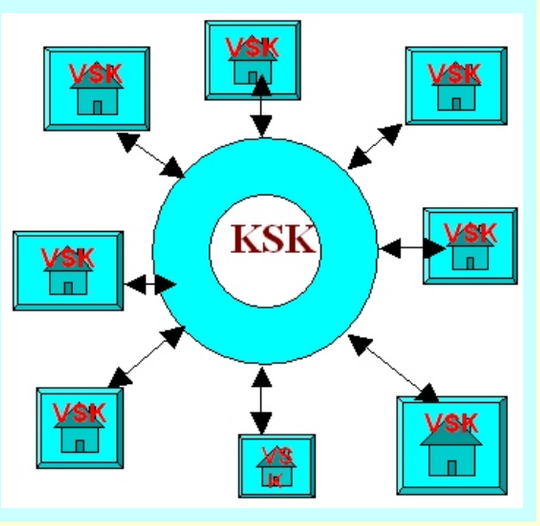




Testing of KSKs (Kisan Soochana Kendra) and VSK (Village Soochana Kendra)

ICAR-RCER, Patna is testing this Kendra as alternate sustainable institutional arrangement for quality information and input delivery through KSKs and its networking units VSKs.

- KSK's may be provided through their respective KSKs. KSKs will be situated in peri-urban areas whereas VSKs in villages,
- KSKs will be source for accessing information by end-user through VSKs and also an outlet for quality agricultural inputs, etc.,
- Information to KSKs will be made available by National/State/ district/block level information hubs.
- All KSKs can be connected with each other whereas access to VSK's to other.



Convergence case with developmental schemes

On request through KSK Vikram, Patna, two rural youths were sent for a 45 day training programme at Central Farm Machinery Training & Testing Institute (GOI), Budni. Madhya Pradesh and one of them got employment in Mahendra tractors Ltd. Looking its success, more than 15 youths are approaching ICAR through KSK for such training.

Production of communication products

The Rojiroti ICAR team selected five themes Raising horticultural nursery, Mushroom production, Vermicompost, Beekeeping, and Fabricating low-cost polyhouse for vegetable production and compiled success cases, FAQ's and scoping sheets. Three extension brochures (Mushroom, Vermicomposting & Beekeeping) have been published for SHGs members and volunteers. The ICAR-RCER is working on videos to complement the extension

Extension brouchers published


Farmers Training

7.1.5.3 : NAIP on developing sustainable farming system models for prioritized micro watersheds in rainfed areas of Jharkhand (co-operating centre)

(R.S.Pan and B.R.Jana)

The technology of off-season cultivation of cucurbits under low polytunnel for early summer harvest was demonstrated successfully for the first time in farmers' fields in Cluster-1 (Jamtara), Cluster-2 (Narayanpur), Cluster-3 (Dumka) and Cluster-4 (Jama). During February-March market prices of the produce was very high (Rs.15-10/kg) compared to Rs 4-6/kg during main season. The maximum net income per decimal (40 m^2) was Rs. 857 for bottle gourd (cv. Arka Bahar) Rs. 370 ((yield 66 kg/d) for Arka Bahar; (Yield 153 kg/d; 382.50 q/ha, Rs.15-10/kg) of produce) and ridge gourd (cv. Swarna Uphar; yield 66 kg/d; 165 q/ha) Rs. 8/kg of produce.

During summer season of 2009-2010, the seeds of improved varieties of bottle gourd (Arka Bahar), ridge gourd (Swarna Uphar), cucumber (Swarna Ageti), long melon (Selection 1), bitter gourd (Green Long), cowpea (Swarna Harita and HACP 44), tomato (Swarna Lalima), water melon (Arka Manik) and okra (Sagun) were supplied to the farmers in all the 4 clusters for cultivation in 10 decimal area. As per availability of land and other resources, the area for summer vegetable cultivation covered per farm family ranged from 2 to 10.7 decimal in cluster-1, 4 to 28 decimal in cluster-2, 1 to 4 decimal in cluster-3 and 1 to 5 decimal in cluster-4. The net income per farm family under farmers own management situations ranged from Rs. 669/- (6 decimal of long melon) to Rs. 2376/- (10.7 decimal of bottle gourd, cowpea, cucumber and water melon) in cluster-1, Rs 679/- (6 decimal of cucumber) to Rs. 5694/- (28 decimal of bottle gourd, ridge gourd and long melon) in cluster-2, Rs 252/- (1 decimal of water melon) to Rs. 1028/- (4 decimal of bottle gourd, long melon and water melon) in cluster-3 and Rs 196/- (1 decimal of cowpea) to Rs.1470/- (4 decimal of bottle gourd) in cluster-4.

Under establishment of fruit based multitier cropping system, mango and guava plants were planted during rainy season in two units (farmers' fields) in cluster-1 covering an area of 1.15 acre (44 mango and 133 guava plants), in two units in cluster-2 with an area of 1.27 acres (48 mango and 146 guava plants), in three units in cluster-3 with an area of 2.1 acres (84 mango and 253 guava plants) and in two units in cluster-4 with an area of 1.94 acres (78 mango and 232 guava plants). Polythene lined rain water harvesting structures (*Doba)* have

Training in progress

been constructed in all the newly established orchards for ensuring summer irrigation during the establishment stage of the plants (1 *Doba* per 10 plants). Income generation started from filler crop (guava) and intercrop (vegetables) in the established multitier systems.

Under the programme on income generation through raising of healthy seedlings of vegetables and fruit plants in potable trays inside polyhouses, the total income was Rs. 6122/- in polyhouse of cluster-1 through sale of papaya cv. Pusa Nanha (1176 seedlings), tomato (1300 seedlings), brinjal (1800 seedlings) and cabbage (936 seedlings), Rs. 2000/- in polyhouse of cluster-2 through sale of 400 papaya seedlings and Rs. 15000/- in polyhouse of cluster-3 through sale of 3000 papaya seedlings.

Under income generation programme by women farmers through mushroom cultivation, spawn packets of oyster mushroom were provided to 87 women for cultivation of mushroom in 340 bags each containing 1 kg straw. Five women farmers in each of cluster-1 and cluster-2, 49 in cluster-3 and 28 in cluster-4 started cultivation of oyster mushroom. The women farmers could be able to harvest 1-1.5 kg mushroom per bag and sell the produce @ Rs 80-100 per kg. Twenty women farmers in cluster-3 made a SHG group (ASRA Group) and sold mushroom of Rs. 3500/-. The group opened bank account in Dumka and deposited an amount of Rs 1500/-.

7.1.5.4 : Improving livelihood security in salt affected watersheds of Muzaffarpur and Sheohar districts of Bihar (NAIP)

(B. Saha)

Baseline survey on socioeconomic and bio-physical features of the project area has been done in selected blocks of Muzaffarpur and Sheohor districts of Bihar. It has been observed that the marginal and landless farmers comprise 70-90 percent of the project area. Most of the lands come under medium land category (60-70%). Salt affected soil comprises 25-50 percent of the land. Rice-wheat is the predominant cropping system in the Muzaffarpur district, whereas rice-wheat, sugarcane, maize and pulses are the cropping system of Sheohor districts of Bihar (Table 53 and 54).

Table 53 : Bio-physical parameters of Muzaffarpur district of Bihar

Parameters	**Kanti Block**		**Motipur Block**	
District-Muzaffarpur	**Bahuara**	**Bhumapur**	**Babruban**	**Matlluna**
Land (%)				
Upland	15-20		20-25	
Medium land	60-70		60-65	
Lowland	15-20		15-20	
Salt affected Soil (%)	25-30		45-50	
Crops				
Rice-wheat	85-90%		80-85 %	
Sugarcane	5-7 %		8-10 %	
Vegetable, Pulse & oilseeds	8-10 %		10-12%	

Fishery (% area) Livestock	12-15 About 60-70% household have a milch animal (cow buffalo) Most of the landless and 30% of the marginal farmers have 2-3 Goats and 5-8 no. of poultry birds	8-10 About 60-70% household have a milch animal (cow buffalo) Most of the landless and 30% of the marginal farmers have 2-3 Goats and 5-8 no. of poultry birds

Table 54 : Bio-physical parameters of Sheohar district of Bihar

Parameters	**Sheohar Block**	**Piparahi Block**
District-Muzaffarpur		
Land (%)		
Upland	10-12	15-18
Medium land	70-75	60-68
Lowland	14-18	15-20
Salt affected Soil (%)	10-15	15-20
Crops		
Rice-wheat %	65-70	50-55
Sugarcane %	15-20	30-35
Maize Pulse oilseeds and vegetables %	15-20	15-20
Fishery (% area) Livestock	5-10 About 50-60% household have a milch animal (dominated by buffalo) Most of the landless and 30% of the marginal farmers have 2-3 Goats and 5-8 no. of poultry birds	8-10 About 60-65% household have a milch animal (dominated by buffalo) Most of the landless and 30% of the marginal farmers have 2-3 Goats and 5-8 no. of poultry birds

7.1.5.5 : Sustainable livelihood improvement through need based integrated farming system models in disadvantaged districts of Bihar

(M.A.Khan, P.K.Thakur, B.K.Jha)

A base line survery was conducted in Darbhanga Sadar Block. The process of PRA to assess the socio-economic, biophysical conditions, problems and constraints for production are in progress. specific sites for different farming system models/technologies, i.e. makhana cum fish along with the horticultural components, vermi -composting, mushroom farming poultry and bee keeping have been identified. Capacity building and sensitization programme through interface meeting between scientists, staff officials and stakeholders was conducted on 21st February, 2009 at ICAR-RCER, Research Centre for Makhana, Darbhanga and formation of commodity interest group is in progress.

To enhance multiple uses of water by the introduction of Makhana + Fish system in the ponds with horticultural plants (Fruits and Vegetable) on the bunds for generating the additional revenue and

maximizing the profit earned per unit area than the conventional method. Also, the alternate income generating activities such as poultry, bee-keeping and vermi-composting were introduced in the vicinity of the farmer's pond. The required training, technical know-how was imparted. The target groups of this project are small and marginal farmers, share croppers and landless labours. In this process the farmer's participation was ensured right from planning to marketing to make it sustainable.

Demonstration model of makhana cum fish along with horticultural components, vermi-composting, bee keeping is in progress at selected farmer's site in the Darbhanga Sadar Block. Makhana and Fishery management and their improvement in Makhana cum fish culture are in progress at different selected farmer's pond site. Improvement and management of fishery in open water (Pond) is in progress. The process of vegetable seed nursery raising is in progress for introduction on the bunds at demonstration model and farmers site of Darbhanga Sadar Block.The harvesting of makhana seeds by the farmers was done in the month of August- October and stocked half quantity of recommended fish seed of Catla, Rohu, Mrigal and Common carp in the March and remaining half were stocked in the month of September-October. The fishes were harvested from the makhana ponds in December-March, 2010.

Evaluation of yield potential of lateral & central vacant space system in makhana cum fish demonstration ponds

An effort was initiated for evaluation of yield potential of lateral and central vacant space system in makhana cum fish demonstration model ponds at Makhana research farm. Fish was integrated in makhana

crop in the month of March, 2009. The half quantity of fish seed of Catla, Rohu, Mrigal and Common carp of the recommendation i.e., 5000 numbers/ ha was stocked in March, 2009.

The makhana seeds were harvested in the month of September October from the ponds and fishes were harvested from December-February, 2010. The average yield of makhana seed in both the ponds was 2.62 and 3.35 q/ha, and fish yield of 5.97 q/ha and 10.2 q/ha respectively. The average weight of fishes harvested in the month of December-February was 728 g, Catla (*Catla catla*) 521 g, Rohu (*Labio rohita*) 428 g for Common carp (*Cyprinus carpio*) 296 g Mrigal. Intervention of poultry, vermi compost, duckery, poly house for nursery seedling raisings on makhana bunds and yield of seasonal vegetables on arches by utilizing vertical slopes and fruit crops like banana gave encouraging results for enhancing water productivity based on integrated makhana cum fish pond based farming system.

Makhana-Fish system in flood prone eco-system : The integration of fish with makhana was proposed in 44 ha in 96 farmers field in Darbhanga Sadar District of Bihar. The harvesting of fish after makhana is in progress. The harvesting in six ponds with total area of 11.506 ha was calculated. It was found that average increase in income per season due to integration of fish with makhana was Rs. 6289/- per ha and average increase in the generation of employment was Rs. 12/- mandays per ha. The income was adversely affected due to drought in 2009-10.

Introduction of six wheat Varieties
at cluster Chakramdas under NAIP (Comp-3)

Intercropping of faba bean (*Vicia faba*)
with QPM (Shaktiman-4)

Integration of fish in farmer's Makhana pond in Darbhanga under NAIP

Production of potato seed

7.1.5.6 A : Scaling up of water productivity in agriculture for livelihoods through teaching cum demonstration

(S.K. Singh, Anil Kumar Singh and K. Rajan)

Demonstration on adoption of drip irrigation in strawberry

To enhance the water productivity, the strawberry was planted in the month of November, 2009 in an area of 500m^2 at the farmer's field in the village Shukulpura, district Bhojpur. The crop is in the establishment phase. The base line data on moisture content per cent of soil was observed to be 27.77, 27.35 and 26.90% at 0-15,15-30 and 30-60 cm soil depth at 0.3 bar, and 18.19,16.69 and 19.21% at 15 bar, respectively. The ground water level was 14 m during summer month. The lay out of drip irrigation on strawberry is in progress.

Strawberry Plantation

Demonstration on adoption of mini sprinkler irrigation in Betel vine

To enhance the water productivity, an established betel vine plantation was selected in an area of 1180 m^2 at the farmer's field in the village Jadua Barai Tola, district Vaishali. The base line data on moisture content (%) of soil was observed to be 25.44, 24.64 and 25.52 at 0-15,15-30 and 30-60 cm soil depth at 0.3 bar, and 13.31,12.75 and 14.86 at 15 bar, respectively. The ground water level was 12 m during summer month. The lay out of mini sprinkler irrigation is in progress, however, plant growth and yield observations are being recorded at regular interval.

Betel vine Plantation

Demonstration on rainwater harvesting

To enhance the water productivity, creation of water resources through construction of farm pond of 1000 m^2 was initiated at the farmer's field in Jagdishpur village, district Bhojpur. The runoff from the contributing fields was channelized into the pond for recharging.

Pond like structure of harvested rainwater

Transfer of technology

Frontline acceleration programme

Under the frontline acceleration programme, a total of 357 frontline demonstrations of improved vegetable varieties were given in farmers' fields. Under the outreach programme of the centre, scientists of the centre visited farmers' fields at Gumla, Khunti, Latehar, Chatra and Hazaribagh districts of Jharkhand, Munger district of Bihar and Keonjhar district of Orissa to provide technical support to farmers on establishment of fruit orchards, canopy management of fruit orchards, nursery management, rejuvenation techniques, rainy season cultivation of tomato. The programmes have been carried out in collaboration with National Horticulture Mission, Jharkhand, PRADAN, Art of Living, Steel Authority of India Ltd., IFFCO.

Providing technical guidance on orchard establishment in collaboration with PRADAN at Keonjhar district of Orissa.

Providing technical guidance on canopy management of young fruit trees in collaboration with PRADAN at Khunti district of Jharkhand.

Providing technical guidance to officials under NHM at Chatra on management of mango orchards

Providing technical guidance on horticulture development at Barhi, Hazaribagh in collaboration with PRADAN

Providing technical guidance for establishment of Model fruit nursery at Munger, Bihar

Providing training on rejuvenation of unproductive mango plants through NHM, Jharkhand

Providing technical guidance on rainy season cultivation of tomato at Manatu in collaboration with IFFCO

Providing technical guidance to farmer from Hahap, Ranchi on rainy season cultivation of tomato in collaboration with Art of Living, SAIL and SRTT

Exposer visit of farmers

A total of 17070 numbers of farmers from Jharkhand, Chhatisgarh, Bihar, West Bengal visited the ICAR RCER, RC, Ranchi for the purpose of exposure visit, consulting with scientists and purchase of seed and planting material.

Women farmers visiting the demonstration plots on improved varieties of tomato

Training programmes organized at ICAR-RCER, RC, Ranchi

S. No.	Topic	Duration of training	No. of participants
1.	Mushroom cultivation	19.01.09 to 21.1.09	25
2.	Hybrid seed production in vegetable	27.01.09 to 31.01.09	37
3.	Mushroom production	02.02.09 to 04.02.09	29
4.	Mushroom production	23.02.09 to 25.02.09	23
5.	Mushroom production	16.03.09 to 18.02.09	23
6.	Mushroom production	19.03.09 to 21.03.09	25
7.	Seasonal vegetable cultivation	23.03.09 to 25.03.09	28
8.	Fruit production/Fruit based multitier system	31.03.09 to 02.04.09	20
9.	Seasonal and un-seasonal vegetable cultivation	29.06.09 to 01.07.09	24
10.	Seasonal vegetable cultivation	06.07.09 to 08.07.09	23
11.	Vegetable and Rabi crop	15.12.09 to 19.12.09	25

Participants of the training programme on mushroom cultivation

Participation in Kisan Mela

The Station participated by putting up exhibition stall in Kisan Mela/Exhibition to disseminate the technologies developed by the Station in horticultural crops.

S.No.	Name of fair	Venue	Organised by	Duration
1	Kisan fair	Getalsut	R.K.Mission	23-24/01/09
2	Kisan fair	Forester trainingg school, Mahilong	Forest Conservator & Director, Forester training school,Mahilong	19-21/03/09
3	Agro-tech 2009	BAU, Kanke	BAU,Kanke,Ranchi	26-28/03/09
4	Kisan fair (Swadesh Prem Jagriti Sangosti 2009)	Mahmada, Pusa Samastipur (Bihar)	Lt.Amit Singh Foundation	28-31/05/09
5	Jaychandi Paryatan Festival	Raghunathpur, Dist-Purlia (West Bengal)	Directorate of Information and Publication of Agril., ICAR, Krishi Anusandhan Bhawan, New Delhi	26/12/09 to 1/01/2010

Participants in Jaychandi Paryatan Festival at Jaychandi Pahar on 26/12/09 to 1/01/2010

Technology dissemination through mass media

The scientists of ICAR RCER, RC, Ranchi delivered 32 talks in Doordarshan, Ranchi on different topics of horticulture.

Intervention : In order to increase production, cropping intensity and employment, 30 new varieties and 12 cropping systems were introduced**.**

Crop	Thirty Improved Varieties introduced under this intervention
Wheat (6-varieties)	PBW- 343, HUW- 234, PBW-373, PBW-502, HD- 2733, HD- 282
Maize (3- varieties)	Devki, Lakshmi, Shaktiman -4 (*QPM hybrid*)
Pea (3- varieties)	Ajad, Harbhajan, Arkel
Potato (3- varieties)	K.Pukhraj, K.Kanchan, Chipsona-1
Rice Scented (4- varieties)	Sughandha-4, Sughandha-5, Raj. Subhasni, Improved Pusa Basmati
Unscented (6- varieties)	PNR 381, Prabhat, Pusa 44, Turanta, Sweta, Rajshree
Tori (2- varieties)	Pusa Tarak, Pusa Mahak
Mustard (1- variety)	Ankur yellow mustard
Lentil (1- variety)	Arun
Moong (1- variety)	Pant moong-1

The following 12 cropping systems were followed

Rice-potato-vegetable (Bhindi/Brinjal etc.)

Rice-potato-moong

Rice- potato + maize-moong

Rice-maize- moong

Rice-wheat-vegetables (Bitter guard/bottle guard/Bhindi/ sponge gourd etc).

Rice-maize + pea-moong/seasmum-vegetables

With the varietals replacement and introduction of the above mentioned cropping systems, it was observed that the cropping intensity which was 200% in the cluster increased upto 300%.

With the increase in cropping intensity the following outcome in terms of employment generation and increase in net income were observed (table 55 and 56).

Table 55 : Increase in employment /ha. due to increase in cropping intensity

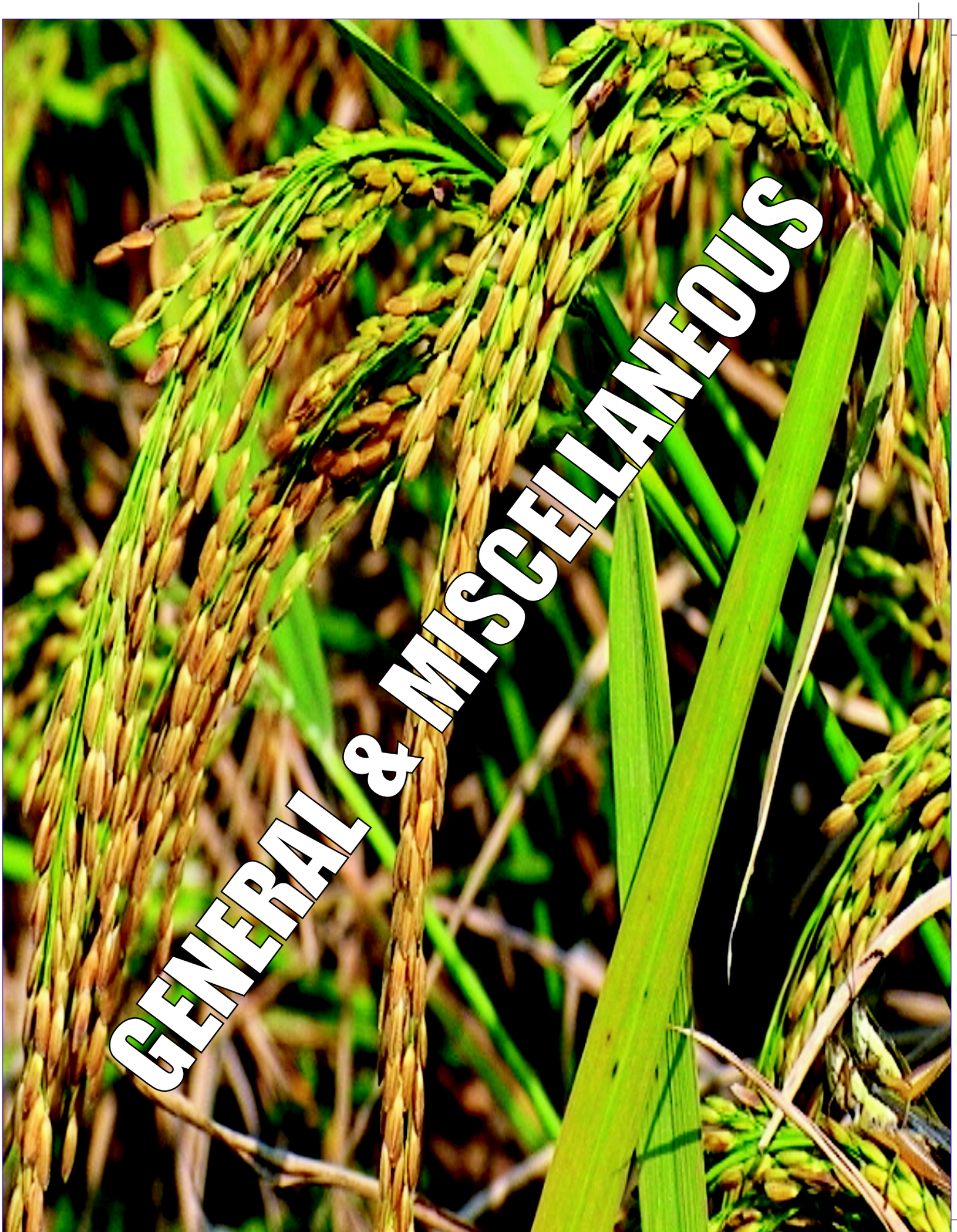
S. No.	Cropping system	Man days employment	per cent increase
1.	Rice-wheat	361	-
2.	Rice-winter maize-moong	375	4.0
3.	Rice-winter maize-vegetables	410	13.5
4.	Rice-potato-moong	416	15.2

Table 54 : Increase in net income /ha due to increase in cropping intensity

S. No.	Cropping system	Net income (Rs.)	Per cent increase
1.	Rice-wheat	57,153	-
2.	Rice-winter maize-moong	72, 553	30
3.	Rice-winter maize-vegetables	89,772	57
4.	Rice-potato-moong	1,44,732	153

RC Makhana, Darbhanga

A series of Transfer of technology programs are regularly being conducted throughout the year benefiting a large no. of Makhana growers and other stake holders. 4 farmers training, 3 Exhibition, 2 Gosthies, 3 Kishan Melas, 1Inter-active programme and 1 field demonstration organized by the Research Centre for Makhana for benefiting growers to a great extent.


GENERAL & MISCELLANEOUS

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Awards and Recognitions

- Dr. A. Upadhyaya, Dr. S.K. Singh and Dr. K. Rajan participated as team members of the Technical Committee constituted by the Ministry of Agriculture, Govt. of India to visit flood affected areas of the Kosi river in Bihar during Feb 2-5, 2009.
- Dr. A. Upadhyaya, Participated in XLIII ISAE Annual Convention & Symposium at BAU, Ranchi during Feb 15-17, 2009 and received Commendation Medal.
- Dr. M. S. Meena, Senior Scientist was awarded 'Young Scientist Award: 2009' by Indian Society of Extension Education for his outstanding contribution in Agricultural Extension, during 5th National Extension Education Congress from 05-08 March, 2009 held at C. S. Azad University of Agriculture and Technology, Kanpur (UP).

- Dr. Ramakrishna Roy, SMS, Animal science received Certificate and memento for participation in Animal health camp organized at 'National conference on technology led development of horticulture for rural development', *Swadesh prem jagriti sangosthi* held at Mahmada village, Pusa, Samastipur from 28-31st May, 2009. (Organized by Lt. Amit Singh memorial foundation).
- Dr. Janardan Jee, received appreciation award as Senior Agricultural Scientist by A. K. S Memorial Charitable Trust, New Delhi, August 2009.
- Dr. A. K. Singh, received 'Scientist of the Year Award -2009', for understanding and recognition in the field of Agronomy on the occasion of first Indian Scientist and Farmers Congress held on 3-4 October 2009, by Society for Recent Development in Agriculture, SVP, Univ. of Agril. & Tech. Meerut (UP).
- Dr. Nitu Kumari; SMS, Horticulture, KVK, Buxar received Ph.D.degree in Horticulture from C.S.A.U.A.T., Kanpur on 5.10.2009.
- Dr R. Elanchezian has worked as Local coordinator for the Indian Society for Plant Physiology at National Conference of Plant Physiology entitled "Frontiers in Plant Physiology towards sustainable agriculture" held at Assam Agricultural University, Jorhat, India during Nov 5-7, 2009. Here, he was also awarded for Best Poster.

- Dr. A.K. Singh, Principal Scientist, was awarded Senior Scientists 'Gold medal Award-2009' by Madhawi Shyam Educational Trust (MEST) and International Consortium of Contemporary Biologists (ICCB), Ranchi, (Jharkhand) for the outstanding contribution in field of Vegetable breeding on 20th November, 2009.
- Dr. Bikash Das, Senior Scientist, got 'Young Scientists Gold medal Award-2009' by Madhawi Shyam Educational Trust (MEST) and International Consortium of Contemporary Biologists (ICCB), Ranchi, (Jharkhand) for the outstanding contribution in field of Fruit Science, on 20th November, 2009
- Dr. D. K. Kaushal recieved appreciation Award by Indian Society of Soil Salinity and Water Quality, CSSRI, Karnal.
- Dr. N. Subash, Scientist (SS) was awarded Ph.D. degree in Agricultural Meteorology from Cochin Univ of Sci. & Tech, Cochin
- First Prize for stall at District Kisan Mela held at Bazar samiti, Buxar from 11th to 12th November, 2009
- Dr. R. D. Singh, appointed as vigilance officer of ICAR-ACER, Patna and NRC. Litchi Muzaffarpur w.e.f. 26th June 2009 till date by ICAR, Krishi Bhawan, New Delhi

Dr. A. K. Singh, receiving 'Sr. Scientists Gold Medal Award-2009' by Madhawi Shyam Educational Trust MEST

Dr. D. K. Kaushal receivieng appreciation Award by Indian Society of Soil Salinity and Water quality.

Education and training of staff undertaken in India/abroad

India

Name of Staff	Name of Training Programme	Organizer	Period
Sh. Dhananajay Kumar and Sh. Pradip Kumar Singh, T-4	Production of disease free seedling and planting material	Advance centre of Plant virology, Division of, IARI, New Delhi	1 - 6 June 2009
Dr. Santosh Kumar Scientist, Plant breeding	87th Foundation Course for Agricultural Research Service (FOCARS)	NAARM, Hyderabad	23 June - 20 Oct. 2009.
Mr. Dilip Sah, Technical Officer and Mr. Suresh Kumar, T-4	Quality Seed Production in Vegetables Crops : An Enterepreneurial Perspective.	IARI, New Delhi	26 - 31 October, 2009
Dr. R.D. Singh Pr. Sci. (Agon)	Special Training on Vigilance Administration for Vigilance Officers of ICAR Institutes	NAARM, Hyderabad	October 29-31, 2009

Sh. Sunil Kumar, Sh. Subhash Kumar, Sh. Kalyan Kumar, Sh. Bipan Kumar, Sh. Manoj Kr. Singh, Sh. Frances Murmuh and All SS Gr. III.	Capacity building at Regional Station, ICAR-RCER, Ranchi.	ICAR-RCER, Patna	December 10-24, 2009

Abroad

Name of staff	Name of training programme with venue	Organizer	Period
Dr. M. A. Khan Dr. S.S. Singh Dr. Ujjawal Kumar Er. A. K. Singh	Visit-cum training at US and UK.	US &UK	September 27 to October 2, 2009

Linkages and collaborations in India/abroad including externally funded projects

- International Water Management Institute, Hyderabad.
- International Livestock Research Institute, Hyderabad.
- Indian Veterinary Research Institute, Bareilly.
- Central Institute of Research on Buffalo, Hisar.
- Directorate of Veterinary and Animal Husbandry, Government of Bihar, Patna.
- Directorate of Fisheries, Government of Bihar, Patna.
- Directorate of Agriculture,Government of Haryana, .Hisar.
- Directorate of Animal Husbandry, Government of Haryana, Hisar.
- Bill and Melinda Gates Foundation/USAID / IRRI for CSISA 2 (Platform Research).
- OUAT, Bhubaneswar.
- IIT, Kharagpur.
- IARI as main center for ICAR network project on Impact, adaptation and vulnerability of Indian agriculture to climate change.
- Bihar Veterinary College, RAU, Patna.
- IIPR Kanpur for AICRP on Pigeon Pea.
- DWR Karnal for AICRP on wheat.
- DRMR Bharatpur for AICRP on Mustard.

- Consortium partners like RAU Pusa, BAIF Patna, CIFRI Barrackpore, IWMI and IFPRI New Delhi, CPRS Patna for implementation of the project under NAIP.
- Rajendra Agricultural University Pusa for Capacity Building of 30-farmers through training on Apiary.
- Vaishali Small Farmer Development Agency.
- ATMA, Darbhanga.
- NABARD, PRADAN, IFFCO.
- Ministry of Water Resources, Govt. of India.
- Birsa Agriculture University.
- Department of Forest, Govt. of Jharkhand.
- Ramakrishna Mission Ashram, Narayanpur, Chhatisgarh.
- Krishi Gram Vikas Kendra, Ranchi.
- ATMA, Hazaribagh.
- Department of Agriculture, Govt. of Bihar.
- Bihar Agriculture Management Extension and Training Institute (BAMETI), Patna.
- NRC, Litchi, Muzaffarpur.

Consultancy, patents and commercialization of technology

Continue to provide Technical support to M/s Sakti Sudha Industry, Patna on makhana production, procurement, product development, processing, storage, marketing, branding & export.

Participation of scientist in Conference/Seminar/Workshops/ Symposia/Meetings in India and abroad

India

Scientist	Name of Seminar /Conference/ Workshops/Symposia/Meetings	Place	Date
Dr. S.S. Singh Dr. Sanjeev Kumar	Workshop for the application of the questionnaire Survey (NAIP), organized by IWMI, India.	ICAR-RCER, Patna	Jan. 19-20, 2009
Dr. R.C. Bharti	International symposium on e-Infrastructures for Distance learning.	India Habitat Centre, New Delhi	Jan. 28-29, 2009
Dr. Ranvir Singh Dr. J. P. Sharma Dr. A.K. Singh Dr. R.S. Pan	XXVII Group Meeting of AICRP of Vegetable crops.	Tamil Nadu Agricultural University, Combatore	Feb. 12-15, 2009
Dr. A. Upadhyaya Er. A.K. Singh	Participated in XLIII ISAE Annual Convention & Symposium.	BAU, Ranchi	Feb. 15-17, 2009
Dr. S.S. Singh Dr. A.R. Khan	Planning workshop of CSISA IRRI, Manila.	NASC, New Delhi	April 26 -30, 2009
Dr. Dr.S.K.Singh Dr. Punam Tiwari	KVK Zonal workshop, Zone II, ICAR.	BAU, Ranchi	May 23-25, 2009
Dr. M. A. Khan Dr. A. Dey	Annual Progress Meeting of the Challenge Programme on Water and Food Project No. 68.	ICRISAT, Hyderabad	May 25-26, 2009

Dr. Ujjwal Kumar	CSISA delivery and adaptive research planning meeting	CSSRI, Karnal	May 28-29, 2009
Dr. Sudhir Kumar Singh Dr. R.K.Roy	National conference on technology led development of horticulture for rural development.	Mahmada Village Pusa, Samastipur	May 28-31, 2009
Dr. P.K.Thakur	National Review Workshop of NAIP (Comp-3).	CIAE, Bhopal	June 1-2, 2009
Dr. K. M. Singh	Workshop on Tracking Changes in Rural Poverty in Household and Village Economies in South Asia.	ICRISAT, Hyderabad	June 30 -July 2, 2009
Dr. R.C. Bharti	Workshop of National Knowledge Network.	National Informatics Centre, New Delhi	July 3, 2009.
Dr. A. Haris, A. Dr. Adlul Islam	Annual Workshop of the ICAR Network Project on Climate Change "Impact, Adaptation and Vulnerability of Indian Agriculture to Climate Change".	CRIDA, Hyderabad	July 3 - 4, 2009
Dr. S.S. Singh Dr. AR Khan Dr. Md. Idris	Joint Review Meeting of Experimental Research Platform (CSISA).	ICAR-RCER, Patna	July 28, 2009
Dr. Janardan Jee	Bihar Maize and Poultry Task Force workshop.	BIA, Patna	July 30, 2009
Dr. Punam Tiwari	Mainstreaming gender concerns in agriculture.	DNS-RICM, Shastrinagar,Patna	Aug.17 - 1, 2009
Dr. S.S. Singh Dr. A.R. Khan Dr. Md Idris	CSISA Experimental Platform Meeting	ICAR-RCER, Patna	Aug. 27, 2009
Dr. A. Upadhyaya	International workshop on "Water quality research to evaluate the effects of Agricultural Conservation Practices utilized in the United States and India.	Allahabad Agricultural Institute, Allahabad	Sept. 7 - 8, 2009
Dr. J. P. Sharma	National Mushroom Mela.	Dir. of Mushroom Solan, Himachal Pradesh	Sept.10, 2009
Dr. R.D. Singh	Workshop on "Alternate imlementation models for efficient public delivery system" organized by World Bank in collaboration with the Rural Development Deptt., Govt. of Bihar.	Patliputra Ashok Hotel, Patna	Sept.15,2009
Dr. R.D. Singh Dr. Shivani Dr. Sanjeev Kumar	Workshop on Advantages of Resource Conservation Technology in minimingthe cost of production & obtaining higher yield organized by ICAR-RCER and sponsored by BAMETI Govt. of Bihar.	ICAR-RC ER, Patna	Sept. 17-19, 2009

Dr. A. Upadhyaya Dr Biplab Saha	Conference on Food and Environment Security through Resource Conservation in Central India : Challenges and Opportunities.	CSWCRTI, Research Centre, Chhaleser, Agra	Sept. 16 -18, 2009
Dr. K. M Singh	Workshop on Strengthening Partnerships and Networks in Agricultural Research and Development.	ICRISAT, Hyderabad,	Sept. 22 -24, 2009
Dr. Nitu Kumari	First Indian Aricultural Scientists and Farmers Congress on Technological Innovation for Enhancing Agriculture oduction.	CCSU, Meerut	Oct. 3-4, 2009
Dr. N. Subash	Indo-Russian workshop on Regional Climate Change.	NERC - India, Cochin	Oct. 8 - 9, 2009
Dr. K. M Singh Dr. Ujjwal kumar Dr. N Chandra Dr. Abhay Kumar Dr. S. K. Singh Dr. A. Dey Dr. S.S. Singh Dr. Sanjeev Kr. Dr. A. R. Khan	Stakeholders Workshop on Fodder Marketing in Bihar organized by ILRI, Asia Centre, India.	ICAR-RCER, Patna	Oct. 27-2009
Dr. S.K.Singh	National Conference on KVKs.	TNAU, Coimbatore	Nov. 06 - 08, 2009
Dr. S. Kumar, Dr. J.P. Sharma	5th International Conference on Plant Pathology in the Globalized Era.	Division of Mycology and Plant Pathology IARI New Delhi	Nov. 10 - 13, 2009
Dr. Janardan Jee	Assocham agriculture Investment - Bihar 2009.	Hotel Patliputra, Patna	Nov. 12.2009
Dr. Janardan Jee	Communal Harmony Campaign week.	ICAR RCER, Patna.	Nov.19 - 25, 2009
Dr. Janardan Jee	Workshop on creating a healthy society with focus on climate change, health and environment.	IEED, Patna	Nov.16 - 18, 2009
Dr. Janardan Dr. A.K. Singh Dr. Bikash Das	2nd International Conference on Bio-Wealth Management for Sustainable Livelihood (ICBMSL).	Institute of Forest Productivity, Ranchi, Jharkhand	Nov. 20 - 22, 2009
Dr. Md. Idris	Int. Conf. on Nurturing Arid Zones for the People and the Environment: Issues and Agenda for the 21st Century.	CAZRI, Jodhpur (India)	Nov. 24 - 28, 2009

Dr. Abhay Kumar Dr. R. C. Bharati	63rd Annual Conference of Indian Society of Agricultural Statistics.	RAU, Pusa	Dec. 3-5, 2009
Ms Punam Tiwari	Post Harvest techology and value addition of grains for designer foods to address life style disorders and health challenges.	College of Rural Home Science, UAS, Dharwad	Dec.03 - 23, 2009
Md. Idris	State Pest Surveillance and Advisory Unit Meeting.	Director Agriculture, Patna	Dec.4, 2009
Dr. B.P.S. Yadav Dr. P.C.Chandran	National Seminar on Strategy for Veterinary Services Vision 2010.	Bihar Vet. College Patna	Dec. 11 - 13, 2009
Dr. S. Kumar Dr. Bikash Das	XIX Group Workers' Meeting of AICRP on Sub-tropical fruits.	B Sawant Konkan Krishi Vidyapeeth, Dapoli	Dec14 to 17, 2009
Mr. B. R. Jana	National Symposium on Recent global developments in management of plant genetic resources.	NBPGR, New Delhi	Dec17 - 18, 2009
Dr. Ujjwal Kumar	Technical working group meeting of Cereal Systems Initiative for South Asia (CSISA) Central Bihar Hub.	ICAR-RCER, Patna	Dec.17.2009
Dr. A. R. Khan Dr. R. D. Singh	International Conference on Food Security and Environmental Sustainability.	I.I.T., Kharagpur	Dec.17 - 19, 2009
Dr. R. K. Roy	Training on Operationalisation of ATMA & SREP.	DNS-RICM, Shastrinagar, Patna	Dec.21-23, 2009
Dr. K. Rajan	Platinum Jubilee Symposium on Soil science in meeting the challenges to food security and environmental quality conducted by Indian Society of Soil Science, New Delhi.	IARI, New Delhi	Dec. 22 - 25, 2009
Dr. M. S. Meena Dr. K. M. Singh	National Seminar on enhancing efficiency of extension for sustainable agriculture and livestock production.	IVRI, Izzatnagar (UP).	Dec. 29 - 30, 2009
Dr. Janardan Jee	20th All India Congress of Zoology and National Seminar on Bioresearches and its Management for Food, Livelihood and Environmental Security & National Helminthological Congress.	CIFE, Mumbai	Dec. 29 - 31, 2009

Abroad

Scientist	Name of Seminar /Conference / workshops/Symposia/Meetings	Place	Date
Dr. S.S. Singh Dr. A.R. Khan	Workshop Planning Meeting of CSISA Project of BMGF/USAID	IRRI, Manila, Philippines	March, 23-24, 2009
Dr. Ujjwal Kumar	Innovation Asia-Pacific Symposium.	Kathmandu, Nepal	May , 4-7 2009
Dr. A. Upadhyaya	Workshop on "Innovation Asia-Pacific Symposium" and presented a paper on "A decision Support tool to explore conjunctive use options in Canal Command.	Kathmandu, Nepal	May, 3-8, 2009

Workshops/Symposia/Conference/Seminar/Scienific Meetings/Training/Farmers' day etc. organized at Institute

1. Two weeks training programme on "*Integrated Farming System*"for B.Sc. (Biotechnology) students of Boston College for Professional Studies, Gwalior, (M.P.), July 10- 24, 2009.
2. Field day for the farmers of Vaishali district under NAIP Component-3 on 20/07/09 at ICAR-RCER, Patna.
3. Seven days training programme for farmers of Vaishali district from 7- 13 September, 2009 at KVK, Hajipur (Vaishali) under "Scaling up of water productivity in Agriculture for Livelihoods".
4. The Vegetable Soyabean Mahotsav was organized on 24th September, 2009 in collaboration with AVRDC (World Vegetable Centre) in which more than 200 farmers participated.
5. One day Krishak Ghosthi on the topic "*Preparation for rabi crops*" on 23 September, 2009 at Vill. Chakramdas, Vaishali under NAIP Component-3 (100 participants).
6. Training program on "Scaling up of Water Productivity in Agriculture for Livelihood" sponsored by Ministry of Water Resources has been organized at KVK, Jamui, Bihar from 5-11 Sep, 2009, at KVK, Harnaut, Nalanda from 26 Nov to 2 Dec, 2009 and at KVK, Siris, Aurangabad from 19-25, Jan 2010. Fifty farmers from the respective districts participated in each training programme.

7. ICAR Sponsored 21 Days,Winter School entitled, "Resource Conservation technologies -Conserving resources for enhancing productivity, sustainability, food security and improvement of rural livelihoods" during November 05 -25, 2009.
8. Training programme on "*Wheat seed production*" on 23 Nov., 2009 at Vill. Chakramdas, Vaishali under NAIP Component-3.

9. Two weeks training programme for B.Sc. Ag Students of AAI, Allahabad from June 22- July 06, 2009 on "*Aspects of Crop Production*" at ICAR-RCER, Patna.
10. Three months Summer Training for four BCA students of Patna Women's College, Patna University on "Library Management System".

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संस्थान के अधिकारियों एवं कर्मचारियों को कार्यालय का दैनिक कार्य अधिकाधिक हिन्दी में करने में होनेवाली झिझक को दूर करने तथा उन्हें राजभाषा नियम–अधिनियमों की जानकारी देने के लिए संस्थान में आयोजित की गयी कार्यशालाओं का विवरण इस प्रकार है:

1. दिनांक 5 से 6 मई, 2009 को आयोजित हिन्दी कार्यशाला में कार्यालय के वैज्ञानिक वर्ग को प्रशिक्षण दिलवाया गया तथा उन्हें अपने शोध कार्यों को हिन्दी के माध्यम से इस क्षेत्र के किसानों तक पहुँचाने के लिए प्रेरित किया गया।
2. दिनांक 24 से 25 सितम्बर, 2009 को आयोजित हिन्दी कार्यशाला में कार्यालय के समस्त स्टाफ को हिन्दी में टिप्पण–प्रारूपण करने का प्रशिक्षण दिलवाया गया तथा उन्हें अन्य अभिलेखों का रख–रखाव भी हिन्दी में करने का सुझाव दिया गया।

S. No.	Title of Workshop, Seminars, Meeting, Farmers' day etc	Place	Organizer	Date
1.	Hindi Karyashalas (03)	Patna	ICAR - RCER	March, May & Sept.2009
2.	Progress Review Meeting of NAIP Projects of Bihar	ICAR-RCER, Patna	Project Implementation Unit, NAIP N.Delhi	18 July, 2009
3.	CAC (Consortium Advisory Committee) meeting	ICAR-RCER, Patna	Consortium Leader	16 Sept. 2009
4.	Scaling up of water productivity in Agriculture for Livelihoods through Teaching cum Demonstratio	KVK, Barh, Patna	ICAR-RCER	Sept. 11-17, 2009
5.	State Level workshop on "Food Security in Times of Crisis"	Patna	Bihar State Productivity Council, Patna	16.10.2009
6.	State Level Workshop on Prime Minister Employment Generation Programme.	Patna	State office of the Khadi and Village Industries Commissio	26.10.2009.
7.	Stake holder workshop in Fodder Marketing in Bihar	Patna	International Livestock's Research Institute, Kenya	27.10.2009
8.	Disaster Risk Management	Patna	UNESCO	16.-18 Nov. 2009
9.	Scaling up of water productivity in Agriculture for Livelihoods through Teaching cum Demonstration	KVK, Nawada	ICAR-RCER	Dec. 15-21, 2009

Sponsored training at KVK, Buxar

Sl. No.	Training Programme	Date	No. of Participants
1.	Scaling up of Water Productivity in Agriculture for Livelihood through teaching and Demonstration.	16-22Nov., 09	50

On farm trials conducted at KVK, BUXAR

Discipline	Topic	Area (ha.)	No. of Beneficiaries	Villages covered
Agronomy	Effect of different weedicides on yield of wheat	--	20	Kukudha
	Assessment of different Green gram cultivar for growth and yield	2.0	20	Bairi, Kukudha, Bharchakiya
Soil Science	Effect of Zinc and Boron on the Yield of Chickpea	1.9	15	Manjhwari, Ahirauli, Ramuvariya and Kukudha.
	Integrated Nutrient Management in Wheat	5.0	16	Basauli, Izari Mathia, Kukudha, Simari, Ramu Variya and Lalganj
	Effect of Zinc on the Economic Yield of Vegetable Cowpea.	1.9	15	Kamarpur, Kesath, Khairati, Bhatauliya and Dullahpur
Horticulture	Evaluation of Different Varieties of Cucumber	1.5	20	Kamarpur and Nayabhojpur
	Effect of Seed Treatment in Onion	3.0	32	Babuganj English, Atimi, Hukaha, Manjharia, Asha Padri, Kaithi, Bharkhar, Jagdishpur, Chakrahansi, Trilochanpur, Simari, Nayabhojpur, Kathrai, Gosaipur and Manjhwari.
	Effect of Different Sowing Dates in Cucumber in Bamboo Polyhouse	---	03	Naya Bhojpur, Bharchakia and Simari
Home Science	Assessment of sickles to reduce the drudgery of farm women caused during the harvesting of paddy	--	17	Kharhana and Bharchakiya
Animal Science	Urea treatment of straw	--	20	Nadawn, Kukudha and Bharchakiya

Fld conducted at KVK, BUXAR

Discipline	Topic	Area	No. of Beneficiaries	Villages covered
Agronomy	Demonstration on ZT on wheat (PBW 502	5.0 ha	23	Bharchkiya and Unnawas
	FLD on Pigeon Pea (full package) NDA 1	5.0 ha	31	Dumraon, Simri, Buxar
	FLD on Chick Pea Var.Pusa 369	3.75 ha	27	Kukudha, Dullahapur, Bharchakiya
	FLD on Pigeon Pea (component) NDA 1	5.0 ha	30	Simri, Buxar, Itarhi
	FLD on Lentil Var.PL 639	3.0 ha	10	Kukudha
	FLD on Mustard Var. NDR 8501	5.0 ha	16	Kukudha, Sarainja, Churamanpur
Soil Science	Effect of rhizobium culture on the yield of black gram (component)	2.5 ha	20	Ramobaria, Majharia, Pawni and Dullahapur
	Effect of rhizobium culture on the yield of black gram (full package).	2.5 ha	20	Simri, Varuna
	Effect of *Rhizobium* Culture on the yield of	10	27	Bharchakiya and Kukudha
	Effect of Chickpea Variety KWR-108	3.1	10	Kukudha
	Effect of Phosphorus Solubilising Bacteria on Yield of Wheat	10.3	33	Daffa Dihari, Ramuvariya, Lalganj, Mukundpur, Manjhariya, Basaon, Simari, Bhitihara and Nayabhojpur
Horticulture	Effect of Weedicide on the Yield of Onion	3.1	33	Kukudha, Bharchakia, Vishrampur and Kathrai
	Demonstration of Improved Variety Swarna Lalima	1.7	18	Bharchakiya, Babuganj English, Kaithi, Bharkhar, Pithari, Jagdishpur, Triloxhanpur, Atimi, Lalganj and Simari
	Demonstration of "Arka Anamika" Okra for tolerance to Yellow Vein Mosaic Virus	1.9	20	Kamarpur nad Nayabhojpur
	Introduction of Quality Planting Material Grand Naine Banana in Buxar District	----	150	Kamarpur and Dullahpur
Home Science	FLD on Nutritional Garden	0.5	20	Jagdishpur, Kamarpur and Bharchakiya

	FLD on ragi health drink cum weaning food	----	30	Bharchakiya and Pawni
	Demonstration on Mushroom cultivation (ATMA sponsored),	----	02	Usra (Navanagar) Kukudha(Itarhi),
Animal Science	FLD on fodder crop (Hybrid Napier IGFRI vr.6)	0.25	19	Khiri(Rajpur),Buxar Bharchakiya, Kukudha, Buxar, Rajpur
	Demonstration on mineral mixture (ATMA sponsored)	----	04	Kukudha, Nadawn, Buxar
Others				

Particulars	Villages covered	No. of beneficiaries
Vaccination camp	Kaithi, Brahmapur	50
Health camp/Diagnostic	Bharchakiya, Kukudha, Simri, Dullahapur, Rajpurm Kamarpur and other parts of Buxar	68
Exposure visit of farmers	RAU, Pusa, Samastipur and ICAR RCER, Patna	80
Kisan Mela	Mahmada, Pusa, Samastipur	1000
	Bazaar Samiti, Buxar organized by ATMA, Buxar	Approx. 1500
	Rajpur Block organized by DAO, Buxar	
	Kila Mandir, Buxar organized by District Administration, Buxar	

Distinguished visitors

S. No.	Visitor	Date
1.	Dr. O.P. Dubey, Former ADG (PP), ICAR and Chairman QRT, IINRG, Ranchi	22.01.09
2.	Dr. Mangla Rai, Secretary, DARE and DG, ICAR, New Delhi	09.02.09
3.	Dr. R. Srinivasan, Entomologist, AVRDC, Taiwan	17.02.09
4.	Dr. Gajendra Singh, Ex DDG (Eng.), ICAR, Ex Vice Chancellor, Doon University, Dehradoon	18.03.09
5.	Dr. Gorakh Singh, Commissioner, Horticulture, Govt. of India	24.6.09
6.	Dr. Mruthyunjaya Hedge, National Director, NAIP, New Delhi	19.07.09
7.	Dr. A. P. Srivastava, National Coordinator, NAIP (Comp-3)	19.07.09
8.	Dr. S. N. Puri, V.C., Central Agricultura University, Imphal	28.07.09
9.	Dr. J. H. Kulkarni, V.C. UAS, Dharwad	28.07.09

10.	Sri. A. K. Upadhyaya, Secretary ICAR, New Delhi	26.10.09
11.	Dr. Allauddin Ahmad, Chairman, RAC	14.10 .09
12.	Dr. R. P. N. Roy Sharma, Member, RAC	14.10 .09
13.	Dr. T. M. Thiyagrajan, Member, RAC	14.10 .09
14.	Dr. A. N. Maurya, Member, RAC	14.10 .09
15.	Dr. C. S. Singh, Member, RAC	14.10 .09
16.	Dr. Harendra Singh, National Seeds Corporation, New Delhi	26.11.09

Dr. Mangla Rai, Secretary, DARE and D.G., ICAR discussing about ongoing trials with the scientists

Dr. Gorakh Singh, Commissioner, Horticulture, Govt. of India interacting with the scientists and farmers

Sri A.K. Upadhyaya planting sapling

IMC, RAC, SRC, Hindi Diwas, and other activities

Research Advisary committee meeting

The Research Advisary committee meeting was held at ICAR-RCER, Patna on Oct. 13-14, 2009 and was attended by following members :

1. Dr. Allauddin Ahmad, Chairman, RAC
2. Dr. R. P. N. Roy Sharma, Member, RAC
3. Dr. T. M. Thiyagrajan, Member, RAC
4. Dr. A. N. Maurya, Member, RAC
5. Dr. C. S. Singh, Member, RAC
6. Dr. D. K. Kaushal, Member-Secretary

Institute Management Committee Meeting

The Institute Management Committee (IMC) meeting was held on 18 Sept. 2009. The meeting was

attended by the following:

1.	Dr. M. A. Khan	Chaimen
2.	Dr. K. K. Kumar	Member
3.	Dr. R. P. Rai	Member
4.	Dr. S. Kumar	Member
5.	Sh. G. F. Shahir	Member Secretary
6.	Dr. K. M. Singh	Special invitee
7.	Dr. S. S. Singh	Special invitee
8.	Dr. Janardan Jee	Special invitee
9.	Dr. R.D. Singh	Special invitee
10.	Sh. A. N. Vashisth	Special invitee
11.	Sh. R. K.Babu	Special invitee

Institute Research Council Meeting

The meeting of Institute Research Council (IRC) was held from 16-19, June 2009 at the Institute seminar hall in which ongoing as well as new research projects were discussed. To provide apportunity to newly joined and other scientists who are not having any research project and also to bring about externally funded projects in to IRC fold mini IRC meeting was held on Dec. 11, 2009, new projects discussed at length and were approved according to merit.

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पूर्वी क्षेत्र के लिए भारतीय कृषि अनुसंधान परिषद का अनुसंधान परिसर, पटना में दिनांक 14 से 30 सितम्बर, 2009 तक सोल्लास हिन्दी पखवाड़ा मनाया गया। इसमें संस्थान के अधिकारियों एवं कर्मचारियों ने उत्साहपूर्वक भाग लिया। हिन्दी पखवाड़ा का उद्घाटन समारोह दिनांक 14 सितम्बर, 2007 को आयोजित किया गया। इसमें सूचना एवं प्रसारण मंत्रालय के गीत एवं नाटक प्रभाग के सुखाड़ कलाकारों द्वारा एक रंगारंग सांस्कृतिक कार्यक्रम भी प्रस्तुत किया गया। इस अवसर पर कार्यालय का कार्य हिन्दी में करने के लिए संस्थान के निदेशक डा. एम.ए. खान द्वारा एक प्रेरणास्पद अपील जारी की गयी। हिन्दी पखवाड़ा की पूरी अवधि के दौरान हिन्दी की अनेक रोचक एवं ज्ञानवर्द्धक प्रतियोगितायें आयोजित की गयीं। इनमें सामान्य ज्ञान एवं सामान्य हिन्दी की प्रश्नोत्तरी, निबन्ध प्रतियोगिता (हिन्दी एवं हिन्दीतर भाषी वर्गों के लिए

अलग–अलग), काव्य प्रतियोगिता, व्याकरण प्रतियोगिता, टंकण प्रतियोगिता, शब्दार्थ प्रतियोगिता, वाद–विवाद, गैरफिल्मी अंत्याक्षरी, एवं हिन्दी कार्यशाला सम्मिलित हैं। इस कड़ी में एक दिन पटना स्थित श्रीकृष्ण विज्ञान केन्द्र के सौजन्य से आपदा प्रबंधन पर तीन लघु फिल्मों का प्रदर्शन एवं व्याख्यान का भी आयोजन किया गया।

इस अवधि में आयोजित प्रतियोगिताओं के विजेताओं को निदेशक महोदय द्वारा दिनांक 30 सितम्बर, 2009 को आयोजित 'समापन एवं पुरस्कार–वितरण समारोह' में पुरस्कृत किया गया।

संस्थान के अधीनस्थ राँची तथा दरभंगा स्थित केन्द्रों में भी हिन्दी दिवस समारोहपूर्वक मनाया गया तथा अधिकारियों एवं कर्मचारियों के लिए विविध प्रतियोगिताओं का आयोजन किया गया। राँची स्थित केन्द्र में हिन्दी में एक गोष्ठी का आयोजन किया गया जिसका विषय था– भा.कृ.अ.प. में क्रय सम्बंधी प्रक्रिया और छठे वेतन आयोग में यात्रा भत्ता से सम्बंधित सिफारिश। तत्पश्चात् जलवायु परिवर्तन के प्रबंधन पर अंतर्राष्ट्रीय राजनैतिक पहल विषय पर व्याख्यान का आयोजन किया गया।

Personnel

Division of Land Water Management

Scientists

Dr. A. Upadhyaya, Head
Dr. Janardan Jee, Principal Scientist (Ento.)
Dr. B. Saha, Principal Scientist (Soil Phy.)
Dr. S. K. Singh, Principal Scientist (Agron.)
Er. Atul. Kr. Singh, Senior Scientist (SWCE)
Dr. Anil. Kr. Singh, Senior Scientist (Agron.)
Dr. A. Rahman, Senior Scientist (Phy.)
Dr. K. Rajan, Scientist (SS) (Soil Phy.)
Sh. M. K.Meena, Scientist (Soil Chem.)
Sh. Manibhushan, Scientist (SS) (Comp. App.) (on study leave)
Sh. Ajay Kumar, Senior Scientist (SWCE) (on study leave)

Technical Officers

Sh. P.K.Singh, Technical Officer (T-5)

Division of Crop research

Scientists

Dr. S.S. Singh, Pr. Scientist & Head, DCR
Dr. A.R. Khan, Pr. Scientist (Soil Phy.)
Dr. T.K. Srivastava, Pr. Scientist (Agronomy)
Dr. Md. Idris, Sr. Scientist (Entomology)
Dr. R. Elanchezhian, Sr. Scientist (Plant Physiology)

Dr. Sanjeev Kumar, Sr. Scientist (Agronomy)
Dr. Chunchun Kumar, Sr. Scientist (Soil Science)
Dr. N. Subhash, Sr. Scientist (Agri. Met.)
Dr. Santosh Kumar Scientist (Plant Breeding)

Division of Livestock and Fishery Management

Scientists

Dr. D. K. Kaushal, Pr. Scientist (Fish and Fishery Science) & Head,
Dr. B. P. S. Yadav, Pr. Scientist . (Animal Nutrition)
Dr. A. K. Jain, Sr. Scientist (Fish and Fishery Science)
Dr. P. M. Sherry,. Sr. Scientist (Fish and Fishery Science)
Dr. A. Dey, Sr. Scientist (Animal Nutrition)
Dr. P. C. Chandran, Scientist (Animal Genetics and Breeding)
Dr. S. J. Pandian, Scientist. (Veterinary Medicine)
Dr. P. K. Ray, Scientist (Veterinary Pathology)

Technical Officers

Dr. S. K. Barari, Technical Officer (T-6)
Sh. Kishori Prasad, Technical Officer (T-6)

Division of Socio-Economics, Extension and Training

Scientists

Dr. K. M.Singh, Head
Dr. P. K. Thakur, Principal Scientist (Agril. Extn)
Dr. N. Chandra, Senior Scientist (Agril. Econ..)
Dr. Abhay Kumar, Senior Scientist (Agril. Stat.)
Dr. R.C.Bharti, Senior Scientist (Agril. Stat.)
Dr. Ujjwal Kumar, Senior Scientist (Agril. Extn.)
Dr. M.S. Meena, Senior Scientist (Agril. Extn.)

Technical Officers

Sh. V.K.Tiwari.T.O. (T-5)
Sh Sanjay Rajput T.O. (T-5)
Sh. Chandra Bhushan, T.O. (T-5)

ICAR RCER, Research Centre, Ranchi

Scientists

Dr. S. Kumar, Principal Scientist (P.P.), Head

Dr. Ranvir Singh, Principal Scientist (Hort.)
Dr. J. P. Sharma, Principal Scientist (P.P.)
Dr. R. S. Pan, Principal Scientist (Hort.)
Dr. A. K. Singh, Principal Scientist (Hort.)
Dr. Bikash Das, Senior Scientist (Hort.)
Sh. I. Tirkey, Scientist (SS) (Agril. Extn.)
Sh. B. R. Jana, Scientist (Hort.)
Sh. Santosh Mali Sambhaji Scientist (SWE)
Dr.(Mrs.) P. Bhavana Scientist (Plant Breeding)

Administration

Sh. Janardan Biswal, Assistant Finance and Accounts Officer

Technical Officers

Sh. Y. N. Pathak, T-6, Technical Officer
Sh. D. K. Sah, T-5, Technical Officer
Sh. Om Prakash, T-5, Technical Officer
Sh. P.S. Sircar, T-5, Technical Officer
Sh. Gokul Bariak, T-5, Technical Officer
Sh. Chandra Kant, T-5, Technical Officer

ICAR RCER, Research Centre Makhana, Darbhanga

Dr. V.K.Gupta, Principal Scientist and Head
Dr. B. K. Jha, Senior Scientist (Hort.)
Dr. Lokendra Kumar, Senior Scientist (Plant Breeding.)

Research Coordination Management Section and Technical Cell

Dr. R.D.Singh, Prinipal Scientist (Agron) and Head
Dr. (Mrs) Shivani, Senior Scientist (Agron.)

Technical Officers

Sh. Kishan Singh, Technical Officer (T-7-8)

Director Cell

Dr. A. Abdul Haris, Senior Scientist (Agro.)
Dr. Adlul Islam, Senior Scientist (SWCE)

Administration and Accounts

Sh. G. F. Sahir, A.O.
Sh. Mithalesh Kumar, F.A.O.

Sh. A. M. Vashisth, A.A.O.
Sh. R. K. Babu, A.F.A.O.

Farm Section

Sh. A. K. Khan, Farm Manager (T-9)
Sh. A. K. Pandey, , Farm Manager (T-6)
Sh. Hari Shankar, , Technical Officer (T-6)

Workshop and Estate Section

Sh. M.L.Swarnkar, Workshop Engineer (T-7)

Library

Dr. K.Rajan, I/c Labrary

New entrants, selection, promotion, transfer and retirements

New entrants

Dr. K. M. Singh, joined to the post of Head, DSEET w.e.f. 22.04.2009
Dr. T. K. Srivastava, joined as Principal Scientist (Agronomy) on 20-05-2009 at DCR, ICAR RCER, Patna.
Dr. A.K.Thakur, Principal Scientist (ASPE) ICAR RCER, RC, Ranchi w.e.f.11.02.2010
Dr. Ajay Kumar, Sr. Scientist (SWE) joined this Institute on 30.06.2009 and relieved for study leave on 03.09.2009
Dr.(Mrs.) P. Bhavana, joined Reserch Centre Ranchi as Scientist (Plant Breeding) w.e.f. 26.8.2009 (FN).
Dr. Santosh Kumar, joined as Scientist (Plant breeding) at ICAR RCER Patna on 30-10-2009.
Sh. Manish Kumar, joined as Programming Asstt. (Computer) KVK, Buxar on 01.09.2009
Sh. Satish Kumar, joined as SMS, KVK, Buxar on 09.10.2009

Selection

Dr. Shivendra Kumar, Principal Scientist to the post as Head, ICAR RCER, RC, Ranchi w.e.f. 29.4.2009
Dr. D. K. Kaushal was selected and joined as Head, DLFM, w.e.f. 29th April, 2009.
Dr. S. S. Singh was selected and joined as Head, DCR, and w.e.f. 29th April, 2009.
Dr. A. Upadhyaya was selected and joined as Head, DLWM, w.e.f. 23th Oct., 2009.
Dr. R.S. Pan, Senior Scientist (Hort.) selected to the post of Principal Scientist (Veg.Sc.) w.e.f. 01.05.2009 (AN).
Dr. Bikash Das, Scientist (Hort.) to the post of Senior Scientist (Hort.) w.e.f. 22.06.2009

Promotion

Sh S. Ahmad, P.A. to Sr.P.S. w.e.f. 10.09.2009

Transfer (Out side)

Dr. R. K. Batta, Principal Scientist transferred from this institute to ICAR, Krishi Bhavan, New Delhi on 28.07.2009

Dr. Pankaj Panwar, Senior Scientist transferred to Chandigarh Station of CSWCR&TI, Dehradun w.e.f. 12.6.2009 (AN).

Dr. Asim Nath, Sr. Scientist (Fishery) joined back parental institute w.e f..03.06.2009

Dr. L.K.Prasad,Sr. Scientist (Soil) transferred to CTRI, Rajamundary w.e.f. 25.09.2009

Sh. A. B. P. Singh, T-4, transferred to IARI, Research Staion, Pusa, Samastipur, w.e.f. 08.03.2010

Transfer (this istitute)

Sh. A.K.Khan, (T-9) Farm Manager from ICAR NEH, Barapani w.e.f. 11.05.2009

Sh. Anil Kumar, (T-4), Computer from IASRI, New Delhi w.e.f. 01.09.2009

Sh. Mithilesh Kumar, FAO, from NIRJAFT, Kolkata, w.e.f. 14.12.2009

Retirements

Sh. Prem Shanker, F.A.O., w.e.f. 01.03.2009.

Sh. I. Trekey, Scientist, Research Station, Ranchi, w.e.f. 31.03.2010.

Sh. Nafees Ahmed, T-7-8 (Garden. Supdt.) w.e.f. 31.12.2009 (AN)

Sh. Sukhdeo Ram, Driver w.e.f. 30.6.2009 (AN)

Resignation

Sh. Manish Kumar, Programming Asstt. (Computer) KVK, Buxar resigned on 31.10.2009

Sh. Arvind Nath Singh, SMS, KVK, Buxar, to selected resigned on 20.07.2009

Information on other section (Library, ARIS and GIS Cell, RCMS)

Library

"A library is the delivery room for the birth of ideas, a place where history comes to life."

—Norman Cousins

Library of ICAR-RCER, Patna is the back bone of scientific community in the Institute for the generation of research concepts and progress of research activities. It provides basic information for the research workers in the form of maps, reports, books and journals. Students, scientists from other organizations, extension workers are also getting benefit from the library. The library has 1665 text books including 40 new arrivals during 2009-10. Subscription of 38 Indian and 22 foreign journals of international repute were made for updating the knowledge of scientific personel. The library also has electronic databases such as CAB CD, AGRIS CD, AGRICOLA CD and SOIL CD. An amount of Rs. 15.06 lakhs was spent during the financil year towards resource development in the library.

The library at ICAR-RCER, Research Centre, Ranchi has a total collection of 1827 numbers of books on different subjects. During 2009, 54 numbers of books were purchased. Currently the library

subscribes 6 foreign journals and 54 Indian Journals. Apart from the institute staff, the library services are being availed by scholars and researchers from different institutions in Jharkhand as well as farmers. During 2009, the library services were availed by 672 numbers of visitors apart from the staff of ICAR-RCER.

View of Library at ICAR-RCER, RC, Ranchi

ARIS & GIS Cell

ARIS & GIS cell is devoted to the storage, retrieval and dissemination of information over the World Wide Web related to agricultural activity. For the purpose, 512 kbps band width of internet connectivity from ERNET India, is linked through BB VSAT modem and wireless local area network with MAC address authentication and security features has been implemented through internal server in the Office-cum-Laboratory building of the Institute for providing internet access as well as resource utilization from any corner of the building. A new website, of NAIP on "Sustainable Livelihood Improvement through Need Based Integrated Farming System Models in Disadvantaged Districts of Bihar" has been launched and the Institute website is being updated regularly. It also provides a platform for the access of scientific recommendations as well as suggestions to the farmers, particularly drought contingency plan during the *kharif* season and tenders, advertisements and other news and information for wide publicity. The ARIS and GIS cell of the ICAR-RCER is well equipped with 4 latest computers to cater the needs of the Institute for day-to-day computing as well as maintenance of computers and other accessories of the Institute and also provide technical inputs related with information technology to scientific, technical and administrative staff of the Institute.

Research Coordination Management Section

The Research Coordination Management Saction serves as a coordinating link between the Institute and Council (ICAR), Government, Semi-Government and other R&D organizations in addition to providing information on various research, training and extension activities of the institute to these agencies. The unit reviews and scrutinizes the research projects/proposals and coordinates the activities within and outside the Institute and also compiles the Annual Report of the Institute.

Information/ativities on gender issue and woman empowerment

Capacity building of farm woman in mushroom production and raising of vegetable seedlings under polyhouse.

Infrastructure development

Infrastructure Development

Main institute : Fitting of false ceiling, partitioning and other work in room no. 124 of the main building.

Photo

Hi-tech shadenet house of sign 2000m^2 inaugurated by Dr. M.A. Khan Director ICAR-RCER

- Created laboratory facilities by acquiring new equipments.

Multiplication of seed and planting material at R. C. Ranchi

A. Seed production during-2009

Sl. No.	Crop	Cultivar	Quantity (kg)
(a) Seed			
1.	Tomato	Swarn Lalima	26.39
		Swarn Naveen	6.38
		Arka Abha	25.70
		Swarn Sampda(F-1)	14.50
2.	Pole bean	HAPB-3	53.00
3.	Brinjal	Swarn Pratibha	180.00
		Swarn Shyamli	72.00
		Swarn Shakti(F-1 hybrid)	2.00
		Swarn Abhilamb	1.00
4.	French Bean	HAFB-2	671.00
		HAFB-4	944.00
		Arka Komal	410.00
		Swarn Priya	331.00
5.	Chilli	K-A-2	15.55
6.	Lima bean	HALB-1	87.00

7.	Dolichos	Swarn Utkristh	95.00
8.	Pea	Azad P-1	828.00
		Swarn Mukti	1362.00
		Arkel	1480.00
		Swarn Amar	102.00
		Swarn Tripti	100.00
9.	Bitter gourd	Arka Harit	49.50
10.	Onion	Arka Niketan	308.00
11.	Cow pea	HACP-44	130.00
		Arka Garima	45.00
		Swarn Harita	17.00
		Swarn Sweta	39.500
12.	Cucumber	Swarn Ageti	2.50
		Swarn Sheetal	5.00
13.	Bottle gourd	HABOG-6	77.60
		Arka Bahar	228.00
		HABOG-16	40.00
14.	Ridge gourd	Swarn Uphar	15.50
15.	Sponge gourd	Swarn Prabha	51.00
16.	Water melon	Arka Manik	18.50
17.	Okra	Arka Anamika	4.00
18.	Paddy	Anjali	304.00
19.	Vegetable Soyabean	Swarn Vasundhra	2724.00
		Total	**10865.62**
(b) Planting material			
20.	Pointed gourd	Swarna Alaukik	14900 nos.
		Swarna Rekha	10900 nos.
		Male	8000 nos.
		Total	**33800 nos.**
(c) Corms and rhizome			
21.	Elephant foot yam	Gajendra	2300.00
22.	Zinger	Suprabha	100.00
23.	Termerik	Roma	850.00
24.	Colocasia	Mukta Kesh	250.00
		Total	**3500.00**

B. Planting material of fruits and ornamental plants

Plant	Numbers
Mango	32535
Litchi	14292
Guava	11472
Aonia	550
Sapota	433
Other minor fruits	1567
Totai	60849
Ornamentai piants	83412

C. Production of mushroom spawn and mushroom

Spawn	Oyster mushroom	Milky mushroom	Button mushroom	Oyster mushroom bags
4420.07 kg	537.35 kg	51.75 kg	0.25 kg	38 numbers

Revenue generated

(A)	Main complex	Rs. 5654831.00
(B)	KVK	Rs. 26603.00
	Total (A+B)	**Rs. 5681434.00**

On-going research projects of the institute during 2009-10

S. No.	Project Code	Project Tine	PI & CO-PI Name
Division of Land Water Management, Patna			
1.	ICAR-RCER/ DLWM/2006/**37**	Development of Decision Support Tool for canal operation	Adlul Islam A. Upadhyaya A. K. Singh A. Haris
2.	ICAR-RCER/ DLWM/ 2008/ **55**	Nutrient management in rice-lentil-cropping system. (Agronomy)	A. K. Singh M. K. Meena R. C. Bharati
3.	ICAR-RCER/	Design and development of a low pressure	A. Rahman

	DLWM /2008/**58**	sprinkling nozzle.	A.K.Singh A. Upadhyaya
4.	ICAR-RCER/	Characterization and classification of ground	M. K. Meena
	DLWM /2008/**59**	water quality of some parts of Maner block of Patna, of Bihar.	Biplab Saha Adlul Islam A.K.Singh
5.	ICAR-RCER/	Enhancing and sustaining the land and water	M.A. Khan
	DLWM /2008/**60**	productivity through multiple use of water. (i) Assessment of land water productivity under multiple water use systems and canal command. (ii) Characterization of soil fertility and water quality under multiple water use system. (iii) Monoculture and polyculture of high value shellfish spacies under multiple water use system.	Abdul Haris A. Upadhyay U. Kumar M.K. Meena P.M. Sherry D.K. Kaushal A. Dey
6.	ICAR-RCER/	Assessment of soil quality in different agro	K.Rajan
	DLWM / 2008 /**66**	eco system of south Bihar	Sanjeev Kumar
7.	ICAR-RCER /	Development of Farmer's friendly Decision	A. Upadhyaya
	DLWM/ 2008 /**71**	Support Tool (DST) for selection of beneficial Integrated Farming System Components	
8.	ICAR-RCER /	Development of drip irrigation practices in	S.K.Singh
	DLWM/ 2008 /**74**	bhindi-potato-mentha system	Chunchun Kumar
9.	ICAR-RCER /	Formulation, development and assessment of	Janardan Jee
	DLWM/ 2008 /**81**	pollen substitute meeting the nutritional needs of Indian honeybees (*Apis mellifera*)	
10.	ICAR-RCER /	Performance evaluation of "water users"	A. Upadhyaya
	DLWM/ 2008 /**82**	Association in Bihar	
Division of Crop Research, Patna			
11.	ICAR-RCER /	Survey and surveillance of insect pest of rice and	Mohd. Idris
	DCR/ 2007/**41**	wheat cropping system of Patna district of Bihar	
12.	ICAR-RCER /	Physiological management for improved abiotic	R.Elanchezhlian
	DCR /2007/ **43**	stress tolerance in rice	A**.** Haris M.K.Meena
13.	ICAR-RCER /	Integrated farming system for irrigated eco-system	Sanjeev Kumar
	DCR /2007/ **45**		Ujjwal Kumar S. S. Singh N. Chandra M. K. Meena Md. Idris

14.	ICAR-RCER/ DLWM / 2008/ **49**	Studies on irrigation and nutrient requirement of diversified cropping system in irrigated eco-system of Central Bihar.	R. D. Singh Shivani
15.	ICAR-RCER/ DCR / 2008/ **52**	Bionomics and integrated pest management of major crops of eastern India.	Md. Idris Janardan Jee Sanjeev Kr
16.	ICAR-RCER/ DCR / 2008/ **53**	Performance of transplanted maize under varying age of seedlings and method of nursery raising.	Sanjeev Kumar M.K.Meena R.Elanchezian
17.	ICAR-RCER/ DLWM /2008/**62**	Development of vegetable base integrated farming systems for marginal farmers of irrigated upland.	Shivani R.D. Singh K. Rajan P.K. Rai
18.	ICAR-RCER/ DCR/ 2009/ **72**	Agricultural drought and flood risk assessment using satellite and meteorological indices over Eastern region of India	N. Subhash A. Abdul Haris
19.	ICAR-RCER/ DCR/ 2009/ **75**	Effect of different type of organic matters on Soil Microbial Biomass Carbon (SMBC) on rice wheat system	Chunchun Kumar
20.	ICAR-RCER/ DCR/ 2009/ **80**	Resource conservation, soil health and carbon sequestration in relation to tillage and nutrient management in organic farming system.	T.K. Srivastava A.R. Khan Chunchun Kumar K. Rajan
Divison of Livestock and Fishery Management, Patna			
21.	ICAR-RCER/ LFIMP/ 2008/ **46**	Development of crop-livestock farming system models.	B. P. S. Yadav P. C. Chandran S. J. Pandian S. K. Singh R. C. Bharati A. Dey
22.	ICAR-RCER/ LFIMP/ 2008/ **47**	Improving the productivity of Black Bengal Goats by Selective Breeding	P.C. Chandran S.J. Pandian P.K. Ray
23.	ICAR-RCER/ LFIMP/2008/**51**	Formulation of poultry broiler and goat feed using Makhana by-products.	A. Dey B. P. S. Yadav P.K.Rai
24.	ICAR-RCER/ LFIMP/2008/**54**	Studies on reproductive diseases in cattle under field condition in Bihar.	S. J. Pandian P. K.Roy P.C.Chandran Manoj Kumar

25.	ICAR-RCER / LFIMP/ 2008 / **64**	Enhancement of land productivity through aquaculture based integrated farming system.	A.K. Jain P.K.Ray Janardan Jee N.Chandra
26.	ICAR-RCER / LFIMP/ 2008 / **76**	Peste des Petits Ruminants (PPR) and Blue Tongue (BT) in goat and sheep: Disease status in Bihar.	P.K.Ray S.J. Pandian Manoj Kumar
Division of Socio-Economic, Extension & Training, Patna			
27.	ICAR-RCER / SEET/ 2007/**40**	Development of composite crop yield forecast system for rice-wheat in Bihar	R.C. Bharti S.S.Singh A.K.Singh Ujjwal Kumar Manibhushan
28.	ICAR-RCER/ SEET /2008-09/**69**	Performance and status of SHGs in disadvantaged districts of Bihar	M.S. Meena P.K. Thakur Abhay Kumar Ujjwal Kumar
29.	ICAR-RCER/ SEET /2008-09/**70**	Socio-economic analysis of access to farm credit in Patna and Vaishali district of Bihar.	N. Chandra R.C. Bharti M.S. Meena Manibhushan
30.	ICAR-RCER/ SEET /2008-09/**77**	Training need assessment of farmers and field functionaries in different agro-climatic zones of Bihar	Abhay Kumar M.S.Meena U.Kumar K.M.Singh P.K.Thakur
31.	ICAR-RCER/ SEET/2008-09/**78**	Constraints and issues of water management in canal and tube well operated areas in Bihar	Ujjwal Kumar Abhay Kumar M.S.Meena K.M.Singh N.Chandra
32.	ICAR-RCER/ SEET/2008-09/**79**	Value chain studies of selected commodities in case of milk and vegetables in Bihar.	K.M.Singh N.Chandra M.S.Meena R.C. Bharati Abhay Kumar
ICAR-RCER, Research Centre , Ranchi			
33.	ICAR-RCER / HARP/2001/ **03**	Management of plant genetic resource and improvement fruit and ornamental crops	Bikash Das B.R. Jana S. Kumar I. Tirkey

34.	ICAR-RCER / HARP/2001/**05**	Management of plant genetic resources and improvement leguminous and minor vegetable crops	R.S. Pan A.K. Singh S. Kumar J.P. Sharma Bikash Das
35.	ICAR-RCER/ HARP/2001/**07**	Regulation of growth development and nursery management of fruit crops	Bikash Das P. Dey S. Kumar I. Tirkey A.K. Singh R.S. Pan A.K. Tewary
36.	ICAR-RCER/ HARP/2001/**08**	Development of sustainable production and utiligation in fruit and ornamental crops	R.V. Singh Bikash Das I. Tirkey
37.	ICAR-RCER/ HARP/2006/**33**	Evaluation of Advance breeding lines and maintenance breeding in Solanaceous and Cucurbitaceous vegetable crops	A.K. Singh R.S. Pan J.P. Sharma
38.	ICAR-RCER/ HARP/2006/**34**	Management of plant genetic resources and improvement of leafy and under-utilized vegetable crops	A.K. Singh R.S. Pan S. Kumar J.P. Sharma Bikash Das I. Tirkey
39.	ICAR-RCER/ HARP/2006/**39**	Development of drip irrigation practices for Litchi in eastern plateau region	A.K. Singh Bikas Das S.S. Mali
40.	ICAR-RCER/ HARP/2008/**50**	Gravity subsurface pipeline fertigation for cucurbits in sandy loam soils of eastern plateau region	S.S. Mali Ranvir Singh M.K. Meena
41.	ICAR-RCER/ HARP/2008/**56**	Development of guava + pineapple based multistoried cropping system under irrigated conditions of eastern region plateau region.	B.R. Jana Bikash Das M.K. Meena
42.	ICAR-RCER/ RC Ranchi/2009 **73**	Evaluation of substrates and assessment of water requirement for commercial production of oyster mushroom	J.P. Sharma S.S. Mali
ICAR-RCER, Research Centre Makhana, Darbhanga			
43.	ICAR-RCER / RCM/ 2008 /**65**	Study on genetic diversity in Makhana	Lokendra kumar V.K.Gupta

On going Foreign-aided and Externally Funded Project during 2009-10

S. No.	Project Code	Project Title	PI & CO-PI Name
1.	ICAR-RCER/ ICCW//2004/ **2 (a&b)**	Impact assessment of climate change on water resources and their productivity. Impact adoption and vulnerability of Indian agriculture to climate change.	A. Haris A. Islam R. Elanchiziean
2.	ICAR-RCER / ACIARFP / 2006/ **5**	Water harvesting and better cropping systems for the benefit of small farmers on watersheds of the eastern Indian Plateau (Australian Centre for International Agricultural Research funded Project).	S. Kumar A. Islam
3.	ICAR-RCER/ Ext.Funded/2008/ **6**	Water saving technologies demonstration under Farmers Participatory Action Research Programme (FPARP)	A. Upadhyaya S.S. Singh A.K. Singh
4.	ICAR-RCER/ Ext.Funded/2008/**7**	Farmers Participatory Action Research Programme (FPARP)	D.K. Kaushal A. K. Singh S.K. Singh Ujjawal Kumar
5.	ICAR-RCER/ Ext.Funded/NAIP/ 2008/ **8**	Development sustainable farming system models for prioritized micro watersheds in rainfed areas of Jharkhand	S.K. Pal R.S. Pan B.R. Jana A.K. Jaiswal R.K. Singh
6.	ICAR-RCER / HARP/BCKV / 2008-09/ **9**	NFBSRA funded project on "Epidemiology and forewarning system of downy mildew disease of cucurbits to develop appropriate IPM strategy"	S. Kumar
7.	ICAR-RCER / NAIP/ 2008-09/ **11**	Sustainable livelihood improvement through need based integrated farming system Model in disadvantaged Districts of Bihar.	M.A. Khan P.K. Thakur B.K. Jha R.S. Sharma M.K. Jha R.P. Rai
8.	ICAR-RCER/ HARP/2008/ Ext.F./CWC/ **12**	Demonstration of Water Harvesting Technology. Farmers Participatory Action Research Programme (FPARP)	S.S Mali. S. Kumar Bikash Das

9.	ICAR-RCER/ Ext.Funded/ 2008/**13**	Farmers Participatory Action Research Programme (FPARP)	Ujjawal Kumar Abdul Haris A. Dey
10.	ICAR-RCER/ EFP/RCR/2008/**14**	Intensification of research on bael with special reference to medicinal value funded by National Medicinal Plant Board.	B.R. Jana
11.	ICAR-RCER/EFP/ LWM/2008/**15**	Livelihoods improvement in saline and alkaline soils of Shiohar and Muzafferper districts of Bihar	B.Saha
12.	ICAR-RCER/ EFP/LWM/ 2008/**16**	Scaling up of Water Productivity in agriculture for livelihoods through teaching-cum-demonstration, training of trainers and farmers	R.K. Batta A.K. Singh S.K. Singh K. Rajan
13.	ICAR RCER / Ext.Funded/ 2009/**17**	Challenge Programme Project On Improving water productivity, reducing poverty and enhancing equity in mixed crop-livestock system in the IGB.	M.A. Khan A. Dey
14.	ICAR-RCER/ EFP/ RIU-DFID/**18**	Promoting sustainable livelihood development (P 1064 Rojiroti)	M.A.Khan S.S.Singh A.K. Singh Ujjawal Kumar
15.	ICAR-RCER/ EFP/NAIP/2009**19**	Modeling the performance of a new major cropping system in Eastern India in the light of projected climate change. (NAIP)	S.S. Singh N. Subash R.C. Bharti
16.	ICAR-RCER/ EFP/**20**	Capacity building of farmer's and field functionaries for scaling up of water productivity	M.S. Meena Abhay Kumar Ujjawal Kumar
17.	ICAR-RCER/ Ext.F/ RCR/ 2009/ **21**	Development of Ultra-High Density Orcharding in Guava under Jharkhand conditions	Bikash Das S.S. Mali B.R.Jana
18.	ICAR-RCER/FF/ RECR/ 2009/ **22**	Crop resource management practices for sustainable future cereal- based systems.	M. A. Khan S. S. Singh A. R. Khan Md. Idris A. K. Singh