Quinquennial Review Report : ICAR RCER

REPORT

of

Quinquennial Review Team

(2001 - 2005)

भाकृअनुप
ICAR

ICAR - RCER, PATNA

ICAR Research Complex for Eastern Region

Patna

QRT ICAR - RCER (2001 - 2005)

REPORT OF THE

QUINQUENNIAL REVIEW TEAM

(2001-2005)

Dr. S.M. Virmani	-	**Chairman**
Dr. R.M. Pandey	-	**Member**
Dr. Dinesh Marothia	-	**Member**
Dr. A.P. Mishra	-	**Member**
Dr. M.S. Gill	-	**Member**
Dr. S.H. Ahmad	-	**Member**
Dr. R.K. Batta	-	**Member – Secretary**

भाकृअनुप
ICAR

ICAR - RCER, PATNA

ICAR Research Complex for Eastern Region

Patna

TABLE OF CONTENTS

ACKNOWLEDGEMENTS

The Quinquennial Review Team (QRT) expresses its deep sense of gratitude to Dr. Mangala Rai, Director General, Indian Council of Agricultural Research for providing the opportunity to its members to review the working of ICAR Research Complex for Eastern Region, Patna for the period 2001-2005.

The Team made visits to 3 regional centres wherein it heard presentations by the Heads of programmes at each regional centre. The Team also visited ICAR-RCER Headquarters at Patna where presentations by Heads of three programmes operational at Patna were made. In all the Team had six meetings including the one with DDG (NRM) and a final review meeting at Patna. The QRT had an opportunity of interacting with the Vice-Chancellors of Rajendra Agricultural Uninversity, Pusa and Birsa Agricultural University, Ranchi. The Team had an intensive interaction with the scientists, farmers and NGOs operating at each of the regional centres. The QRT had an opportunity to visit operational field areas at Patna, Ranchi, Darbhanga and Pusa and saw the on-station and field demonstrations on the various research activities at the respective centres.

The QRT is thankful to Dr. J.S. Samra, Deputy Director General (NRM) for guiding the QRT in its preliminary meeting held on August 8, 2006 for formulating the Review Programme.The QRT is also thankful to Dr. P.S. Minhas, Assistant Director General (IWM) for fruitful discussions from time to time.

The QRT would like to place on record their deep sense of appreciation to the Vice-Chancellors, Directors of Research and Extension of SAUs and Heads of the Programmes of ICAR-RCER at the regional centres for providing all the necessary facilities for smooth conduct of the meetings at their respective centres.

The Chairman is also grateful to Dr. A.K. Sikka, Director, ICAR-RCER, Patna for providing the necessary facilities and for his overall cooperation.

The Chairman, QRT is personally thankful to all the QRT members for their valuable contribution and close cooperation throughout the period of Review. The Chairman is also thankful to Dr. R.K. Batta, Member-Secretary & Head LWEERP, ICAR-RCER for his sincere efforts in organizing all the meetings, working-out logistics and in the preparation of the final report.

S.M. Virmani

(S.M. Virmani)
Chairman,
Quinquennial Review Team,

Dated: September 30, 2007

PART –I
Report of the QRT

CHAPTER - I

INTRODUCTION

1.1 COMPOSITION OF THE TEAM, TERMS OF REFERENCE, PROGRESS OF VISITS AND REVIEWS

ICAR Research Complex for Eastern Region, Patna came into existence on the 22 February 2001 after the merger of Directorate of Water Management Research, Patna with the Complex. On April 1, 2001, Central Horticultural Experimental Station, Ranchi and Central Tobacco Research Station, Pusa were also merged in the complex. The ICAR Research Complex for Eastern Region, Patna has, thus, a broad-based framework to address diverse agricultural issues related to water and land resources' management, crop husbandry, horticulture, fisheries, livestock and poultry, agro-processing and socio-economic aspects in a holistic manner for enhancing research capacity and for providing a backstopping for improvement in agricultural productivity and sustainability in the eastern region of India. After the amalgamation of the aforesaid three units and by the creation of new programmes, the ICAR Research Complex for Eastern Region currently is comprised of five research programmes viz. Land, Water, Environment and Engineering Research Programme (LWEERP), Patna; Crop Research Programme (CRP), Pusa; Horticulture and Agro-forestry Research Programme (HARP), Ranchi; Livestock and Fishery Improvement and Management Programme (LFIMP), Patna; and Socio-Economic and Extension Research Programme (SEERP), Patna. The National Research Centre *Makhana* at Darbhanga has also been brought under the administrative and financial control of the Research Complex in the approved X Plan vide EFC Memo of ICAR-RCER. The Complex is now a multi-commodity and multi-disciplinary institutional framework which is aimed to address research issues and to develop technologies relevant to the prevailing biophysical and socio-economic environment of the eastern region of India.

1.1.1 COMPOSITION OF TEAM

The Director General, Indian Council of Agricultural Research constituted the QRT vide F.No.18-8/05-IA.II dated 26.04.2006 to review the work of ICAR Research Complex for Eastern Region, Patna and its Research Centers nominated Dr. S. M. Virmani, former International Scientist, ICRISAT and Ex-Foreign Secretary, NAAS as the Chairman of QRT.

The composition of QRT is as follows.

1. Dr. S.M.Virmani — Chairman
   House No.811A, Road 41
   Jubilee Hills,
   Hyderabad-500033
2. Prof. M.S.Gill, — Member
   Project Director
   Project Directorate for Cropping System Research (ICAR)
   Modipuram, Meerut – 250 110 (UP)

3.	Dr. Dinesh K. Marothia, Prof. & Theme Leader (CNRM) KIIT School of Rural Management KIIT University, at P.O.-KIIT,	Member
4.	Dr. R.M. Pandey, Ex-Director, IIHR E-29E, DDA (MIG) Flats, Mayapuri, New Delhi-110064	Member
5.	Dr. S.H.Ahmad, Ex-Dean (Fy.), RAU 405, Saket Enclave, Khajepura, Bailey Road, Patna-801014	Member
6.	Dr.A.P.Mishra, Dean (Agril. Engg.) Rajendra Agricultural University Samastipur, Pusa-848125 (Bihar)	Member
7.	Dr. R. K. Batta Pr. Scientist & Head, LWEERP ICAR Research Complex for Eastern Region, Patna ICAR Parisar, PO: B.V.C., Patna-800014 (Bihar)	Member-Secretary

1.1.2 TERMS OF REFERENCE

I. Research Achievements and their impact

To examine and identify the research achievements of the Institute, Projects/KVKs its Regional Stations and Sub-Stations, AICRPs operated by them vis-a-vis sectoral programmes since the previous QR and critically evaluate them. Commensurate with the objectives, mandates and resources of the organization, the socio-economic impact of research on farmers/beneficiaries and transferability of results to farmers through extension should be critically reviewed.

II. Research Relevance and budget allocation

To examine the objectives, scope and relevance of the research programmes and budget of the Institute for the next 5 years in relation to overall/state/ regional national plans, policies and long and short-term priorities. The Committee may also draw its attention to the EFC/SFC Memo in relation to recommendations of the previous QRT and also the Perspective Plan and Vision 2025 document of the Institution.

III. Policies, priorities and strategies

To examine the policies, priorities, strategies and procedures adopted by the Institute and the system in relation to Perspective Plan in arriving at these decisions particularly the effectiveness of working of the Staff Research Council, RAC and the Management Committee as well as the Consultative machineries like Grievance Cell and Joint Staff Council.

IV. Relationship/collaboration with SAUs and other stakeholders

Whether the research programmes of the past and proposal for future are in harmony with the Vision of ICAR (HQ) and the programme of related centres of research and Agricultural Universities, state government, private sector, and LARCs.

V. Linkages with clients/endusers

To examine the kinds of linkage established with the clients and endusers of research results, i.e., farmers /fishermen and the extent of interest displayed in conducting "on-farm research", on farmers fields and in organizing demonstrations/training courses for the transfer of technology to extension agencies.

VI. Proposed changes in organization, programmes and budget

To examine whether any changes in the organizational setup are called for, to achieve an improved and effective working. The Committee may also examine and draw attention to any imbalances in the staffing pattern consistent with the scientific, technical and administrative needs as well as the allocation of research funds towards capital works, establishment and research contingencies. Further the Committee may also examine the resource generation efforts and assess the problems and prospects of the same. The progress and problem of implementing Project Based Budgeting may also be highlighted. While proposing major changes in organization and functioning, their feasibility in relation to ICAR's rules, autonomy, resources etc. need to be kept in view.

VII. Organization and Management

Whether the organizational structure of the Institute is conducive to efficient functional/ working autonomy, decentralization and delegation of authority in day-to-day routine working and whether the Director and senior staff are interested in promoting a collegiate and co-operate method of administration is to be assessed. The Committee may also critically examine the status of implementation of O&M reforms as introduced by the Council from time to time and suggest ways and means to implement them at the Institute level. They may also suggest further reforms to be considered by the Council. The suggested staff ratio by the Council may have to be kept in view while reviewing the staff position in the Institute.

VIII. Constraints

To examine constraints hindering the Institute in achievement of its objectives and implementation of its programme and goals and to recommend ways and means of minimizing or eliminating them.

IX. Looking forward

To look into any other points considered relevant by the Committee or referred to it by the ICAR, the Institute Director or the Management Committee, in respect of future project development, research prioritization and management changes.

The above terms of reference may be modified at the suggestion of Director of Institute/Project/ Management Committee of Institute/Project/ICAR Headquarters/GB keeping in mind any specific problems of the Institute.

1.1.3 PROGRESS OF VISITS AND REVIEWS

The QRT organized its work by visiting the different Regional Centers of the ICAR-RCER, Patna. The QRT asked the Heads of the Programmes to make presentations and saw on-station trials and outreach field activities of the programmes. During their visits, the QRT also interacted with the various partner institutions, NGOs, Farmers and field functionaries both in the field and by inviting them for the interaction meeting. The details of the venue of each meeting and the period of review are indicated in Table 1.

Table 1 Field visits and reviews by QRT.

S N	Venue & Host Univ./Organization	Period	Center(s) visited/reviewed	QRT Members Present
1.	New Delhi	Aug. 8, 2006	Preliminary Meeting with DDG (NRM)	Dr.S.M.Virmani, Chairman Dr.J.S.Samra, DDG (NRM), ICAR, New Delhi Dr. A.K.Sikka, Director, ICAR-RCER, Patna Dr.P.S.Minhas, ADG (IWM), ICAR, New Delhi Dr.R.K.Batta, Member-Secretary
2.	ICAR-RCER, Patna	Oct. 4-6, 2006	LWEERP, SEERP and LFIMP Programmes of the ICAR-RCER	Dr.S.M.Virmani, Chairman, Dr.S.H.Ahmad, Member Dr.R.M.Pandey, Member Dr.A.P.Mishra, Member Dr.M.S.Gill, Member Dr.R.K.Batta, Member Secretary
3.	HAFRP, Ranchi	Feb. 26-27, 2007	HARFP Programme of the ICAR-RCER	Dr.S.H.Ahmad, Member Dr.R.M.Pandey, Member Dr. Dinesh Marothia, Member Dr. M. S. Gill , Member Dr. R. K. Batta, Member-Secretary
4.	CRP, Pusa	March 15-16, 2007	CRP, Programme of the ICAR-RCER	Dr. R. M. Pandey, Member Dr. A. P. Mishra, Member Dr. Dinesh Marothia, Member Dr. R. K. Batta, Member-Secretary
5.	RCM, Darbhanga	March 17-18, 2007	RCM Programme of the ICAR-RCER	Dr. R. M. Pandey, Member Dr. A. P. Mishra, Member Dr. S.H.Ahmad, Member Dr. Dinesh Marothia, Member Dr.M.S.Gill, Member Dr. R. K. Batta, Member-Secretary
6.	ICAR-RCER, Patna	June 18-20, 2007	Final Meeting	Dr.S.M.Virmani, Chairman, Dr. R. M. Pandey, Member Dr. A. P. Mishra, Member Dr. S.H.Ahmad, Member Dr. Dinesh Marothia, Member Dr.M.S.Gill, Member Dr. R. K. Batta, Member-Secretary

1.2 OBJECTIVES, MANDATE, ORGANIZATION, RESOURCES AND FUNCTIONS e.g. RESEARCH, TEACHING AND EXTENSION.

1.2.1 OBJECTIVES AND MANDATE

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

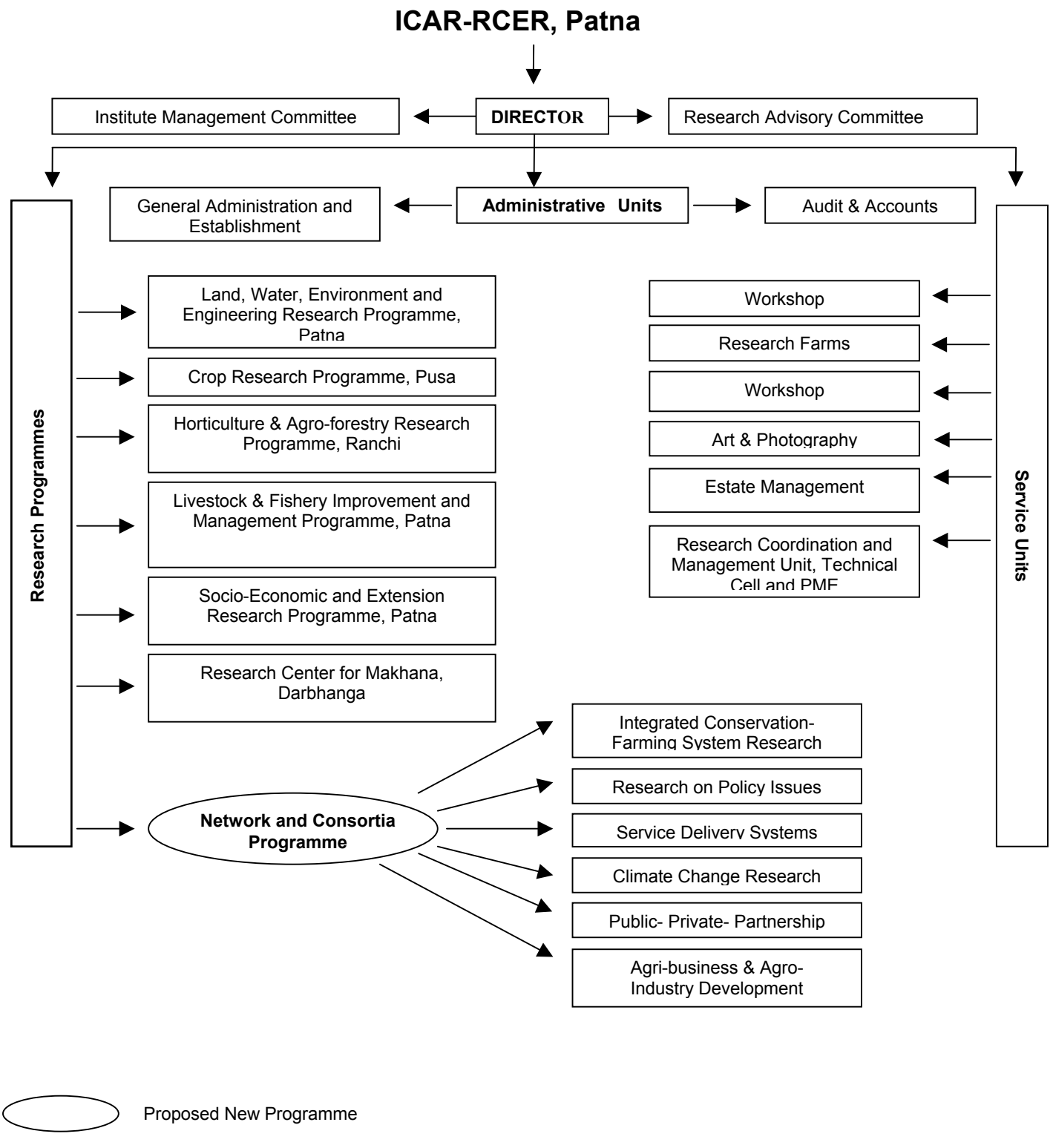
The modalities to achieve the mandate are*:*

- 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 center 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 liaisons with state and central government departments in achieving the above objectives for enhanced 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.

MISSION

- *Transform* "**Low Productivity-High Potential**" eastern region into high productivity region for food, nutritional and livelihoods security in a manner that is environmentally sustainable and socially acceptable.
- *Tap* unutilized potential of vast seasonally waterlogged and perennial water bodies for multiple uses of water and aquatic crops for social upliftment.
- *Suggest* poverty alleviation, livelihood improvement and women empowerment through income and employment generation through on-farm and off-farm job opportunities.
- *Promote* network and consortia research in the eastern Region.

1.2.2 Modified And Proposed Organizational Structure Of ICAR-RCER



1.2.3 RESOURCES AND FUNCTIONS

The research programmes of the Complex have been undertaken under following seven research programmatic themes:

Resource appraisal and inventorization:

- Inventorize natural (including environmental) resources by use of modern state-of-the-art tools for planning research and development projects and for monitoring the impacts of improved technologies.
- Analyze constraints and prioritization for sharply focusing research and development projects.
- Observe and quantify Climate Changes.

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

- Collect, conserve and evaluate genetic resources.
- Develop improved cultivars.

Improved production technologies for field, horticultural and aquatic crops

- Standardize production and multiplication technologies.
- Integrated nutrient management.
- Integrated pest management.
- Develop improved post harvest technologies and value addition of agriculture produce.

Integrated land and water management

- Conservation agriculture including RCTs.
- Integrated management and use of rain, canal and ground-water resources 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 and use.
- Modern irrigation methods including small holder irrigation.

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 round the year fodder production and enrichment of crop residues and agricultural byproducts
- Crop-livestock integration through dairy based enterprises.

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 and site-specific sustainable and conservation-effective farming system models

Socio-economics, technology transfer and HRD

- Participatory technology development
- Technology transfer assessment and refinement of technological packages/options
- Livelihood analysis and impact assessment of agricultural technologies
- Socio-economic institutions and policy guidelines for governance of resource management for sustainable use
- Information and service delivery systems
- Training methodologies, need assessment and capacity building.

CHAPTER - 2

MANAGEMENT

2.1 Constituent programmes of the ICAR-RCER

The ICAR Research Complex for Eastern Region functions through its following six research programmes viz.

(i) Land, Water, Environment and Engineering Research Programme (LWEERP), Patna

(ii) Crop Research Programme (CRP), Pusa

(iii) Horticulture and Agro-forestry Research Programme (HARP), Ranchi

(iv) Livestock and Fishery Improvement and Management Programme (LFIMP), Patna

(v) Socio-Economic and Extension Research Programme (SEERP), Patna

(vi) Research Centre for *Makhana*, Darbhanga (since Dec. 12, 2003).

2.2 Staff Strength at ICAR-RCER

The staff strength of the ICAR-RCER during the X Plan is as follows:-

Table 2 Staff Position of ICAR-RCER including Centre for *Makhana*, Darbhanga as on March 2007

Sl. No.	Category	ICAR-RCER, Patna			RC *Makhana*, Darbhanga			Total		
		Sanctioned	In position	Vacant	Sanctioned	In position	Vacant	Sanctioned	In position	Vacant
1.	Scientific	79	44	35	14	2	12	93	46	47
2.	Technical	61	60	01	14	-	14	75	60	15
3.	Administrative	41	37	04	07	-	07	48	37	11
4.	Supporting	63	45	18	10	-	10	73	45	28
	Total	**244**	**186**	**58**	**45**	**2**	**43**	**289**	**188**	**101**

The manpower inadequacy at the ICAR-RCER as per norms of ICAR is presented in Table 3.

Table 3 Manpower inadequacy at ICAR-RCER

Grade	Sanctioned	In position	As per norms of ICAR	Difference
Scientific	93	46	93	----
Technical	75	60	140	65
Administrative	48	37	70	22
Supporting	73	45	93	20

The QRT observed that due to large number of positions being vacant at the complex, manpower inadequacy at all levels is major bottleneck for effective and efficient implementation of research programmes. As per ICAR norms of 1:1.5:0.75:1 of Scientific, Technical, Administrative and Supporting Staff, with the present level of 93 sanctioned post of Scientists, there is shortfall of 65, 22 and 20 posts respectively in Technical, Administrative and Supporting

grade. The requirement of Administrative and Supporting grade staff is being met by Contractual Services to a certain extent. However, the inadequacy of Technical Personnel cannot be managed by contractual services, the requirement of job being subject-specific. Further in set up like that of HARP, Ranchi where size of farm is large (585.88 acres) and located in five different places, there is a necessity of working with need based Technical positions for meaningful utilization of the research resources. In this event it is proposed that the additional positions are provided and till than need based hiring of services of Technical persons through RA/SRF/JRF may be allowed on term basis to address this critical gaps and to meet research needs. Policy support in this respect will be required.

2.3 Existing budget and proposed changes

The Head-wise expenditure at ICAR-RCER during IX and X Plan during the period under report of the QRT is as follows:-

Heads	**2001-2002** (Rs. in lacs)		**2002-2003** (Rs. in lacs)		**2003-2004** (Rs. in lacs)		**2004-2005** (Rs. in lacs)		**2005-06** (Rs. in lacs)	
	Plan	**Non Plan**	**Plan**	**Non Plan**	**Plan**	**Non Plan**	**Plan**	**Non Plan**	**Plan**	**Non Plan**
Estt. Charges	44.07	238.43	0.00	310.66	0.00	330.80	0.00	380.44	2.18	413.91
TA	10.32	2.70	9.45	2.85	7.86	2.77	7.86	3.50	5.00	3.50
HRD	0.00	0.00	0.00	0.00	0.00	0.00	2.12	0.00	1.95	0.00
Contingencies	32.51	30.63	78.21	26.20	104.08	22.70	105.06	39.49	128.95	46.14
Sub Total	***86.90***	***271.76***	***87.66***	***339.71***	***111.94***	***356.27***	***115.04***	***423.43***	***138.08***	***463.55***
Equipments	96.16	6.98	57.40	0.59	43.17	14.12	41.87	5.29	36.97	1.87
Works	211.17	7.68	28.83	8.62	110.38	12.29	311.81	21.43	184.76	29.49
Furniture	34.21		6.23	1.34	1.95	1.52	10.46	0.88	0.00	0.00
Vehicles	0.00	0.00	0.00	3.83	4.56	0.00	0.00	0.00	0.00	0.00
Livestock	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.22	0.00
Library	5.55	0.09	19.47	0.01	15.48	0.00	20.01	0.17	14.97	0.02
Sub Total	***347.09***	***14.75***	***111.93***	***14.39***	***175.54***	***27.93***	***384.15***	***27.77***	***236.92***	***31.38***
G.Total	**433.99**	**286.51**	**199.59**	**354.10**	**287.48**	**384.20**	**499.19**	**451.20**	**375.00**	**494.93**
BE	***463.60***	***331***	***345.00***	***411.00***	***376.00***	***468.25***	***500.00***	***483.00***	***375.00***	***506.00***
% Expenditure	***93.0***	***86.0***	***57.8***	***86.1***	***76.4***	***82.0***	***100.0***	***93.4***	***100.0***	***97.6***

The QRT observed that during 2001-2002, the Complex has been able to spend 93% of its Plan budget and 86% of the Non-Plan budget, in the very first year of its establishment. During 2002-2003, the Complex spent 57.8% and 86.1% of its Plan and Non-Plan budgets respectively. In 2003-2004, the Complex spent 76 and 82% of its Plan and Non-Plan budgets, respectively. During 2004-2005 and 2005-2006, the Complex spent 100% of its Plan budget and

93-97% of its Non-Plan budget. The QRT expressed satisfaction over the relative expenditure of the allotted budget for both Plan and Non-Plan schemes and hopes that the Complex would be able to spend the enhanced allotted budget during the subsequent five year plan.

Since the Complex is new and its budget requirements are higher, the QRT **recommends** that the budget allocation for the Complex for the XI Plan period may be enhanced by atleast 40% over the budget allocated during the Xth Plan, so that its infrastructural and laboratories facilities are adequately developed and furnished, and provided an efficient work space for productive use.

CHAPTER - 3

POLICIES, PRIORITIES, STRATEGIES AND PROGRAMS

Policy issues research is an integral part of the research programme of the ICAR-RCER mission. In order to disseminate agricultural technologies to farmers, socio-economic constraints for the adoption of biophysical solution need to be identified and principles, and policy guidelines have to be blended for the integration of production technologies with socio-economic environment. Major emphasis has to be given for socio-economic characterization of the region for the identification of overcoming production constraints.

Based on fresh SWOT analysis, commitments in recent EFC, recommendations of RACs, QRTs, SRCs, Regional Committee meetings, system priorities and sub-priorities of CGIAR, National Agriculture Policy, Government Policies, the Vision: 2025 Perspective plan document prepared by ICAR-RCER a listing of the issues and strategies is given as follows:-

3.1 ISSUES AND STRATEGIES

ISSUES

- Addressing the problems faced by resource poor farmers with lowest per capita income, lowest per capita land availability and small and fragmented farm holdings,
- Low seed replacement rate and low fertilizer use,
- Poor infrastructure, roads, communication, power supply, storage, processing and marketing facilities for agricultural produce,
- Frequent occurrence of floods, droughts, cyclones and other natural calamities in plains of eastern region especially Bihar, Orissa, Assam and West Bengal,
- Seasonal flooding and water congestion during *kharif* season and secondary water-logging in canal irrigated plains,
- Soil erosion and land degradation in hilly and plateau regions,
- Acute shortage of water during post-monsoon season in plateau areas,
- Unavailability of timely and adequate irrigation water and improper use of agricultural inputs in irrigated plains,
- Predominance of monocropping system,
- Unexploited potential of commercialization of fruits and vegetables and absence of post harvest technologies,
- Low factor productivity and unavailability of suitable cultivars with tolerance to abiotic stresses,
- Unavailability of quality planting and seed material,
- Poor livestock and fish health and low productivity,
- Untapped potential of flooded, flood prone and water-logged areas in flood prone

ecosystems for fisheries and aquatic crops in parts of the eastern region,

- Lack of knowledge base on impact, vulnerability and adaptation of climate change on agricultural production system,
- Inadequate extension and other service delivery mechanisms (ICTs),
- Low level of adoption of technologies,
- Poor pooling of expertise and resources,
- Absence of effective value chain management,
- Inadequate alliances, partnerships and linkages for research and development, technology dissemination and commercialization, and
- Lack of policy research for inclusion into regional and national policy formulation and public-private partnership.

STRATEGIES

- Assessment of biophysical and socio economic resources of eastern region,
- Developing quality cultivars of field, horticultural and aquatic crops,
- Development of integrated location-specific, multicommodity farming systems comprising of crops, horticultural, aquatic crops, livestock, fisheries and other income generating enterprises in participatory mode,
- Water productivity assessment, benchmarking and mapping,
- Enhancing the productivity of water in irrigated and rainfed/dryland areas through integrated land, water, nutrient, biomass, livestock and aquatic system management,
- Development of location-specific integrated pest and disease management technologies,
- Exploring options for participatory water management integrating 'blue' and 'green' waters involving wider constituency of stakeholders,
- Exploring multiple uses of irrigation water by incorporating fish, horticulture and *makhana* in irrigated and rainfed ecosystems,
- Raising productivity of rainfed agriculture through 'green water' management and watershed management research in uplands of eastern plateau and hills,
- Development and popularizing resource conservation technologies for enhancing total factor productivity and input use efficiency,
- Strategies for management of flooded and flood-prone areas including wetlands, *diara. tal, chaur* and *mauns* for productive utilization,
- Contingent cropping systems for partially/completely damaged crops in flood and drought affected areas,
- Global climate change impact on agriculture and anticipatory research for preparedness and adaptation,

- Exploring potential of aquaculture and livestock through technological interventions,
- Surveillance and monitoring of animal and fish health,
- Improvement of nutritional status of animals and fish,
- Support for development and growth of livestock and poultry based enterprises through cooperatives or SHG for income and employment generation,
- Post harvest technology development and value chain management,
- Prioritization of high potential interventions (technologies or combinations of technologies and institutions/policies) to improve water and land productivity,
- Participatory technology development and dissemination,
- Capacity building of stakeholders including farmers and extension workers,
- Evolving appropriate communication strategies (ICTs) for effective information and service delivery,
- Conducting socio-economic and policy research to help support effective planning, monitoring and governance and public-private partnership in research, extension, production and marketing, and
- Risk & uncertainty analysis and management including decision support system. Develop linkages, partnership and networking research.

3.2 Prioritization of researchable issues

A log frame based research prioritization exercise was undertaken by the scientists of ICAR-RCER to identify priority researchable issues for networking research and development in the eastern region. The researchable issues have been prioritized in view of the identified constraints and the available limited and scarce natural and financial resources. The prioritization exercise has been accomplished by ranking of production constraints and through measurable indicators in respect of five agro-climatic zones, namely, Eastern Himalayas, Lower Gangetic plain, Middle Gangetic plain, Eastern plateau and hills and East coast plain and hills and is presented in Table No.4**.**

The prioritized issues have led to the formulation of the programmes, which are described in the Vision : 2025 document. In order to transform the 'low-productivity-high potential' eastern region into 'High Productivity' region, the Complex need to adopt agro-ecosystem based Integrated Farming System approach in various identified eco-systems in the region viz. irrigated plain ecosystem, rainfed ecosystem, plateau ecosystem, flooded and flood prone ecosystem, and coastal ecosystem. A new business model of partnership involving ICAR Institutes, SAUs, CG Centres, NGOs, Private Institutes, and State Agencies in a network/consortia approach is essential.

Table 4. The agro-climatic zone wise prioritized researchable issues for the eastern region

Thematic Issues/ areas	Zonal priorities				
	Eastern Himalayan Region	**Lower Gangetic Plain**	**Middle Gangetic Plain**	**Eastern Plateau & Hills**	**East coast plains and Hill Region**
Development of quality cultivars of agricultural, horticultural and aquatic crops	High	High	High	High	High
Integrated location specific, multi-commodity farming system involving field crops, horticulture, fisheries, crops and other enterprises	High	High	High	High	High
Production techniques for field, horticultural, agro-forestry and aquatic crops like *makhana*	Medium	High	Medium	High	Medium
Integrated water management	Medium	Medium	High	Medium	Medium
Multiple uses of water	Medium	High	High	Medium	High
Rain water harvesting and watershed management	High	Low	Low	High	Medium
Development, testing and popularization of resource conservation technologies	Medium	High	Medium	Medium	Medium
Management of flooded & flood prone and water congested areas	High	Medium	High	Low	Medium
Risk analysis and management	Medium	Medium	Medium	Medium	High
Animal husbandry and fisheries practices and potentials	Medium	Medium	High	High	Medium
Feeds and feeding of livestock and fisheries	Low	High	High	Medium	Low
Livestock and fish production	Medium	High	High	Medium	Medium
Animal and fish health management	Medium	High	High	Medium	Medium
Post-harvest technology and value addition of agricultural, horticultural and aquatic produce	High	High	High	High	High
Plant & seed material production	High	High	High	High	High
Technology assessment, refinement and dissemination.	High	High	High	High	High
Socio-economic and policy research	High	Medium	High	High	High

3.3 Network and Consortia Approach

The Complex will have a full fledged Programme on Networking & Consortium with objective of providing research & developmental support to (i) Integral System Research, (ii) Policy Issues, (iii) Service Delivery System (iv) Public-Private Partnership & (v) Agri-Business & Agro based Development Industry. The programme will emphasise on planning, coordinating & implementing research & development programmes which will cater to the need of all stakeholders in Agriculture including Agro Industry & Entrepreneur of Agri-Business. Eastern Region of our country is rich in Horticultural, Cereal & Livestock commodities which can be explored in booming Agri-Business & establishment of Agro based Industry with development & marketing of quality, premium, innovative & nutritive food products for the world market. The modalities of establishment of a consortium of ICAR-RCER with other ICAR Institutes, SAUs, Private Organization, NGOs, Public Sectors will:

- **Provide** guidance/direction for identifying researchable issues & setting of priorities.
- **Enable** formulation & Implementation of networking/ mission mode research project for addressing critical issues of common interest.
- **Encourage** resources mobilization & financial management.
- **Coordinate**, administration & harmonize & promote team sprit & capacity building.
- **Encourage** & support partners to assume leadership role in areas of comparatives advantage & high stakes.

This programme will undertake research, development & consultancy assignments in all emerging areas of Agriculture & Food science covering cereals, oilseeds, pulses, fruits & vegetables, aromatic & medicinal plans, aquaculture products, livestock, water productivity, seeds production, agri-mechanization etc. The Unit will have multi-disciplinary personnel. Separate fund for this programme are required in plan budget to utilize strength of SAUs & other and harmonized synergies to promote research on need based sustainable farming system and capacity building in this area. The anticipated Annual Requirement of the Center for undertaking this programme will be Rs. 100 lacs i.e 500 lacs in 5 year of XIth Five Year Plan**.**

CHAPTER – 4

ACHIEVEMENTS

4.1 HIGHLIGHTS OF ACHIEVEMENTS DEPARTMENTWISE AND INSTITUTE/PROGRAMWISE

The ICAR Research Complex for Eastern Region is a newly established institute. Ever since its establishment, despite constraints on facilities and manpower, it has made significant achievements in the areas of natural resource management, crop improvement, horticultural and agro-forestry and socio-economic and extension research. A modest beginning has been made in research on livestock and fisheries improvement and *makhana*. Some of the salient research achievements of its constituent programmes for the period 2001-2005 are presented in this section.

4.1.1 LAND, WATER, ENVIRONMENT AND ENGINEERING RESEARCH PROGRAMME (LWEERP), PATNA

Resource Appraisal and Inventorization

- A water resources' database of Bihar and Jharkhand containing surface water; ground water; crop area and crop production; meteorological information containing rainfall, temperature, humidity, sunshine, wind speed; soil information containing soil type, texture, chemical and physical properties; social information containing population, literacy rate, land holdings etc, was created using MS-Access. The database tables are created to store different data basin-wise, district-wise and block- wise.

- Under the Integrated National Agricultural Research Information System (INARIS), E-R diagrams for six databases namely ground water database, surface water database, water pricing database, water quality database, project database and technology database are prepared.

- Resource appraisal at regional level was carried out using secondary data of socio-economic and biophysical resources in a Geographical Information System (GIS) environment. Thematic maps of socio-economic and biophysical resources in respect of eastern region have been developed. A status report on natural resources of eastern region has been prepared.

Integrated Land and Water Management

- The observations on development of operational plans/ strategies for efficient water allocation and distribution from Patna canal in Bihar, showed that there was a large gap between water release and irrigation requirement. In order to minimize the gap between water supply and irrigation requirement, OPTALL model based on quadratic programming technique was employed.

- A simple water balance spreadsheet model was developed which was further linked with GIS. Such a tool helps in analyzing the availability and demand and suggesting various water management options.

- To simulate soil-water flow in SWAP model, Richards' equation was solved using an implicit backward finite difference scheme with explicit linearization. It was observed that with increase in bund height runoff decreases. By shifting rice crop growth period by one month, rainfall utilization decreases to the tune of 36 per cent. By reducing the irrigation depth from 7.5 cm to 5 cm in rice, deep percolation reduces, transpiration increases and total irrigation requirement reduces.

- In an attempt to predict the unsaturated hydraulic conductivity from particle size distribution data it was revealed that the Particle Size Distribution (PSD) model of Arya et al. (1999b) quite reasonably predicted the unsaturated hydraulic conductivity of clay, clay loam and loamy textured soils within the studied range of water contents.

- A Low Energy Water Application (LEWA) device operating at 0.4 kg/cm^2 pressure and fittable on existing sprinklers has been developed for irrigating rice, wheat and other close growing crops. The system has resulted in reducing overall energy requirements and high water and nutrient-use efficiency as compared to other pressurized irrigation systems. In order to cut down on cost and energy requirement by using low pressure rating pipes and other system sub components, a low cost LEWA (Low Energy Water Application) irrigation system has been developed and compared with the sprinkler. The system is estimated to cost 2.5 times less than the cost of sprinklers (impact) system for the small area.

- Application of micro irrigation to vegetables revealed that drip irrigation scheduled at 80% ET once in three days gave maximum marketable yield (85.7 t/ha) of tomato. For cabbage, drip irrigation scheduling at 60% ET once in two days gave maximum yield of 61.7 t/ha.

- Under fertigation studies, a combination of conventional and liquid fertilizer were identified for cauliflower and tomato. The results indicate that the results indicate fertigation through CF+LF gave maximum yield. Fertilizer-use efficiency was maximum under 50% of recommended dose.

- Studies conducted to demonstrate the beneficial effects of Deep Summer Ploughing (DSP) revealed that DSP had significant effect on grain yield and yield attributes over non-DSP. DSP effectively reduced the weed population. Effect of normal supply of water was pronounced in DSP over non-DSP. Similar trend was recorded on nematode population.

- Studies on tillage management under rice-wheat system in South Bihar indicate that Deep Summer Ploughed (DSP) field retained more moisture and offered less penetration resistance providing conducive environment for root development in wheat. Zero tillage also showed better root growth under DSP plots. DSP on alternate years resulted in

significantly higher grain yield of wheat (4.14 t/ha) over non-DSP (3.93 t/ha) fields. Similarly in rice, though the initial root proliferation was observed in DSP every year, highest root growth was observed in DSP in alternate years along with a maximum grain yield of 4.69 t/ha.

- Evaluation of geo-textile material for mulching in *pointed gourd* crop indicated improved root growth with increase in thickness of the geotextile mulch. The highest growth was observed in 300-gsm mulch treated plots followed by 250 gsm plots. Root growth in straw mulched plots was found to be at par with 250 gsm geo-textile mulched plots.

- Studies on soil moisture dynamics and nutrient uptake in rice based cropping system under optimum and sub optimum supply of water and nutrient indicate that cereal dominated rice-based cropping sequence was more remunerative than pulse dominated with respect to production potential of crops.

- Among diversified cropping systems developed at Sabajpura Farm, Patna, maximum yield equivalence was recorded in rice-tomato-bottle guard (50.30 t/ha) followed by rice-potato-onion (26.72 t/ha), rice-mustard-tomato (26.58 t/ha) and rice-coriander-ladies finger (26.42 t/ha), respectively.

- Studies to evaluate the impact of late sown wheat indicated that grain yield was significantly higher for early December sowing (5.31 t/ha) followed by mid December sowing. Among the dates of first irrigation, grain under 20 and 26 Days After Sowing (DAS) was significantly superior over 38 DAS.

- *Boro* rice seed sown in November in open field with use of FYM @ 15t/ha avoided injury due to severe cold and saved 15 per cent additional seedlings for transplanting. By use of polyhouse, raising of boro rice seedling was possible even in January when seed did not germinate in open field due to cold.

- In order to promote multiple uses of water to improve the productivity of canal/ground water by routing it through a fish pond-cum-secondary reservoir and weekly exchange of water, the studies indicate that fish harvest upto 10 t/ha as additional income can be obtained. Out of the three interventions on multiple uses of seasonally waterlogged lands in the canal commands, canal seepage fed secondary reservoir supplemented by tube well yielded Rs.1,32,000/ha income from horticulture on bunds (banana, guava, lemon and vegetables), fishery, and duckery besides irrigation for cereal production.

- Research conducted to evaluate different drought tolerant and water use efficient traits in wheat indicated that Drought Stress Index (DSI), Dry Matter Stress Index (DMSI) and Yield Stability Ratio (YSR) calculated from the post-harvest data could be used to identify drought tolerant and susceptible wheat genotypes. Whereas genotypes RW 899, RW 890 are identified as most susceptible to drought, C-303, K-8047 and RW 927 are identified as drought tolerant.

Improved Production Technologies for Field, Horticultural and Aquatic Crops

- A comparative study of different tillage technologies revealed that adoption of zero tillage could save a total of Rs. 1850/ha under land preparation (Rs.1400 in sowing and Rs.450 in irrigation). Under raised bed system, an additional amount of Rs. 600/ha was incurred for land preparation and sowing but there was a saving of Rs. 2622/ha from irrigation water application.

Socio-Economics, Transfer of Technology & HRD

- The Complex has developed and demonstrated a participatory approach for water and land management with wider stakeholders participation. Under DFID project, participatory process was developed and demonstrated for efficient management of land and water resources by involving constant dialogues, communication products and wider constituency of stakeholders.

- For optimization of rice transplanting date for efficient rain water utilization, raising nursery in the last week of May to first week of June using tube -well water by advancing the date of transplanting by 15-20 days and transplanting in the last week of June to middle of July resulted in maximum (94%) utilization of rain water. This practice saves about 2-3 irrigations usually required by the late transplanted rice during its last growth phase. Rice transplanted during the week 25th June to 1st July in kharif, results in average paddy yield of 6.6 t/ha against 3.2 t/ha under traditional transplanting in August.

- Raising bund height of paddy fields from 5-7 cm to 20-30 cm in 50 plots of 9 ha, prolonged soil moisture duration causing reduction of 1-2 irrigations from canal water and less disease incidence and weed.

- Farmers of RPC – V adopted low cost interventions like maximum utilization of rainwater by raising bund height, canal management by installing low cost wooden gates, adoption of improved irrigation practices in rice and wheat, conjunctive use of water, multiple use of water logged areas by including rice-fish and fish production.

- Under resource conservation research technologies, the Zero Tillage technology has been popularized in 22 districts of Bihar, covering more than 6000 ha area. This reduced the cost of cultivation by about Rs. 2000/ha. Majority of farmers (80 per cent) reported that there was increase in wheat yield under ZT in comparison to conventional sown wheat. Twenty two per cent farmers reported 2 to 4 q/ha increase in yield through ZT.

4.1.2 CROP RESEARCH PROGRAMME, PUSA

Prior to 2001, the center was part of Central Tobacco Research Institute, Rajamundry till it was merged with ICAR Research Complex for Eastern Region, Patna and was named Crop Research Programme, Pusa. Its erstwhile mandate of tobacco was revised to include oilseed and pulses and tobacco based intercropping systems. The significant achievements of the center during the period 2001-2005 are given below:-

Crop Production

- The wheat – *elephant yam* + *black gram* gave net return of Rs. 85,805/- per ha followed by tobacco – summer maize – dhencha (GM) (Rs.71737/- ha) under irrigated upland conditions.

- The winter maize intercropped with aromatic and medicinal plants gave maximum benefit cost ratio (5.49), closely followed by maize + *musukdana* (5.17) and under maize + *ashwagandha* (3.83).

- Data on long term manurial cum irrigational trial on chewing tobacco in fallow-tobacco system revealed that high rainfall during transplanting and at maturity adversely affected the total cured leaf yield and its quality.

- The average of 38 years of total cured leaf yield of tobacco varied from 809-3182 kg/ha with the CV values of 32 percent.

- The continuous cultivation of tobacco since 1963 resulted decline in organic carbon status from 0.55 to 0.46% till 1990.

- The first grade cured leaf tobacco gave same yield level when intercropped with garlic and rajmash, whereas tobacco+garlic gave net returns of Rs.42948/ha.

- In intercropping with garlic and rajma; application of 75% recommended dose produced total and first grade leaf yields at par with 100% recommended dose.

- The interaction between inters crops and years was significant for total and first grade cured leaf yields.

- In another study, application of sulphur (40 kg/ha) through iron pyrite and gypsum (source of sulphur) produced highest total cured leaf yield per hectare (/ha).

- Sulphur application through iron pyrite improved puckering score significantly over control and achieved net return of Rs.2675/ha.

- Fertilizer application of 50% N as castor cake and 50 per cent Nitrogen urea as well as 75% N as ammonium sulphate and 25% N as castor cake, significantly improved puckering scores in tobacco.

Crop Improvement

- Out of eleven F4 generations grown with 100 plants each, 06 best individual plants were selected for further testing and evaluation under line X tester analysis of chewing tobacco.

- The advanced breeding lines of *rustica* tobacco (06) collected from Anand produced significantly highest yield (2821 kg/ha) by line R-12 (c) followed by line AR-87 (2431 kg/ha).

- 71 local collections of fababean were evaluated and noticed variability ranged 38.7 to 103.3 cm in plant height, 5 to 18 in productive branches/plant, 5.0 to 55.0 for nos. of pods/plant, 3.2 to 5.8 cm for pod length, 1.6 to 3.7 for nos. of grains/ pod and 2 to 11.7 q/ha in grain yield.

- Only 76 germplasm of *N. tabacum* were maintained during 2005-06 for breeding purpose.

4.1.3 HORTICULTURE AND AGRO-FORESTRY RESEARCH PROGRAMME (HAFRP), RANCHI

Genetic resource management of horticultural crops

- A total of 2958 germplasm lines including fruits (771), vegetables (1836) and ornamental plants (351) have been collected and are being characterized, evaluated and used in breeding programme to develop high yielding varieties resistant to biotic and abiotic stresses.

- Ten different varieties and 6 F_1 hybrids orticultural crops including viz., *Swarna Manohar* and *Swarna Poorti* in Jackfruit; *Swarna Shobha, Swarna Ajay* (F_1 hybrid) and *Swarna Shakti* (F_1 hybrid) in brinjal; *Swarna Baibhav* (F_1 hybrid), *Swarna Sampada* (F_1 hybrid) and *Swarna Samridhi* (F_1 hybrid) in tomato; *Swarna Sheetal* in cucumber, *Swarna Amar* and *Swarna Mukti* in garden peas; *Swarna Sweta*, *Swarna Suphala* and *Swarna Harita* in cowpea, *Swarna Utkrist* in Dolichos bean have been developed. These varieties are gaining popularity for their special attributes including high yield, better quality, disease and pest resistance etc.

- Stable, high yielding and promising varieties for different maturity periods, flavor, quality and usages for different purposes have been identified for mango, litchi, guava, aonla, sapota, strawberry and bael. The station has also evolved 18 elite lines of vegetable crops which are at an advanced stages of evaluation under the All India Coordinated Vegetable Improvement Project.

- For round the year cultivation in the Eastern plateau and hill agro-ecologies, brinjal cultivars *Swarna Shyamli* and *Swarna Pratibha* and tomato hybrids *Swarna Sampada* and HATH-5 have been found suitable. In pea, the powdery mildew resistant line CHPMR-2 was found promising for prolonging the availability period in the market till May by growing at higher altitude in Jharkhand (Netarhat hill).

Development of production technology of horticultural crops

- Among fruit crops, in mango cultivar *Amrapali*, planting at a spacing of 2.5x2.5m accommodating 1600 plants per ha as compared to 100 plants per ha in case of traditional method of planting resulted in nearly 2.5 times higher fruit yield than the traditional method of planting up to 12 years age.

- Fruit crop based cropping system model consisting of aonla, litchi and mango as main crop; guava/*Kagzi lime*/Assam Lemon as filler crop and cowpea or French bean as intercrop has been found to provide sustainable higher returns per unit area from the uplands and medium uplands. Intercropping of French bean, cow pea and groundnut have been found to be the most profitable combinations under mango, litchi and aonla based multitier cropping systems with guava as filler crop under Chotanagpur plateau conditions up to initial 10 years of orchard establishment. Under grown up mango orchards, intercropping of shade tolerant crops like turmeric was found to be most profitable.

- Application of 100 g N, 600 g P_2O_5 and 800 g K_2O in guava variety Allahabad Safeda resulted in highest fruit yield per plant whereas soil application of Phosphobacterin was found to be most effective in improving the fruit quality of guava cv. Lucknow-49.

- Exposing litchi roots in a trench of 150 cm diameter around the trunk to a depth of 30 cm after harvesting for 7 days and filling up the trench with recommended dose of manures and fertilizers after the onset of monsoon resulted in increase in yield of litchi cv. Shahi.

- Full-moon terracing and mulching with paddy straw was found to improve fruit size, reduce fruit cracking and increase yield of litchi cv. *Shahi*.

- In guava cultivars Allahabad Safeda and Lucknow-49, manual removal of 50 per cent of rainy season crop was found most effective for increasing the yield of winter crop and total profitability both under rainfed as well as irrigated conditions of eastern plateau and hill conditions.

- Rejuvenation pruning during December and application of fertilizer at a rate of 800:300:1000 g NPK + 50 kg FYM per plant was found effective for improving the productivity of old, senile and unproductive mango orchards in three years.

- In vegetable crops, intercropping of cowpea with okra gave 31 to 53 per cent increased okra equivalent yield. Similarly, planting of 4 rows of onion 15 cm apart between 2 rows of tomato (30 x 100 cm) gave 36 per cent higher tomato-equivalent yield and higher return without affecting the quality of tomato. In cabbage, intercropping with coriander or fenugreek enhanced the yield (16 per cent) and also restored the soil fertility. The maximum net returns were recorded from cabbage-fenugreek followed by cabbage-coriander intercropping.

- In cabbage cv. Pride of India, application of N P K : 180:60:50 with a plant spacing 45 x 30 cm recorded 28 per cent higher yield. Under soil amelioration studies for vegetable crops, application of lime at the rate of 3.4 t/ha and molybdenum 1.5 kg/ha or ammonium

molybdate as foliar spray 0.2% of four times at 12 days interval increased curd weight and curd diameter of cauliflower cv. Pusa Snowball-1. Application of lime increased the yield by 12 per cent, and improved the soil pH, available molybdenum in soil and also increased molybdenum, calcium and magnesium in leaf tissue. Soil application of 1.5 kg B/ha during rainy season was found sufficient for 3 successive crops of cauliflower in overcoming brown rot and to boost yield. However, when Boron was applied to the winter crop, its residual effect was extended to next rainy season only.

- Regeneration of pointed gourd explants in media containing BA 1.0 ppm + IAA 0.2 ppm and sub-culturing them in media containing IAA 0.2 ppm +IBA 1.5 ppm were found optimum for *in vitro* multiplication of pointed gourd.

Integrated pest management of horticultural crops

- In fruit crops, guava wilt was verified to be caused by *Fusarium oxysporum* f. sp. p*sidii* and association of spiral nematode *Heliotylencus* dihystera aggravated the disease. Use of biopesticides gave encouraging results. Application of *A.niger* (Kalisena) was found to reduce the incidence of guava wilt and improve the plant vigour
- In vegetable crops, powdery mildew in pea caused by *Erysiphe pisi* could be managed by preponement of sowing date in September and October. The disease could be controlled by spraying calexin (0.05%). Powdery mildew of cucumber caused by *Erysiphe chichoracearum* could be controlled by spraying karathane 0.1% and powdery mildew of bottle gourd caused by *Sphaerotheca fuligena* could be controlled by spraying Topsin M-70 (0.1%). Bacterial wilt of tomato caused by *Ralstonia solanacearum* could be managed by soil application of Karanj (*Pongamia*) cake @ 0.10 and 0.15 kg/m2 or bleaching powder @ 30 kg/ha or lime @ 2500 kg/ha applied 15 days before transplanting. Seed treatment of tomato with *Azotobactor chroococcum* + soil application was most effective against incidence of damping off. Treatment of tomato seeds with *Trichoderma viride* + Captan showed minimum root and shoot length indicating the incompatibility with them.

Basic studies in agricultural and horticultural crop production

- In *litchi* cv. *Shahi*, the time of emergence and girth of second flush, content of carbohydrate and tryptophane in the second flush during October was found as promising criteria for prediction of intensity of panicle emergence under Chotanagpur plateau conditions.
- Role of plant phenolics and oxidative enzymes in mechanism of host-resistance against powdery mildew in different pea genotypes has been understood.

Technology Transfer, Assessment and Refinement

- Large scale FLDs on released varieties of tomato, brinjal, cucumber, pointed gourd, ridge gourd, peas and beans etc. have been conducted to demonstrate the advantages of new varieties. Similarly FLDs on 3-tier system production involving mango/litchi/aonla as main crop, guava/custard apple/lemon etc. as filler crop and vegetable/cereals/ pulses/oilseeds/tuber crops as intercrop have been demonstrated at 60 farmers' fields.

- Minikit trials of pre released vareiteis in different vegetable crops have been conducted at farmers' fields to help growers know the performance of pre released varieties.
- Kisan *Diwas*/Field days were organized from time to time to educate the farmers. Every year field days on litchi, aonla, vegetables etc. are organized.
- Training programmes on different horticultural crops for increasing production and productivity have been organized. Altogether 60 training programme of 1 to10-days and

  two programme of 72-days duration have been conducted in which more than 3500 farmers/officers have been trained.
- Seeds and planting materials were supplied to Zonal Research Stations of BAU at Dumka, Chianki and Darisahi; KVKs at Hazaribagh, Ranchi, Sahebganj, Chianki in Jharkhand and Jamuai and Madhubani in Bihar. Seeds have been supplied to Deptt. of Agriculture, Govt. of Jharkhand and to various NGOs and farmers for distribution/cultivation in almost all the districts of Jharkhand.
- The improved varieties of different vegetable crops developed at HARP have been demonstrated in fields' of 1000 farmers. Under economic assessment of horticultural technologies at farmers fields, the varieties developed at HARP, Ranchi demonstrated under the Front Line Demonstration proved their consistency by promising returns worked out as with the benefit: cost ratio ranging between 2.11 to 4.79 irrespective of different categories of farmers.
- The technology of raising early vegetable seedlings for winter and summer vegetables was adopted by large number of farmers and farm women. This increased their income by 2-3 times.

4.1.4 SOCIO-ECONOMIC & EXTENSION RESEARCH PROGRAMME (SEERP), PATNA

Major thrust areas of the programme are Socio-economic and policy Research, Technology Assessment and refinement, Transfer of technology, Human resource development and Impact assessment of technology. The achievements of the programme during the period 2001-2005 are given below:-

Technology Assessment and Refinement through Institute Village Linkage Programme (IVLP)

- Technology Assessment and Refinement through Institute Village Linkage Programme (IVLP) in irrigated Agro-Eco region in the command of Sone canal system, Bihar was started in April 2000 in four contiguous villages, viz. Bhelura Rampur, Beeranchak, Beerpur and Dosiya, situated in the command of Majhouli distributory (a part of Sone canal System), Patna, Bihar. Emphasis was given to the farmers' needs and local resources, treating farmers as an active partner at the decision as well as implementation stages in the research and technology transfer.
- Various sustainable farming system models were assessed in selected villages of Patna district. Interventions on participatory management of natural resources, water resources,

pests, plant nutrients, and socio-economic improvement were made to enhance the overall productivity of the production system for sustained livelihood improvement in densely populated, high potential, but low productive region. The interventions on introduction of horticultural crops with energy efficient irrigation (drip) systems, multiple uses of water using fishponds, mushroom production and beekeeping were assessed. Encouraging results in diversification, income and employment generation were obtained. Some of the important achievements are:

Technology Acceleration Programme

- Under this programme twelve technologies v*iz.* Multiple Use of Water, Multi Tier Horti Based Cropping System, Fish Production in Low Land Area Programme, Poly house for raising Early Vegetable Nursery in winter season and Early Summer Crop, Mushroom Production through landless families, Zero Tillage in Wheat, Rice Fish System, Backyard poultry for livelihood improvement of resource poor farmers, Small-scale duck farming for livelihood improvement of landless families and unemployed rural youth, Animal health-care support to farmers, Bund height and LEWA (Low Energy Water Application) were accelerated in farmers field.

Accelerating the Adoption of Resource Conservation Technologies (RCTS) for Farm Level Impact on Sustainability of Rice-Wheat Systems of the Indo-Gangetic Plains

- The Project is based on the principle of Resource Conservation Technologies (RCTs) to protect land degradation by reducing disturbance of soil structure due to tillage, building of organic carbon, stimulating beneficial microbes, and improving infiltration to save water, rainwater and prevent soil loss. Conservation tillage saves labour and energy. It includes zero tillage, surface seeding, use of leaf colour chart for N management, weed control and other cultural practices etc. A total of 22 districts were covered under Zero Tillage wheat. Under direct surface seeding of wheat total 670 ha areas was covered in 67 villages in Patna and Bhojpur district. Around 25 ha areas in 21 villages were brought under Zero Tillage rice covering 74 farmers.

Farmers Advisory Services

- Advisory Services were provided to the farmers who visited this institute for seeking advice to their problems and knowledge about latest techniques. The number of farmers seeking advice increased from 190 in 2001 to 675 in 2005.

Participatory Impact Assessment of Agricultural Technologies on Farmers in the Eastern Region

- This project was initiated to study the adoption of the technology and its impact on biophysical and socioeconomic impacts. It was found that nearly 92 per cent farmers have adopted the optimization of rice transplanting (ORT) technology. ORT has generated more opportunity for women particularly on transplanting, hoeing and harvesting. The farmers have also opined that their cropping pattern has also changed due to this technology. Farmers told that, due to OTR adoption there is timely sowing of

wheat crops apart from better utilization of rain water in Kharif. It has also resulted into saving of nursery seed by more than 50 per cent.

Understanding *Makhana* Production System

- This project was taken up with following four major objectives which are to be achieved through separate sub projects: (i) To study socio-institutional parameters affecting *makhana* production and livelihood system of *makhana* producers. (ii) To study cost of production and input output relationship in *makhana* production. (iii) To study price and marketing of *makhana.* (iv) To study production, environment and management aspects of *makhana* cultivationThe first three sub projects are in this programme while the last one is at research Centre for *Makhana*, Darbhanga. The research team visited the selected districts (Darbhanga, Madhubani, Purnia and Katihar) and interacted with different stakeholders.
- There was a myth that *makhana* can be cultivated in ponds only. The myth has been broken. In Katihar & Purnia, *Makhana* is cultivated in low land rice fields. Additional irrigation, fertilizers and pesticides are also used in this area. In the well managed system, production of *Makhana* seed (*guri*) ranges from 25-30 q/ha and in traditional ponds/ water bodies (Darbhanga & Madhubani), production ranges from 20-25 q/ha. Farmers get net income of Rs. 8000-9000 per acre under well managed system and Rs. 6000- 7000 per acre in traditional ponds.
- *Makhana* cultivation is highly rainfall-dependent. In year of low seasonal rainfall, production costs increased due to additional irrigation costs (Katihar & Purnia). Under well managed system, rice is also taken by some of the farmers in the same field after the harvesting of *makhana*.
- *Makhana* is harvested by technically skilled personnel only. It is done mainly by Sahani community. In Katihar & Purnia, harvesting is carried up to longer duration as compared to Darbhanga and Madhubani. In Katihar and Purnia, even Rice is transplanted in the same field after harvesting of *Makhana*. Usually harvesting is carried out three times (called "Buharayi" locally) in the same field. If the rate of Guri is high in the market, harvesting up to 4 – 5 times is carried out. In first three harvestings, the quantity harvested is – 60%, 30% and 10% respectively.
- Harvested *Guri* is first of all cleaned and sun dried. After sun drying, grading is done. As many as nine Sieves (Chalani) are used for grading purpose. If the climate is not suitable for drying, Guri is restored in water up to 20-30 days. Graded Guri is heated and then left for cooling in shade for a day (24 hours). Final popping is done with these pre heated Guri's. Since it involves heating of Guri up to 250 – 300 degree celcius, pre heating and popping both are done generally during nights. Generally, 40 % (w/w) popped *Makhana* is produced from Guri.

Human Resource Development:

- An ICAR sponsored Short course on "Communication Strategies and Skill Development for Participatory Irrigation Management" (Sep 28 – Oct 7, 2004) was organised by SEERP in which 18 scientists from KVKs, SAUs and ICAR institutes participated.

Around 7,000 farmers have been trained on diversified activities *viz* crop production, animal husbandry, fishery, horticulture, water management, natural resource management, alternate livelihoods (Mushroom production, Honeybee, Polyhouse, poultry, duckry etc) etc. through different training programmes, *Kisan Gosthis* and Field days during last five years.

Establishment of Krishi Vigyan Kendra in Buxar

- Efforts were made to establish *Krishi Vigyan Kendra* in Buxar district. Approval was received from the Council. Bihar cabinet has already given its approval for the transfer of 25.64 acre of land to ICAR. Similar demonstrations were laid in Buxer district during *kharif*, 2007.

4.1.5 LIVESTOCK AND FISHERIES IMPROVEMENT AND MANAGEMENT PROGRAMME (LFIMP), PATNA

Traditional animal husbandry and fishery practices and disease occurrence pattern in some selected villages of Bihar.

- A survey was undertaken in some selected districts of Bihar. Results revealed that animal husbandry and fishery practices are similar to other parts of the country. Buffaloes are preferred over cows due to better acclimatization and higher fat content of milk whereas crossbred Holstein Friesian and Jersey is preferred over indigenous cattle due to higher milk yield. It was also observed that socio-economically weaker sections of people raised goats and pigs and some backyard poultry. Women of landless families, on an average, spend 6-8 hours a day on management and care of household animals. Progressive farmers use concentrate feed for crossbred cows and milking buffaloes. Agricultural by-products are mainly used as feed.

- The available land for fodder cultivation is negligible in villages because small & marginal farmers are growing only food crops for their own consumption and some cash crops for meeting their day to day requirement. However, some middle/large farmers are cultivating sorghum and *berseem* for feeding lactating crossbred cows and buffaloes. Wheat, paddy and mustard straw and maize stover are the major sources of dry, fodder whereas mustard, linseed and rapeseed oil cakes are the main sources of proteins for the animals. Under farmers' condition lactation yield of crossbred cow and buffaloes is recorded 2755.00 ± 207.00 & 1467.86 ± 19.36 litres respectively per lactation. Foot-and-mouth disease is the most important livestock diseases followed by hemorrhagic septicaemia so far as the economic losses are concerned, Besides surra, anestrus, unexplained infertility, Degnala like disease, mastitis, nonspecific GI disorders, ecto and endo-parasitic infections etc. are also very common**.** Low milk yield, delayed maturity, repeat breeding, anestrus, poor Veterinary services, inadequate market infrastructure for animal products, scarcity of green fodder specially during lean period (May to June and October to December), high cost of animal feeds are some of the constraints for animal production identified in the region.

- Currently available fresh water resources in the villages are meagre and untapped. Most of the farmers are unaware of scientific techniques of aquaculture. They stock fish fries at

the high rate of 14 – 30,000/ ha while productivity is observed to be 0.9 – 1.2 t/ ha. Even the fish yield from developed ponds is at very low level of about 2.1 t / ha / yr. The riverine fisheries is dominated by catfishes namely *Channas sp, Mystus aor, M. seenghala and Heteropneustes fossilis* etc. Mustard oil cake and rice bran are the main source of feed for carps whereas banana leaves, wild grasses and *berseem* are being used for feeding grass carp. Fish ponds in the villages are infested with aquatic weeds like *Hydrilla*, *Eichhornia*, *Azolla* and *Potamogeton*. Lack of technical knowledge about aquaculture; nonavailability of quality fish seed and infestation of ponds by weeds are some of the major constraints in traditional fish production.

Development and evaluation of economic ration based on locally available feed resources for milk production

- Out of total cost of animal rearing, about 60-70% is accounted for the feeding the animal alone. To make the traditional animal rearing as an enterprise, it is essential to feed the animals economically as well as with balanced feed for getting maximum benefit. Moreover, shortage of quality feed is a major constraint in animal-based farming systems. After an initial survey in Patna district of Bihar, it has been observed that livestock are being maintained on a sub-optimal feeding system. So, there is a need to develop suitable feeding system for dairy animals at village level considering the poor purchasing power of farmers.
- A Survey in some selected villages of Bihar revealed that 60 per cent household cultivates green fodder and 58.13 per cent practice grazing. It is also observed that only 8.5 per cent of land is used for fodder cultivation. *Berseem* and sudan grass are the most cultivated fodders, cultivated by as many as 98 per cent farmers with average yield of 366 and 330 q/ha for *berseem* and sudan grass, respectively. Fodder scarcity is observed in 122-days/year during May – June & Oct – Dec. Feeding of *berseem* increases milk yield by 30 per cent while s*udan* grass increases yield by 22 per cent. During the lean periods the farmers feed 30% more concentrate in order to compensate for green fodder.

Strategies for enhancing land and water productivity through multiple uses of water (Fishery and Duckery components)

- Fish-duck farming is considered as a best combination of fish based integrated farming system. Duck forage on fishpond during daytime and their dropping are used as fish feed. Moreover, ducks act as good aerator for fishpond to increase dissolved oxygen level required for fish growth. In waterlogged condition rice-fish combination is considered as one of the tools to increase land productivity. A model of duck-fish farming and rice-fish culture has been developed to increase productivity of land and water under multiple uses of water.
- Four different systems were followed, namely, i) Duck – fish farming, ii) Rice/ Wheat – fish farming, iii) Fish culture in service reservoir and iv) Fish culture in trenches. System of polyculture followed. Stocking of Khaki Campbell duck was done @ 300 /ha of water area. Ducks started laying eggs at the age of 24 – 26 wks. Average egg production 160 eggs/bird/yr. Average weight of eggs were 64 g after 90 days of egg laying. The production of fishes varies from 3 - 5 t/ha in pond and about 2 t/ ha in trenches.

4.1.6 RESEARCH CENTER FOR *MAKHANA*, DARBHANGA

Collection, Evaluation and Documentation of *Makhana* (*Euryale ferox* Salisb):

- With the active support of NBPGR, New Delhi, scientist of Research Centre for *Makhana*, Darbhanga, conducted First Exploration of Germplasm in the district of Darbhanga, and Madhubani. The 46 accessions of *Euryale ferox* were collected in 2004-2005 which have been deposited in the Gene bank of NBPGR, New Delhi and got the accession number of each Germ plasm collected. Again with the active support of NBPGR New Delhi, scientist of Research Centre for *Makhana* Darbhanga, conducted Second Exploration of Germplasm in the district of. Kisanganj, Arariya, Purnia, & Katihar. The 18 accessions of *Euryale ferox* were collected which has been transplanted in the Gene Bank of *Makhana* Research farm and being maintained.

Germination and Establishment of *Makhana*

- Systematic scientific experiments on *Euryale ferox* are being conducted at the lab and in field condition for generating information on establishment, growth and morphogenesis of *Euryale ferox*. Encouraging result has been found in the lab conditions where successful and early establishment of the crops is under way. An innovative attempt to germinate the seed under *ex-situ* condition and further seedling where transferred in the polybags for domestication of the crops to overcome the traditional way of its cultivation.

Evaluation of yield potential of *Makhana* cum fish with FYM

- An effort was initiated for evaluation of yield potential of *Makhana*, *Makhana* cum fish with FYM and Fish alone in newly excavated ponds at our research farm. Fish has been integrated in *Makhana* crop and observations are under progress.

- An aquatic cum *Makhana* Gene Bank was constructed at the Research farm in which collection of *Euryale ferox* and other aquatic species e.g. *Trapa bispinosa*, *Nelumbo nucifera*, etc. are maintained.

Socio economic Survey of *Makhana*

- A socio-economic Survey of 64 *Makhana* growers by interview method with the help of a structured scheduled questionaire was conducted. Information was collected on the various socio-economic and technological aspects from the districts of Darbhanga and Madhubani. Secondary information on demography, no. of Ponds, growers, cultivation practices, production and marketing of *makhana* were collected from various sources. The fisherman community is basically poor, illiterate and disadvantaged resourcewise. Their livelihood comes from cultivation of fish, *makhana* and by employment as labourer in agricultural operation. Sixty per cent of the fishermen are landless. 22 per cent have animals (cow, goat and hen) and 83 per cent live in *kuchcha* thatched houses. They have no knowledge of scientific cultivation of *makhana* or fisheries.

Ex-situ germination of *Makhana*

- Ex-situ germination studies were carried out on freshly harvested seeds of *Euryale ferox* Salisb. by using unpricked and pricked seeds in water and in mud along with water and observations were recorded at an interval of 7 days. From the present observations it is evident that the seeds of *Makhana* showed hypogeal germination. The pricked seeds germinated very early than the unpricked seeds. Initiation of sprouting in pricked seeds started only 7 days after planting. The unpricked seeds on the other hand showed on initiation of sprouting even 42 days after planting. The germination percentage of unpricked and pricked seeds after 70 days of planting was found to us 20 and 67 to 73 per cent respectively. These results show that the pricking of seeds enhances germination percentage and that seeds can be stored in water at ambient temperature.

Germination performance

- Ex-situ germination studies were carried out on seeds of three different average sizes, and weights viz., large seeds (average weight 1.20 gm, av. Dia 1.35 cm); medium seeds (average wt. 0.81 gm, av. diameter 1.1 cm) and small seeds (av.wt. 0.55 gm; av.dia. 0.5 cm). Large seeds showed 50 to cent-per-cent germination, medium seeds to 50 to 90 per cent and small seeds 50 to 70 per cent germination in laboratory condition.

4.2 EXPLICIT ACCOUNT OF SOCIO-ECONOMIC IMPACT ON THE TARGET GROUPS

ICAR Research Complex for Eastern Region, Patna is a newly established institute (w.e.f. Feb., 2001) after merger of DWMR, Patna; CHES, Ranchi; CTRI Regional station, Pusa and very recently NRC for *Makhana*, Darbhanga. The on-going programs for these centers were carried forward and are being reoriented to meet the mandate of the Complex. The institute, over a period of short time has made some visible impact through generation and dissemination of various technologies.

4.2.1 RICE-WHEAT PRODUCTION TECHNOLOGY

The Complex with the support of Center for Environment and Agricultural Development (CEAD), New Delhi has demonstrated integrated agricultural technology in a participatory mode in 178 villages in the commands of 8 distributaties of Sone Canal System in Patna district to enhance crop productivity. A System approach consisting of techniques such as advancing the date of transplanting of rice, improved package of practices for rice and wheat production, balanced use of fertilizers, improved water management practices and plant protection made significant impact which is evident from the increased yield of rice and wheat in these areas to an average of 4.5 t/ha for rice and 4.0 t/ha for wheat as against 1.9 t/ha for rice and 2.0 t/ha for wheat respectively. There has been an encouraging trend of adoption of this System technology and its effect could also be seen in other adjoining districts of south Bihar. Based on the benefit of this approach, the farmers and the institute scientists were able to convince Irrigation Department, MoWR, Bihar Government for timely release of water to coincide with early nursery raising and transplanting. This System approach also resulted in timely sowing of wheat in the study area (starting from mid November)

against earlier practice of sowing wheat in the first week of December to the first week of January.

4.2.2 PARTICIPATORY LAND AND WATER MANAGEMENT FOR IMPROVING LIVELIHOOD

The Complex has been striving to make its presence felt in the area through various land and water management interventions. Through the DFID-NRSP project, the institute has been able to show a convincing impact of land and water management through involvement of wider constituency of stakeholders (WUAs, SHGs, Outlet Management Group) with least or no incentivisation for implementation of need based and people driven low cost interventions. Technological interventions and adoption of these interventions viz. conjunctive use of ground water, canal water and rain water management, increased bund height, installation of low cost wooden gates on the outlets, multiple use of water bodies for fish including rice fish culture, micro level GIS mapping and development of decision support tool in a participatory mode have helped in improving the livelihood of the local community farmers, landless farmers, sharecroppers and the poor.

4.2.3 CONSERVATION AGRICULTURE

The institute over the past five years has undertaken extensive work on accelerating Resource Conservation Technologies (RCTs) under NATP, USAID and IFAD projects. The technologies fostered were (i) zero till direct seeded rice (ZTDSR), (ii) Co-culture of Sesbania with Rice for Brown manuring, (iii) use of LCC for real time N use in rice, (iv) zero till wheat through different methods, (v) balanced use of nutrient in surface seeded wheat, (vi) rice based crop diversification, (vii) introduction of extra early pigeon pea for crop intensification, (viii) promotion of alternate livelihood production system of socially/ economically weaker section through SHGs like commercialization of vegetable nursery raising in polyhouse, mushroom production, duckery/backyard poultry and honey production.

Under NATP, introduction of ZT wheat had been accelerated in 22 districts of Bihar covering an area of over 6000 ha owned by more than 7200 farmers. A total saving of the order of Rs. 6,600/- per ha in zero tillage over conventional sowing of wheat in various items is reported. There was monetary saving of Rs. 7,500/ha along with 50 % water saving and 1.3 t/ha additional yield due to ZTDSR over conventional transplanted rice, which also resulted in better yield of rabi crop due to no puddling. Co-culture of *Sesbania* could save 20 – 25 kg N/ha in rice and improved soil health by addition of organic matter. LCC could save 30 – 50 kg N/ha by farmers using excess N in rice traditional rice. ZT wheat performed better over conventional in many ways like resource saving in tillage (Rs. 2500/ha), seed (60 kg/ha), first irrigation and weed management besides timely seeding and yield gain of about 5 – 8 q/ha. Wheat sowing in rice residue was successfully possible through double disc and rotary till disc drill. ZT wheat sown in control traffic with rice residue was found best for yield and restoring soil health. Economically weaker section could be organized in Self Help Group mode and were able to earn income through raising vegetable nursery in polyhouse, mushroom cultivation and

backyard poultry/duckery. These activities improved their livelihood. Large-scale sensitization of different stakeholders.

4.2.4 FARMING SYSTEM AND MULTIPLE WATER USE

Under the Technology Assessment and Refinement program through Institute Village Link Program (IVLP), various aspects such as a Farming System integrating crops with livestock, fisheries and horticulture were assessed, refined, and demonstrated in irrigated ecosystem in the four selected villages of the Patna district in Naubatpur and Phulwari Blocks. Introduction of fisheries component, through the secondary reservoirs and on common property resources i.e. common water bodies paid rich dividends to the farmers. Based on the convincing results, the farmers of the area have undertaken the activity of multiple water use by utilizing otherwise under-utilized waterlogged areas for raising fish and horticultural crops through different Self Help Groups and Social Fisheries Associations. The average profit per family increased by 25 per cent through crops and 30% through fish based activities. As a result of the interventions in mushroom cultivation, bee keeping etc., through women Self Help Groups, the role of women in decision making has facilitated women empowerment. Drip irrigation system for cultivating banana has shown encouraging impact on water saving and increase in yield (uniformity of the quality and size of the fruits) and early flowering and subsequent early maturity of fruits to capture early market.

4.2.5 TECHNOLOGY ACCELERATION PROGRAMME

Well-tested 12 technologies were accelerated in canal-irrigated area of Patna district. In 50 rice fields bund height was raised up to 30 cm by 12 farmers of 5 villages. Due to raising of bund height there was availability of soil moisture for longer time during critical period, saving 2 irrigations, less incidence of diseases, reduction of input cost and possibility of extra crop like pigeon pea and Okra. LEWA demonstrated in one village had shown that there was overall saving of 30 – 50 % water and energy saving besides higher yield. The mango and Aonla based cropping systems were demonstrated in five villages. Multiple use of water and fish production in lowland was demonstrated in 03 villages.. Through mushroom production, the landless families especially women SHGs could earn Rs. 40 per day per head during growing season. From rice + fish system, extra yield of fish by 2 to 3 t/ha was harvested. Due to the introduction of improved poultry bird Divyan, there was an average income of Rs. 600 per bird per year. Khaki Campbell breed of ducks reared by 41 landless farmers and unemployed youth of 8 villages, an additional income of Rs 700 per family per year was generated.

4.2.6 CROPS RESEARCH

The Complex has released a chewing tobacco variety “Lichhavi” in 2001 with a yield potential of 2700 kg/ha with a mean productivity of the crop in north Bihar of 1730 kg/ha. The tobacco + garlic/coriander intercropping system developed by the Complex has spread over 40-50 per cent of tobacco cultivated area.

4.2.7 HORTICULTURE AND AGRO-FORESTRY

The growth of horticulture sector in the eastern region during the last four decades has already resulted in a perceptible influence on the overall socio-economic condition of the people. There has been a rapid increase in the area under different fruits and vegetable crops resulting in improvement in the nutritional as well as economic security of the farmers. The presence of the Complex in the region has contributed significantly towards growth of horticulture sector in the region. With the identification of improved varieties of different horticultural crops with different maturity period, the availability period of different horticultural produce has been prolonged which has helped in reducing the market glut to a considerable extent.

Rapid increase in the area under different horticultural crops has also resulted in upsurge in pesticide consumption. The demand for aesthetic values in the horticultural produce for fetching premium market price has also added to the problem of overuse of pesticides. The institute has already developed integrated pest management packages for different horticultural crops. The farmers of the region have already started using these technologies for management of pest and diseases of different horticultural crops resulting in reduction in pesticide consumption in the region.

4.2.8 IMPROVED VARIETIES OF VEGETABLE CROPS

With the development of improved varieties of different vegetable crops in the HARP, there has been significant increase in the area under different vegetable crops in the plateau region. Efforts made for popularization of the technologies since last five years have resulted in wide spread adoption of the improved varieties developed at HARP in an area of about 4450 ha area. The community vegetable nursery programme initiated for production of healthy seedling of wilt resistant tomato and brinjal has resulted in promotion of rainy season cultivation of tomato and brinjal in the state of Jharkhand. The increased income obtained due to cultivation of these improved varieties has contributed significantly towards ensuring nutritional and economic security in the tribal region. Cultivation of improved varieties of vegetable crops also increased the employment opportunity by about four fold than that in case of traditional varieties. This has been adopted as an entry point activity by the NGOs of the plateau region.

4.2.9 FRUIT BASED MULTITIER CROPPING SYSTEM FOR UPLANDS

The fruit based multitier cropping system for uplands, a technology developed at HARP has been included in the State Plan of Govt. of Jharkhand under the Chief Mininster's Bagwani Vikas Yojna for its plantation in 2500 ha area in Jharkhand, after its evaluation and declaration as bankable by NABARD. Under the National Horticulture Mission, the system has already been planted in 250 ha area in the state of Jharkhand. With the adoption of the technology, there has been a marked improvement in the input use by the farmers, particularly an increase in the use of seeds of improved varieties, organic manure and farm labour. A two-fold increase in the use of pesticide by the farmer warrants integration of integrated pest management practices in the fruit based multitier cropping system. With the adoption of the technology there has been a shift in the waste

utilization pattern from the farming system. The leaf litter, which was used earlier for fuel purposes, is now being used for composting purpose. A significant proportion of paddy straw produced is being used for mulching of fruit plants. The increased availability of fruits and vegetables in the multitier system has resulted in increase in the consumption of fruits and vegetables in the household. The multitier system has been effective in generating more job opportunities for the women particularly in the operations like marketing of produce, weeding, fertilizer application.

4.2.10 IMPACT IN POLICY CHANGE

The efforts on statewide demonstration and sensitization on Zero Tillage resulted in influencing Govt. of Bihar to declare 25% (up to Rs 5000) subsidy on purchase of Zero Till drill and bed planter. Water Resource Department in Bihar rescheduled release of canal water as per output of our water management research in canal command areas. Multi-tier cropping system technology (3 fruit based systems namely mango, aonla and litchi) was made bankable by NABARD and have also been included as a policy instrument to implement this model through Mukhya Mantri Uddyan Yojna in Jharkhand.Various finance institutions are supporting the financial help to SHGs for agricultural purposes in the model developed by institute under DFID project. Institute developed technology of multiple use of water was recognized by the Bihar state for productive utilization of waterlogged areas and accordingly existing Leasing Policy for leasing of water bodies was modified for long term.

CHAPTER - 5

TECHNOLOGY TRANSFER

5.1 RESULTS OF RESEARCH GOING TO EXTENSION AGENCIES/USERS

The Complex has developed a number of technologies under its technology development, assessment, transfer and refinement programme. A number of technologies have gone to the farmers/extension agencies and user agencies. A brief description of the technologies developed, expected yield gain and the area cover under each technology is given below in Table 5.

Table 5 Technologies developed by ICAR-RCER and their extent of dissemination

Sl. No.	Types of Technologies	Description	Yield gain	Interventions*	Area covered under Technology Transfer/Potential area
1.	**Optimization of rice transplanting date for efficient rain water utilization & enhanced productivity**	Timely raising of rice nursery and its transplanting results in efficient utilization of rainwater (94%), minimizing irrigation requirement and enhancing rice productivity in silty clay soils in Bihar	Rice grain yield enhanced to 5.5 to 6.5 t/ha from a present yield level of 3.0 t/ha in irrigated areas of South Bihar.	Raising of nursery by 25th May and transplanting in last week of June using tube-well water preferably on community basis specially for small holders	178 villages covered in Sone command, (Bihar) covering an area of 10,000 hectares. It has further potential in 8-10 lakh ha in Bihar. As a result of the technology transfer the ICAR-RCER has been able to convince the Irrigation Department, Govt. of Bihar to release the water for rice timely from May 25 – October 25 every year.
2.	**Raising bund height of paddy fields for maximum rainwater conservation**	In canal commands areas, raising bund height of paddy fields conserves maximum amount of rainfall, retain moisture for a longer period and reduces irrigation water requirement from canal water.	Saving of 1-2 irrigations from canal water during rainless period and increased water productivity with yield grain of 10 per cent.	Raise paddy field bund height from existing 7.5 – 15 cm to 25-30 cm	20 villages in Sone command (Bihar) covering an area of 800 hectares. This has immense potential in command area of canal and tubewell irrigation.

3	**Low Energy Water Application Device (LEWA) for irrigating wheat and rice**	The device is a T shaped nozzle made of 40 cm long, 25 mm diameter PVC pipe with 15 holes of 1.5 mm diameter arranged appropriately in six lines. The nozzle can be pivoted at the centre on a sprinkler riser with a socket and bush arrangement for facilitating the rotation. The lab and field test of the LEWA device suggested that it has excellent prospects as a low cost water and energy efficient device which can be affordable even to small farm holders. The main characteristics of the LEWA device is that it requires an operating pressure of 0.4 – 0.6 Kg/cm^2 to operate satisfactorily which is approximately 5 times less than the commercial sprinklers.	In comparison to similar sprinklers, field testing of LEWA in rice and wheat reflects water saving of 10 to 13 % and around 30-50% of energy saving over sprinkler irrigation. Whereas, when compared with surface method of irrigation, it registered an overall saving of 30 – 50% of water as well as energy. The complete LEWA nozzle unit with rotating mechanism costs approximately Rs. 50/- against sprinklers which are not costing less than Rs. 200/-.		The device has been successfully tested under indoor and at farms of the ICAR-RCER and in the farmers field in the Sone Command, Bihar. For outscaling its adoption, the LEWA system has also been installed and tested in four ICAR institutes namely CRRI, Cuttack, WTCER, Bhubaneswar, ICAR Research Complex for NEH Region, Barapani and WTC, IARI, New Delhi.
4.	**Release of New Chewing tobacco variety "Lichchavi"**	"LICHCHAVI" has been released by IVRC for cultivation in all chewing tobacco growing areas of Bihar and U.P.	Its total average yield is 27 q/ha with 15 q/ha first grade leaf. The spangling (4.2) and puckering (4.2) scores proved superior in this variety than the earlier released and established variety e.g. Pusa Tobacco-76 (3.8 & 3.7) and Vaishali Special (3.6 & 3.7). Nicotine content in the cured leaves of this variety is 3.53% superior to Vaishali Special (3.50%). "Lichchavi" bears highest cured leaf thickness (11.0mm) as compared to PT-76 (8.5 mm).	As per standard package of practices for cultivation of tobacco.	The mean productivity of the variety is 1730 kg/ha in North Bihar. The variety is the ruling variety in North Bihar. The tobacco + garlic/coriander intercropping system has spread over 40-50 per cent of tobacco cultivated area.

5.	**Multi-tier cropping system for horticultural crops**	• Undulating topography coupled with poor soil fertility and water holding capacity of uplands soils in Jharkhand plateau holds promise for fruit based multi-tier cropping production systems consisting of main crop, filler crop and inter crop. • The space available between two trees of tall growing base fruit trees viz. mango, litchi, and aonla can be profitably used for growing filler crops like guava having cooperatively less gestation period, lesser canopy size and small life span. Further the interspace available during initial years can be utilized for growing rainfed vegetables for better sustainability	**Pre bearing Orchards** • Litchi+Guava + Cowpea. • Mango+Guava+Cowpea **Bearing Orchards** Mango+Guava+Turmeric • Litchi based cropping system can give Rs.13.0 lacs/ha against an investment of Rs.6.5 lacs in first 20 years of orchard establishment. • Mango based cropping system can yield Rs.8.8 lacs against an investment of Rs.4.5 lac during the first 20 years of orchard establishment. • Aonla based cropping system can yield Rs.7.5 lacs/ha against an investment of Rs.3.5 lacs during first 20 years of orchard establishment.	• For irrigated conditions : Litchi based cropping system • For rainfed conditions with good soil fertility :Mango based cropping system • For rainfed conditions with poor soil fertility :Aonla based cropping system. **Main crops :** Litchi, Mango and Aonla **Filler crops :** Guava, custard apple and lime **Inter crops :** Cowpea, french bean, millets, grasses, upland paddy, pulses and oilseeds • Plant main trees at 10 x 10 m spacing • Incorporate filler trees in between 5 x 5 spacing. • Use interspace for intercrops for few initial years	• The technology is made bankable by NABARD and included as policy instrument to implement the model through **Mukhya Mantri Udyan Yojna** in Jharkhand. • The technology has potential of covering 10000 ha in five years in Jharkhand.

6.	**Fish-pond-cum-secondary reservoir for economized and multiple uses of irrigation water in agriculture production system in irrigated areas and multiple use of water in seasonally waterlogged areas**	• In agriculture production system, additional income through fish production can be obtained from water meant for irrigation alone by routing it through a secondary reservoir introduced in the irrigation system (canal and tubewell). This will boost fish production in fish starved eastern region where fish is imported from Andhra Pradesh presently. It will generate employment potential and industrial development for processing of fish products. • Bihar has got about 9 lac hectare area under permanent or seasonally waterlogging and surface stagnation which can be used for productive utilization through and horti. fish based integrated farming system. • Productivity of fish can also be enhanced by integration of fish with *makhana*-a cash crop of North Bihar.	• Up to 11 t/ha additional fish yield could be obtained from a small pond-cum- secondary reservoir of 16.5 x 14.5 m of 2 m depth against fish yield potential from farmers pond of about 2 t/ha in irrigated areas. • Seepage-fed fish ponds supplemented by ground water and integrated with fisheries, duckery and horticulture could give Rs: 1,32,000/ha • Fish trenches-cum-raised beds integrated with horticulture and fish could give up to Rs: 85,000/ha as against Rs. 29,000/ha from rice crop alone in such areas. • The multiple use of *makhana* water bodies by integration of fish would enhance the fish yield and could give approximately Rs.20,000/ha in addition to earning from *makhana*.	• Secondary reservoir 16.5 x 14.5 m top, 12 x 10 m bottom and 2.0 m depth. • Stocking of Indian Major Carps, Catla, Rohu and Mrigal and Exotic Carps (Grass Carps, Common Carp and Silver Carp) • Weekly exchange of water to maintain desired level of dissolve oxygen during summer. • Seepage fed ponds with fish + duckery + horticulture. • Fish trenches cum-raised bed + horticulture • Integration of carps with *makhana* farming.	• Farmers dug up 20-ponds in the 10 hectare area of RPC-V command of Sone Command Bihar**.** • Participatory management of common property ponds for fish production in Sone Command, Bihar gave encouraging results • Secondary reservoir and multiple use of waterlogged areas well received by farmers & adopted by few. • About 200 farmers were trained in four canal commands of Bihar in water management and integrated farming systems in Deptt. of Water Resources, sponsored training programmes. • Participatory management of *makhana* water bodies in North Bihar.

7.	**Resource conservation technologies like, zero tillage, brown manuring, and use of Leaf Colour Chart**	• Upscaled adoption of zero tillage in wheat will ensure timely sowing of wheat, reduce cultivation cost and reduce irrigation water requirement and increase wheat grain yield in Indo Gangetic Plains and Tal areas of Bihar • Broadcasting of sesbania seeds immediately after transplanting rice and its co-culture after drying can supplement nitrogen, add dry matter and recycle nutrients • Leaf Colour Chart can guide farmers for reducing nitrogen requirement of rice in direct seeded/transplanted/zero tilled rice	• Saving in cultivation cost by Rs. 1850/ha • Reduction in irrigation requirement by 20-25% • Increase in yield by 8 to 10 q/ha • Incorporation of dried sesbania reduced nitrogen requirement by about by 38 kg N/ha • Improved soil organic carbon • Reduction of weed population • Saving of nitrogen fertilizer by about 46 kg N/ha	• Sowing of wheat by zero tillage immediately after rice in wet condition by Nov. 15. • Broadcasting of sesbania seeds @ 20 kg/ha, 3 days after transplanting rice and allow 30 days growth • Dry sesbania crop by spraying 2-4-D ethyl ester. • Schedule nitrogen top dressing by LCC based on soil N supply and crop demand	• 5450 ha in 22 districts of **Bihar** involving 6982 farmers • As a result of success to zero till technology Bihar Govt. sanctioned Rs. 5000/- per zero till machine • 15 villages 3 districts of Bihar • 15 villages 3 districts of Bihar • Overall different RCTs have potential in 10-12 lakh ha in Bihar.
8.	**Development of disease resistant high yielding varieties of horticulture crops**	• Bacterial wilt in solonaceous vegetable is major problem in about 32000 ha affected area in Jharkhand. Bacterial wilt resistant varieties have a potential to improve yield up to 30 percent in the affected area. High yielding varieties of Brinjal, Tomato, Cucumber, ridge gourd, sponge guard, garden pea, french bean, cowpea, dolichos bean have a potential of 20 per cent higher yield.	• Eight wilt resistant varieties including four (swarna pratibha, swarna shyamli, swarna ajay-hybrid) in brinjal ; and four (swarna lalima, swarna navin, swarna samridhi, swarna sampada–hybrid, in tomato have been developed and these have yield increase potential by 30% in affected area. • 21 high yielding varieties of vegetables have been developed. These have potential of 20 per cent of higher yield over traditional varieties.	• Substitute traditional varieties with resistant and high yield varieties. This will need supply of seed and planting material of different vegetable varieties which the center can meet up to a certain degree • The farmers need to be encouraged to produce their own seed in a participatory manner.	• 32000 ha potential wilt affected area in Jharkhand can be brought under cultivation of these varieties. This can yield Rs.70,000/acre against Rs.30,000/acre under traditional varieties. • 40000 ha potential area of high yielding varieties in Jharkhand can be brought under cultivation of these varieties. • Some of these varieties are suitable for Bihar, HP, J&K, Uttranchal, M.P., Maharashtra, Karnataka, Kerala, Rajasthan, Andman & Nicobar Islands NE states

9.	**Development of practice of high density planting of fruit crops**	• High density planting of fruit crops holds promise for increasing productivity of land for horticultural crops by reducing the inter plant and row spacings	• **In litchi the practice can yield three times compared to traditional planting 9 x 9 m accommodating 123 trees/ha giving Rs.18.0 lakhs/ha in first 20 years against Rs.8.0 lakhs under normal density planting.** • **In guava the practice could yield two times yield compared to traditional planting at 5 x 5 m accommodating 400 trees/ha giving Rs.6.0 lacs/ha in first 10 years against Rs.4.2 lacs/ha/year under normal density planting.** • **In mango the practice could yield 2.5 times yield compared to traditional planting at 10 x 10 m accommodating 100 trees/ha giving Rs.11.0 lacs/ha in first 10 years against Rs.6.0 lacs/ha/year under normal density planting.**	• Plant litchi trees at 4.5x4.5x9 m in double hadge row planting accommodating 329 trees/ha • Plant allahabad safeda guava at 2.5x2.5x5 m in double hadge row planting accommodating 1060 trees/ha • Plant amrapali mango trees at 2.5x2.5 m in accommodating 1600 trees/ha	• The practice has potential of increasing productivity by 50 per cent in 5000 ha in Jharkhand

10.	**Rejuvenation of existing old and senile orchards in mango**	• Prevalence of unmanaged and over crowded, old and senile plantations in mango is the cause of low productivity, which needs to be rejuvenated for improving production.	• **The technology has the potential of improving productivity by 30-50 percent.** • **Similar possibility exists for litchi and guava also** • **A net profit of Rs.3.0 lac/ha can be obtained in a period of 10 years after rejunivation against Rs.1.0 lacs/ha from the senile orchards during the same period.**	• Prune/cut limbs during December, proper wound dressing, selection of optimum number and position of sprouts emerging from right and removing all unselected sprouts, management of selected sprouts to be developed into desired canopy • Rejuvenation costs only Rs. 545/tree over three years.	• The technology has potential in 5000 ha affected area in Jharkhand.
11.	**Acid soil amelioration and micro nutrient disorder management**	• The light textured acid soils (Alfisols) are generally deficient in Boron and Molybdenum. Cabbage and cauliflower are two main vegetable crops grown in Chotta Nagpur platau dominated by Acid soils. Boron deficiency causes brownrot and causes reduction in yield and quality. Molybdenum deficiency causes whiptail and riceyness causing yield and quality reduction	• **Amelioration of Zn and Mb deficiency can increase productivity of cabbage and cauliflower by 15-20 percent in 20,000 ha affected area in Jharkhand** • **Liming of acid soils can improve productivity of other vegetable crops by 10-15 percent in potentially affected 60,000 area** • **By application of ameliorative technology net additional benefit up to Rs.37,000/ha can be obtained.**	• Apply 14kg/ha Borax 10 days after transplanting for mitigating Boron deficiency. Folier application of 1.25 g of Boric acid per litre of water with 1 ml tee pol three times at 10 to 12 days interval starting from 10 days after transplanting • Apply 3.85 kg sodium molybdenum 10 days after transplanting. Folier application of 1.25 g of Boric acid per litre of water with 1 ml tee pol three times at 10 to 12 days interval starting from 10 days after transplanting • Apply lime @ 2-4 t/ha for acid soil and amelioration.	• 20,000 ha area affected by Zn and Mb deficiency in Jharkhand • 60,000 ha area affected by acid soils in Jharkhand

12.	**Toposequencial rainwater harvesting for multiple uses of water in uplands**	• The shallow and light textured soils of uplands in Jharkhand yield considerable surface and sub-surface runoff during rainy season. Toposequencial harvesting of runoff can ensure its efficient utilization for multiple uses of water for fisheries + horticulture	• **Net benefit of Rs.24,000/ ha/year can be obtained as compared to Rs. 9000/ha/ year from traditional cultivation of paddy in the same field.**	• Construct water harvesting pond 20 x 20 m, 2 m depth and 1:1 side slops • Plant aonla in the catchment area upstream of the pond • Plant vegetable crops/horticulture crops on the bunds and grow fish in the pond • Plant, litchi or mango based multi tier horticulture system with guava as filler crop and vegetables at intercrops. • Provide irrigation to multi-tier system through gravity fed drip irrigation system • Store extra surface/sub-surface runoff in dugout pond below the multi-tier plot	• The technology has potential of increasing area under horticulture crops in 14,000 ha in Jharkhand.

* These interventions will be implemented with the support of State Deptts. of Agriculture by providing them technical backstopping, capacity building and taking up pilot studies.

CHAPTER – 6

INTERACTION AND LINKAGE

During the period of report (2001-2005), the Complex has developed several national/international linkages in order to achieve its mandate of the Complex. The Complex is the seat of coordination unit of the "Challenge Programme on Water and Food" of the CGIAR. The Complex has executed two projects under NRSP of DFID (UK) on integrated water management for livelihood improvement. The Complex has successfully tested micro irrigation in LEWA device in collaboration with IDE international. Linkages and interaction with the state departments of Agriculture/Irrigation/Water Resources of Govt. of Bihar have been established and are successfully implemented. The recommendations emanating out of the research results have been passed on to these departments for policy interventions. Effective linkages exist with NABARD, NHB and Bihar State Productively Council. The themewise existing linkages with national and international agencies are presented in Table 6.

Table 6 Themewise national and international linkages of ICAR-RCER

Sl. No.	Programmes	Existing linkages with	
		National organizations	International organizations
1.	Resource inventorisation	NBPGR, NIH, MoWR,	IWMI
2.	Development of quality cultivars of agricultural, horticultural and aquatic crops	NBPGR, NBFGR, CRRI, CIFRI, Directorate of Rice Research, IIHR, CIFA, IVRI	IRRI, IPGRI
3.	Integrated location specific, multi-commodity farming system involving field crops, horticulture, aquatic, livestock, fisheries, crops and other enterprises.	RAU, PDCSR, NABARD, Water Resource Department, Govt. of Bihar, NHB	ACIAR
4.	Production techniques for field, horticultural agro-forestry and aquatic crops like *makhana*	BAU	
5.	Integrated Water Management	CADAs, NIH, CWC, Irrigation & Water Resources Department, Govt. of Bihar, NATP	IWMI, DFID (UK), IDE
6.	Multiple uses of Water	CIFRI, MOWR, CIFA	IWMI

7.	Rain water harvesting and watershed management	MOWR, SAUs	
8.	Development, testing and popularization of resource conservation technologies	PDCSR, RAU, BAU	CIMMYT
9.	Management of flooded and flood prone and water congested areas	SAUs, MOWR, GFCC, NIH,	
10.	Risk analysis and management	IIT, NIH, IMD	IWMI
11.	Animal husbandry and fisheries practices and potentials	NBPGR, NBFGR	
12.	Introduction and evaluation of package for aquaculture	CIFA, CIFRI, RAU	
13.	Livestock and Fish Production	CIFA, CIFRI	ILRI, WFC
14.	Plant seed material production	BAU, IIVR, IIPR, IIHR	
15.	Technology assessment, refinement and dissemination	RAU, BAU	
16.	Socio-economic and policy research	NCAP	
17.	Transfer of technology	RAU, BAU	
18.	Human resource development	NCAP, NAARM, IASRI	CG Centers
19.	Networking Research	RAU, BAU, CSWCRTI, CRIDA	IWMI, IRRI, IFPRI

CHAPTER – 7

FUTURE PROJECTION AND PROGRAMMES

The Perspective Plan "Vision –2025" document of ICAR-RCER in section 9 gives the time-frame of the major 23 thrust areas. The comments on the Perspective Plan 'Vision-2025' ICAR-RCER alongwith short, medium and long-term action plans are as follows:-

7.1 PERSPECTIVE PLAN "VISION – 2025" ICAR-RCER

The Perspective Plan "Vision – 2025" of ICAR-RCER has been brought out. It is elaborate and is fairly comprehensive. It covers all mandated areas of the ICAR-RCER. Although the projects under most of the thrust areas have been listed, it is necessary to identify the mechanism and time-frame and the minimum essential feasible components of these broad areas that can be feasibly covered during the period indicated. This probably would require more intensive examination of the resources available and the capabilities of ICAR-RCER to work out a few important components on priority basis for which the resources would have to be mobilized. These should be supplemented by following a network and consortia approach envisioned in the document and by the mobilization of resources through externally aided national and international projects and through consultancy and contract research.

7.2 PRIORITISATION OF THRUST AREAS

The various projects as outlined in the Perspective Plan "Vision – 2025" can be tentatively categorized into high and medium priorities and those to be undertaken in collaboration with other institutions.

High Priority

- Integrated location-specific, multi-commodity farming system involving field crops, horticulture, aquatic, livestock, fisheries, crops and other enterprises
- Networking research for introducing sustainable conservation farming system.
- Multiple uses of water in the mandated areas of the Complex.
- Post-harvest technology and value addition of agricultural, horticultural and aquatic produce.
- Plant & Seed material production and distribution to the farming communities.
- Technology assessment, refinement and dissemination
- Socio-Economic and policy research
- Development of quality cultivars of agricultural, horticultural and aquatic crops

- Management of flooded and flood prone and water congested areas
- Livestock and fish production
- Climate Change: its assessment, impacts, vulnerability and adaptation

Medium Priority

- Production techniques for field, horticultural agro-forestry and aquatic crops like *makhana*
- Integrated water management
- Rain water harvesting and watershed management.
- Development, testing and popularization of resource conservation technologies
- Risk analysis and management
- Animal husbandry and fisheries practices and potentials
- Animal and fish health management
- Transfer of technology
- Human resource development

Research areas to be taken up in collaboration with other institutions

- Resource Inventorization
- Feeds and feeding of livestock and fisheries
- Intellectual Property Right

CHAPTER – 8

RESOURCES AND ORGANIZATION

Researches in agriculture are different than those in scientific and industrial fields. The natures of research in scientific and industrial fields are more identified and compact for which sufficient funds can be generated from industries and other scientific organizations. Researches in agriculture are, however, area-based and require more time to produce results and hence are different from industrial research. The findings of agricultural research benefit the farmers and sustain the natural resource base. Therefore, it is not possible to generate funds on a short-term basis as can be done through industries for specific items. The central government and other funding organizations will have to continue sponsor research on agriculture-on a long-term basis.

Budgetary allocation from Government, though has been constantly increasing over the years, it may not be adequate to sustain the proposed research programmes outlined in this document. There will be a need for mobilizing additional resources from internal resource generation as well as external non-Governmental sources in order to adequately meet the demand of the research programmes. These resources will be mobilized by way of efficient management of the research farm, introduction of revolving fund schemes, charging for advisory services, selling technologies developed by the Institute, charging royalties/license fee on patented technologies and other innovations. The budgetary support will be supplemented by competitive grants from international programme like DFID, CPWF. The financial resources will also be mobilized from external funding agencies through consultancy and adhoc research grants from agencies, namely, MOWR, INCID, CBIP, DST, Ministry of Environment and Forest, Industry, Horticultural etc. Contract and collaborative research programmes and sponsored training programmes will be undertaken by ICAR-RCER to strengthen its financial resources. Resource generation status of the Complex during different Plan periods is given in Table 7.

Table 7 Resource generation (Rs. in Lakhs)

IX Plan (2001-02 only)	X Plan (2002-07)	XI Plan (Projected)
21.50	154.90	280.00

Since the Complex is new and its budget requirements are higher, the QRT recommends that the budget allocation for the complex for the XIth Plan may be enhanced by 40 per cent over the budget allocation for the Xth Plan to develop its infrastructural facilities and to furnish the laboratories. The XI Plan EFC Memo of the Complex is under preparation and we understand that it will reflect the observations and recommendations of the QRT for enhanced budget allocation.

CHAPTER – 9

EXECUTIVE SUMMARY AND RECOMMENDATIONS OF QRT

EXECUTIVE SUMMARY

The Director General, Indian Council of Agricultural Research constituted the QRT vide F.No.18-8/05-IA.II dated 26.04.2006 to review the work of ICAR Research Complex for Eastern Region, Patna and its Research Centers with Dr. S. M. Virmani, former International Scientist, ICRISAT and Ex-Foreign Secretary, NAAS as Chairman. The other members of the QRT are: Prof. M.S.Gill, Project Director, Project Directorate for Cropping System Research (ICAR), Modipuram, Meerut; Dr. Dinesh K. Marothia, Prof. & Theme Leader (CNRM), KIIT School of Rural Management, KIIT University, Bhubaneshwar; Dr. R.M. Pandey, Ex-Director, IIHR, E-29-, DDA (MIG) Flats, Mayapuri, New Delhi; Dr. S.H.Ahmad, Ex-Dean (Fy.), RAU, 405, Saket Enclave, Khajepura, Bailey Road, Patna; Dr.A.P.Mishra, Dean (Agril. Engg.), Rajendra Agricultural University, Samastipur, Pusa; Dr. R. K. Batta, Pr. Scientist & Head, LWEERP, ICAR Research Complex for Eastern Region, Patna, as Member-Secretary.

The QRT held its first preliminary meeting with Deputy Director General (NRM) on August 8, 2006 at New Delhi. The meeting was held to chalk out modalities for conducting further meetings of QRT. As an essential requirement for the QRT, a document on Background Information on ICAR-RCER for the period 2001-2005 was prepared by Dr. R.K. Batta and Dr. A.K. Sikka. It was presented to the Chairman, QRT and the DDG (NRM).

Dr. Virmani proposed that the QRT may visit Ranchi, Pusa and Darbhanga apart from holding meetings at Patna. It was felt that it may not be necessary for all the QRT members to visit all the centers. A small group of 2-3 QRT members may visit the respective centres depending upon the specialization of the QRT members. Accordingly the QRT held four meetings at Patna, Ranchi, Pusa and Darbhanga respectively between the period from October 2006 to March 2007 wherein the respective Head of Programmes at the centres made presentations for their work for the period 2001 to 2005. At all the centres the QRT held interaction meetings with the scientists, it visited field operational areas, farms and laboratories and held interactive meetings with the farmers, partner organizations and NGOs operating in the regions.

The QRT had its final meeting at Patna wherein all the QRT members were present collectively. The QRT interacted with the scientists of the institute in a scientists-QRT interface meeting wherein the QRT members made Programmes-specific presentations on the proposed recommendations to obtain feedback. The inputs of the interaction meeting were incorporated in the final recommendations. The recommendations of the QRT report is as follows:-

I ADMINISTRATIVE

- **CONTINUATION OF ICAR RESEARCH COMPLEX FOR EASTERN REGION, PATNA**

The QRT strongly feels that the newly established ICAR-RCER (in 2001) has done commendable work during the last five years despite its skeletal staff strength. The complex has made its presence felt in the Eastern Region through its various research and development programmes and out-reach activities. The expectations of the state departments and other agencies from the Complex have increased. The QRT, therefore, recommends the continuation of the ICAR Research Complex for Eastern Region, Patna on a permanent basis. Since the Complex is a broadbased, multicommodity, multidisciplinary institute and its jurisdiction comprises of seven states of the Eastern Region, its mandate is large. Therefore, the QRT recommends that the status of ICAR-RCER may be expanded and the position of Director, ICAR-RCER, Patna may be upgraded to a higher level and an additional position of Joint Director (Research) be created at ICAR-RCER.

- **MANPOWER INADEQUACY**

The QRT has observed that due to a large number of positions being vacant at the Complex, manpower inadequacy at all levels has been a major bottleneck for effective and efficient implementation of research programmes. As per ICAR norms of 1:1.5:0.75:1 of Scientific, Technical, Administrative and Supporting Staff, with the present level of 93 sanctioned post of Scientists, there is shortfall of 68, 31 and 22 posts respectively in Technical, Administrative and Supporting grades. The requirement of Administrative and Supporting grade staff is being met by Contractual Services to a certain extent. However, the inadequacy of Technical Personnel cannot be solved by short-term contractual services, these requirement of job being subject-specific. Further in set-up like that of HARP, Ranchi where size of farm is large (586 acres) and it is located in five different places, there is a necessity of working with need based Technical positions for meaningful utilization of the research resources. In this event it is proposed that the additional positions are provided and till then need-based hiring of services of Technical persons through RA/SRF/JRF may be allowed on term-basis to address this critical gap and to meet research needs. Policy support in this respect will be required.

- **FUNCTIONING OF THE SRC, RAC, IMC, GRIEVANCE CELL AND INSTITUTE JOINT STAFF COUNCILTRAINING**

After examining the proceedings of the SRC, RAC, IMC and Institute Joint Staff Council, the QRT expressed its satisfaction over the functioning of these committees. The Committee noted with satisfaction that their meetings were held regularly, proceedings issued and follow-up action taken in-time.

- **NEW PROGRAMME**

The Complex will have a full fledged new Network and Consortia Programme with the objective of providing research & developmental support to (i) Integration of System Research, (ii) Policy Issues, (iii) Service Delivery System (iv) Public Private Partnership & (v) Agri-Business & Agro based Development Industry. This programme will undertake research, development & consultancy assignments in all emerging areas of Agriculture & Food science covering cereals, oilseeds, pulses, fruits & vegetables, aromatic & medicinal plans, aquaculture products, livestock, water productivity, seeds production, agri-mechanization etc. The unit will have multi-disciplinary personnel. Separate provision of Rs. 2.0 crores needs to be made in the budget estimate of XI Five Year Plan for this Programme.

In order to expand the institute base in the proposed mandated area and to facilitate network research, it is proposed to establish small field units in the ICAR institutes/SAUs in the eastern region.

- **CROP RESEARCH PROGRAMME TO FUNCTION FROM HEADQUARTERS**

The Crop Research Programme, Pusa, a constituent programme of ICAR-RCER has been merged with Regional Centre, IARI, Pusa vide ICAR letter No.18-1/07-IA dated 08.03.07 with assets and part allocation of staff. The QRT feels that since research on crops is one of the major thrust areas of the Complex, the QRT recommends that the Crop Research Programme may function from Patna with the transferred staff and scientific support of other programmes of the Complex. The QRT further recommends that the programme may be strengthened.

II FINANCIAL

Since the Complex is new and it has recently shifted into new building, its budget requirements will be higher, the QRT recommends that the budget allocation for the complex for the XIth Plan may be enhanced by 40% over the budget allocation for the Xth Plan to develop its infrastructure facilities adequately and to furnish the laboratories for efficient working.

III EXTENSION

- **RELATIONSHIP/COLLABORATION WITH ICAR INSTITUTES, SAUs AND OTHER STAKEHOLDERS**

A well established network of All India Coordinated Research Project on cropping system under the aegis of Project Directorate for Cropping System Research (PDCSR) is in position covering all the 7 Eastern States viz., Bihar, Jharkhand, Chhatisgarh, Assam, West Bengal, Orissa and Eastern U.P. A complete package with reference to crop diversification and intensification, integrated nutrient management to enhance input-use efficiency and soil health, sustainable production system by identifying the non-sustainable key factor, development of site specific nutrient

management studies to break the yield barrier and organic packages for the high value intensive cropping systems have been developed. The research technologies developed by different centres in above quoted states can be utilized for their dissemination among the rural masses and for scientific use. The QRT recommends that the representatives of PDCSR should participate in the Annual Workshops/meeting of the Complex and contribute/include their ideas while framing the technical programme for the Eastern States. It will save resources, time, scientific manpower and also avoid duplication of efforts.

- **COMMERCIALIZATION OF DEVELOPED TECHNOLOGIES**

In order to upscale and commercialize the technologies emanating from its various constituent programmes of the ICAR-RCER, the QRT recommends the constitution of following three committees.

Committee on Public-Private Partnership on aquatic systems

Director, ICAR-RCER, Patna	Chairman
Dr. D.K. Marothia	Member
Dr. S.S. Ahmad	Member
A prominant NGO	Member
Representative of	Member
Bihar Industuries Association and	Member Secretary
Confederation of Indian Industries	

The Committee will have the mandate to foster Public-Private Partnership in respect of *Makhana* and other aquatic crops and fisheries, horticultural crops (e.g. litchi) and intensification of *rabi* maize/pulses and oilseeds.

Committee on Tobacco

Vice Chancellor, RAU, Pusa	Chairman
Director, PDCSR, Modipuram	Member
Dr. D.K. Marothia	Member
Director, CTRI, Rajahmundry	Member
Head, IARI Regional Centre Pusa	Member-Secretary

The committee will have the mandate of strengthening the research on Tobacco and tobacco related system particularly its seed availability

Committee on Special Agricultural Zones (SAZ's)

The QRT suggests that the Complex has developed technologies that can be commercially exploited by developing the concept of Special Agricultural Zones (patterned after the SEZ's) for the production of litchi, *makhana* and maize crop (for bioenergy). The Committee for this purpose will have to be developed suitably.

IV INFRASTRUCTURAL

- Since the Complex has shifted to its new building in January 2007, the building needs to be furnished with procurement of adequate furniture. The old furniture available with the Complex may have to be replaced with new furniture in a phased manner. The QRT recommends that adequate provision may be made in the XI Plan budget for this purpose.

- The Complex library needs to be strengthened by the procurement of books and journals. In order to make use of information technology, the library may subscribe to new online/e-journals.

V SCIENTIFIC RECOMMENDATIONS

The QRT has made following programme specific recommendations:-

V.1 LAND, WATER, ENVIRONMENT AND ENGINEERING RESEARCH PROGRAMME (LWEERP), PATNA

1. The land and water resources of the eastern states have been inventorized and appraised for recommending sustainable land use. **The QRT recommends that :**

   - **All the soil, climatic, and water-related data-bases be put in GIS -environment in a user friendly format so that these can be accessed by all the scientists/development departments interested in efficient use of land and water on a sustainable basis for the mandated areas of the Complex.**

   - **That the AEZ maps produced by NBSSLUP for the eastern region should be harmonized with the natural resources map produced by NRSA. The watersheds/ catchments and water storage bodies should be plotted in georeferenced maps. Cadestral maps may be used as base maps.**

2. Several models of Integrated land and water management for varying land - use systems have been developed and tested. **The QRT recommends that:**

   - **All the models like OPTALL or SWAP should be operationally used in cooperation with irrigation / agriculture departments of the cooperating/mandated states, so that the field testing is completed in the next few years.**

   - **Operational scale watersheds for the development of rainfed farming areas in the mandated states of the Complex may be taken up under the Rainfed Development Programs so that the productivity of the rainfed areas is increased in a sustainable manner.**

3. Attempts have been made to develop Low Energy Water Application (LEWA) device, micro- irrigation in integration with fertigation for efficient use of available water resources and nutrient. **The QRT recommends that:**

- **The industries should be encouraged that these devices are commercially produced and their availability is ensured to farmers.**

- **Also after sales, repair and maintenance of these devices should be ensured to facilitate their continued good performance.**

4. Conceptual models have been developed for multiple use of water resources for agri-horti-aquaculture system in different ecological zones of eastern region. **The QRT recommends that:**

- **Studies on integrated farming system including crops, vegetables, fruits, animal and fish may be undertaken at the farmers' field in different Agro-eco region or different categories of farmers including small and marginal farmers.**

5. Resource Conservation Technologies like zero tillage, raised bed cultivation and suitable mechanization have been tested for economic production of crops, vegetables and fruits. **The QRT recommends that:**

- **Local entrepreneurs in different agro-eco zones be encouraged for production and popularization of low cost RCT related machinery through public private partnerships.**

- **The farmers may be trained for the use and maintenance of these equipments and machinery.**

6. Land and Water Management technology developed needs to be upscaled in the different Agro-eco regions' of eastern region. **The QRT recommends that:**

- **It could be achieved through networking & consortia approach by involving different SAU's/GO's/NGO's and ICAR institute for avoiding duplication and ensuring optimized use of resources.**

7. There has been a relatively low level of conjunctive use of ground water for exploitation of grey areas in the Eastern Region. There have been problems of groundwater pollution particularly Arsenic, fluoride, nitrate and heavy metal concentration in ground water in the eastern region. **The QRT recommends that:**

- **Studies on ground water quality and their effect on crop, animal and human health may be initiated.**
- **Models for conjunctive use of surface and ground water may be developed to minimize dependence of canal water and to ensure timely availability of water during canal 'off' periods and to ensure timely sowing of crops.**

8. The Complex has explored the possibility of managing flooded, flood prone and waterlogged areas by suggesting alternate cropping strategies. **The QRT recommends that:**

- **The Complex should develop farming system models including fisheries, aquaculture, *makhana* specific for tal, diara, chaur and mauns areas by using farming system approach.**

- **The Complex should have inter-institutional linkage with wetlands institutes operating in the region.**

9. The Complex has made a modest beginning in studies on climate change and its effects on water resources in selected basins. **The QRT recommends that:**

- **The Complex should strengthen these studies for long and short term effect of climate change on productivity of major crops of the different agro-eco regions through network and consortia approach.**
- **Since the environmental concerns are strong, more focused research on environment and related issues need to be undertaken.**
- **The Complex needs to develop decision support system for optimized use of land, water and environment resources.**

V.2 CROP RESEARCH PROGRAMME (CRP), PUSA

In Bihar, there are about 1.5 lakh tobacco growers and they are demanding new genotypes of tobacco crop enabling them to get high and quality produce. **The QRT recommends that:**

- **There is an urgent need to encourage the farmers to produce their own seed and the center should organize the short duration training courses (5 days) in a farmers' participatory mode at regular intervals. A nominal fee for this purpose may be charged.**
- **The tobacco processing is still being done by traditional methods. The center should develop/extend modern processing techniques.**
- **The technical staff of the Center may extend training facilities towards superior cultivation and processing of tobacco.**
- **There is urgent need to explore the possibilities of drip irrigation in tobacco crop.**
- **The center should undertake analysis work of plant and soil of different experiments to make an assessment of the nutritional requirementof the crop.**
- **During the interaction meeting with the farmers, the QRT strongly felt the farmers' sentiments who insisted that Wheat Research Station, IARI, Pusa with whom the CRP is being merged should continue the production of tobacco seed in particular**

and seed of pulses and oilseeds in general so that farmers' may not suffer any hardship. The center may look into this aspect favorably.

- **Since the Center has been dissociated from this Institute, it is suggested that the tobacco related proposed technical programme for the next 5 years should be passed on to the Wheat Research Station, IARI, Pusa.**
- **The Center could fulfill its mandate to the extent of 30 per cent on account of the paucity of scientific staff, only tobacco cultivation research programme was undertaken. The other important aspect w.r.t. pulses and oilseed. Development work related to improved cultivars and production, and protection technology was partially attempted.**

V.3 HORTICULTURE AND AGRO-FORESTRY RESEARCH PROGRAMME (HARP), RANCHI

1. **Genetic Plant Resource Management in horticultural crops**: Genetic resource management is the most important aspect for increasing the productivity of different horticultural crops. Research efforts carried out at the centre on this aspect has resulted in identification/development of superior genotypes of different fruits and vegetable crops. A total of 2958 germplasm lines including fruits (771), vegetables (1836) and ornamental plants (351) have been collected and are being characterized, evaluated and used in breeding programme to develop high yielding varieties resistant to biotic and abiotic stresses. 33 different varieties of horticultural crops have been developed which are gaining popularity for their special attributes including high yield, better quality, disease and pest resistance etc. **The QRT recommends that:**

- **In the wake of increased importance of elite germplasm in post-WTO era, work on survey, collection, introduction and documentation of germplasm both from local and exotic sources should be further intensified. All germplasm should be registered with NBPGR.**
- **High water requirement of horticultural crops coupled with the low availability of irrigation water is contributing significantly towards low rate of area expansion of horticultural crops in the plateau and hills of eastern India. Development of varieties having drought tolerance and water use efficient traits can help in rapid spread of horticultural crops in drier regions of eastern India.**

2 **Production Technology of Horticultural Crops:** High density planting in mango, litchi and guava have been standardized at the Center. Nutrient requirements in these crops have also been worked out. Effect of soil amelioration on crop production has been demonstrated. Multi-tier tree based production system has been standardized. **The QRT recommends that:**

- **Effective nutrient management, pest management, canopy management, floor management hold the key for quality production of horticultural crops. There is a need to work also on fertigation and water management in important fruit crops.**
- **Research on organic farming particularly for vegetable production may be started.**

- **Research on protected cultivation in case of high value vegetable and flower crops may also be started.**

- **Nursery should be further modernized and more genuine and elite planting material should be propogated. More and more vegetables & flower seeds to be produced and made available to the farmers.**

3 **Agro-forestry Research :** Agro-forestry is a new component in the programme. Presently several MPTs are being evaluated for growth and their suitability in agro-forestry. The **QRT recommends that :**

- **To start with it is required that survey and documentation of existing agro-forestry practices in the region should be taken up.**
- **Generation of scientific data on fast growing MPTs and their suitability for developing different tree based production models are needed to cater the requirement of the region.**

4 **Basic and Strategies Research** : The Center has conducted basic studies in litchi cv. Shahi, promising criteria for prediction of intensity of panicle emergence under Chotanagpur plateau conditions and role of plant phenolics and oxidative enzymes in mechanism of host-resistance against powdery mildew in different pea genotypes has been understood. **The QRT recommends that :**

- **In view of decreasing land resources, it is imperative that in multi-tier tree based production system and in high density orchards, studies on root distribution pattern, infiltration of light in canopy, photosynthetic activity and translocation of photosynthates from source to sink should be conducted.**
- **Cause of mango decline in adult bearing stage in plateau region may be investigated from angle of soil fertility, water availability, disease and pest incidences etc.**
- **Studies on nutrient recycling and carbon sequestration in agri- horti-silvi production system be initiated.**
- **Development of forecasting tools and decision support system for different crop production processes in horticultural crops be commenced.**

5. **Popularization of Technology**: Efforts made for popularization of the technologies since last five years have resulted in wide spread adoption of the improved varieties developed at HARP in an area of about 4450 ha area. However, there is a need for strengthening of research efforts for efficient economic assessment of horticultural technologies. **The QRT recommends that :**

- **Public Private Partnership and Institutional networking should be attempted to popularize technology developed at the Centre namely, rejuvenation of old and**

senile orchards, high density orcharding, mushroom production, new high yield and disease resistance varieties, community nursery for vegetable production, soil amelioration and rain water harvesting.

- **On farm research and participatory technology assessment also requires to be addressed for faster technology dissemination.**

6 **Post Harvest Technology** : Inefficient post-harvest management is contributing towards 30% loss of different horticultural produce due their perishability nature. Standardization of technologies on efficient harvesting, handling, storage and value addition in different horticultural produce can largely address towards promotion of horticulture sector in eastern India and hence deserves immediate attention. Research effort on this important aspect is at its infancy at this Center. Hence there is an urgent need for initiation of research programme on this important aspect with sufficient manpower and infrastructure support. **The QRT recommends that :**

- **In order to minimize post harvest losses in horticulture crops, there is a need to start research on pre and post harvest management practices. Inter-institutional collaboration may be established in the aspect of value addition and processing.**

7 **Capacity Building** : Human resource development in key sectors hold promise for global competitiveness and in qualitative improvement. In the fast changing socio-political and economic situation, capacity building exercise required to be properly attempted. **The QRT recommends that :**

- **There is a need of training of Scientists in WTO, IPR, Information and Space Technology, Bioinformatics, ISO 9000, HACCP and related issues.**

8 **Removal of constraints:** The Center has expressed following bottlenecks in fulfilling the research requirements in the region. **The QRT recommends that :**

- **There is unavailability of scientific manpower in critical areas viz. Post Harvest Technology, Biotechnology, Plant Physiology, Soil and Water Engineering, Entomology, Floriculture, Animal Science and Fisheries which is a major hindrance in conducting multi disciplinary system research. Similarly there is inadequacy of scientific manpower in Soil Science, Social Science, Fruit Science, Plant Protection for conducting detail studies under different experiments. Hence, scientific manpower support is required to be adequately strengthened.**

- **Lack of infrastructure for farmers' training is limiting factor for farmers' capacity building. Thus there is a need to set up a Farmers Training Center with needed facilities.**

- **Shortage of supporting and technical manpower and inadequate transportation facility is also limiting effective management of the five experimental farms situated at distant locations. This adequate Technical manpower support at middle and lower levels are also required.**

V.4 SOCIO-ECONOMIC AND EXTENSION RESEARCH PROGRAMME (SEERP), PATNA

Socio-economic and technological status of farmers' of eastern region has been documented using published data sources. **The QRT recommends that:**

- **Mapping of socio-economic and technological profile of farmers of eastern region: This study can be carried out involving ICAR, SAU's, NGO and other institutions working in eastern region. All published/ available documents pertaining to socio-economic profile with other institutions may be obtained and additional information may be generated through series of PRAs.**

2. Socio-economic evaluation and impact assessment of the agricultural technologies developed by the institute is in process. **The QRT recommends that:**

- **Impact assessment of the technologies transferred in the eastern region in networking mode with SAUs, other ICAR institutes, NGOs and CGIAR centres can be undertaken.**

3. Institutional arrangements for efficient working of WUAs have been developed. **The QRT recommends that**:

- **Institutional arrangements for sustainable use of tanks/tube wells may be designed in command area using the scientists understanding of WUAs exercise.**

4. SEERP has so far carried out a few studies on common pool resources which form the basic life support system for the millions of poor. **The QRT recommends that**:

- **To assess status, contribution, total economic valuation (monetary and non monetary values) and existing governance structures of common pool resources in the sub zones of eastern India (NTFPs, Freshwater Aquaculture, Bio-diversity resources, land and water resources)**

5. Scientists of SEERP need exposure to the current analytical framework to understand the complex research issues of Eastern India.**The QRT recommends that**:

- **Scientists may be given opportunity to participate in capacity building workshops to relate the recent concepts with Eastern India problems.**

- **To work out the gender budgeting in relation to agricultural technology transformation and other livelihood activities.**

- **To study the implications of human and livestock migration and understand the conditions confronted by migrants population during migration period**.

V.5 LIVESTOCK AND FISHERY IMPROVEMENT MANAGEMENT PROGRAMME (LFIMP), PATNA

1 Livestock and poultry (including Quail and Duck) improvement and production

The eastern region contributes significantly in milk, meat, egg, chicken and fish production supporting 33% of country's population and covering 22% of total geographical area. However, the low productivity in the region resulting in poor economic returns. Livestock and poultry play an important role in livelihood support and employment generation in rural population specially for landless, marginal, small and medium farming community. Whereas, for large farmers it is an enterprise for high income in agricultural production system. **The QRT recommends that**:

- **Development and evaluation of livestock based farming as an enterprise, suitable to socio-economic condition and agro-ecological climate of eastern region.**
- **Livestock component research comprising breeding, feeding, healthcare and management is needed based on problems and constraints faced in integrated farming system models with livestock as a component.**
- **To document the diversity of livestock and poultry from secondary data to improve genetic potential and productivity.**
- **Development and assessment of livestock production technology to produce hygienic and clean milk, meat and eggs for security and safety of consumers, considering the present era of market competitions and training programme for farmers is needed.**

2 Fisheries improvement and production

Bihar a landlocked state of India possesses only freshwater resources and that too is partially tapped. Main constraint is that most of the farmers lack technical knowledge of modern scientific techniques of aquaculture. Therefore, **the QRT recommends that**:

- **Training programme on various aspects of aquaculture should be arranged by this institute for benefits of pisciculturist, private enterprises and NGO's. Refresher courses should also be arranged for trainers extension officers at this Center.**

Majority of Indian fish farmers are stuck up either with major carp training or with major carp based composite training. These systems once profitable, over years, become disadvantageous to farmers. Overall increase in major carp production has had the effect of lessening down market prices of major carps to an unviable level. In this situation, it is now imperative to identify and introduce an alternative system that would fetch viable return to farmers. In this context, training of giant fresh water prawn, *Macrobrachium rosenbergi* should be taken by this institute on priority basis. **The QRT recommends that:**

- Integration of several system of food production such as paddy, *Makhana*, duckery has proven to be beneficial to farmer by this institute. Integrated farming system, as it is known, enable utilization of water resources and recycling of wastes in a beneficial way therefore new animals such as goat, pig, poultry be introduced in this system and the technology is standardized.

V.6 RESEARCH CENTRE ON *MAKHANA* (RCM), DARBHANGA

The QRT recommends that:

- **The status on *Makhana* cultivation should be thoroughly documented including all aspects of its cultivation in collaboration with the other institutions like RAU, Pusa. The review of earlier work on *Makhana* cultivation should be documented.**

- **The work on survey, collection, introduction, cataloguing and exchange of germplasm and their characteristics using molecular techniques should be strengthened.**

- **There is a need for breeding varieties of *Makhana* for high yield potential, resistant to biotic and abiotic stresses and having good quality for processing and export.**

- **Expansion of the mandate of *Makhana* Center by including other economic crops like *"Singhara"* (Water chestnut), Lotus (*Kamalgatta*) and *Khobhi* (*Scirpus articulatus*);**

- **There is a need to develop complete package of practices for the shallow water and deep water bodies under different ecosystems for *Makhana* cultivation.**

- **There is a need to develop and to standardize appropriate harvesting and post harvesting techniques of growing, packaging and storage of *Makhana*.**

- **The QRT further recommends that a study of the integration of *Makhana* with Singhara, Fish and also with other aqua crops be taken up on priority and training programmes for farmers be conducted from time to time.**

PART –II
Appendices and Supplementary Material

APPENDIX – 1

PROCEEDINGS OF THE QRT MEETINGS AND FIELD VISITS

PROCEEDINGS OF THE PRELIMINARY MEETING OF QRT, ICAR-RCER WITH DDG (NRM) AT NEW DELHI AUG. 08, 2006

The following were present:

1. Dr. J. S. Samra, Dy. Director General (NRM), ICAR, New Delhi
2. Dr. S. M. Virmani, Chairman, QRT, ICAR-RCER
3. Dr. A. K. Sikka, Director, ICAR-RCER
4. Dr. P. S. Minhas, Asstt. Director General (IWM), ICAR, New Delhi
5. Dr. R. K. Batta, Member-Secretary, QRT, ICAR-RCER

The Meeting was held to chalk out modalities for the conducting further meetings of QRT. As an essential requirement for the QRT, a document on Background Information on ICAR-RCER for the period 2001-2005 prepared by Dr. R.K. Batta and Dr. A.K. Sikka was presented to the DDG (NRM) and Chairman, QRT.

For apprising the Chairman, QRT about ICAR-RCER, Dr. J.S. Samra gave an introduction about the genesis of ICAR-RCER by merger of Directorate of Water Management Research and Regional Station, Pusa of CTRI and CHES, Ranchi of IIHR in 2001. Dr. Samra outlined the difficulties faced by ICAR-RCER ever since inception since the sanctioned staff strength originally envisaged to be met by redeployment was not met out and the Complex is still facing accurate shortage of Scientists for its new Programmes. For example at present only 1 Fisheries scientist and 3 Animal Science scientists are in position in Livestock & Fisheries Improvement Programme. The research work is suffering for want of adequate manpower.

Dr. Samra outlined the constraints of eastern region, a low productivity and high-potential region. Dr. Samra opined that Natural Resource Management is the key to enhance agricultural production on sustainable basis and to preserve the quality of natural resources. Dr. Samra emphasized that the rice cultivation in the Eastern India is to be replaced by Farming System Approach to increase resource productivity and income enhancement. Rice cultivation may be integrated with rice-fish farming. Since the Complex was originally a water-focused national institute, it is to be seen whether the present water management projects are addressing the problems of eastern region. Further, the region needs adoption of diversification in an aggressive mode. There is a strong possibility of replacing wheat with winter maize whose productivity in Bihar is highest in the country. Since the Complex is to play the role of a nodal research institute in the Eastern Region, networking of the research is needed for which provision has to be made in the budget. There has to be a complementarity between the Complex and SAU's in the region since the SAU's have less funds and adequate manpower whereas the Complex has less manpower and adequate funds. Since the Eastern Region has abundant seasonal water bodies particularly in north Bihar, their potential has to be utilized by enhancing the aquatic productivity for livelihood improvement. Also since the eastern region is also frequented by seasonal floods/and droughts, its needs strategies anticipatory

crop planning for mitigating the damage. For this purpose the major constraints is the nonavailability of the quality seeds. Other possible improvements needed are the promotion of agro-processing and value addition industries and promotion of ground water market in the nonconsolidated small holdings.

Dr. S.M. Virmani, Chairman, QRT thanked the ICAR for giving him an opportunity to review the work of ICAR-RCER. Responding to Dr. Samra's remarks, Dr. Virmani opined that the Eastern Region is a misused/underused region where people are hardworking but the local conditions are not conductive. It is essential, therefore, to increase per unit land and water productivity. There is a potential to increase land productivity of rice in uplands up to 3 t/ha as per a recent publication of IRRI. For nonconsolidated small holdings, productivity can be increased by arranging water through water markets by ground water exploitation. There is a need to use Agro-eco region and Length of Growing Season maps of the eastern region. It is also desirable to superimpose district boundaries on the eastern region Agro-eco maps prepared by NBSSLUP, Nagpur for their use for development purpose. It is also necessary to use the harmonised data sets of NRSA and NBSS&LUP for the eastern region for enhancing the productivity of natural resources.

Dr. A.K. Sikka, Director and Dr. R.K. Batta, Member-Secretary interacted during the meeting and provided input to the queries of the Chairman, QRT and offered valuable suggestion for further review by the QRT.

Dr. Virmani proposed that the QRT may visit Ranchi, Pusa and Darbhanga apart from meetings at Patna for which the detailed programme will be developed. Dr. Virmani has tentatively fixed first fortnight of October, 2006 for first Meeting of the QRT at Patna. Consequent to the Meeting, the Background Information Document was mailed by Member-Secretary to all QRT members for their perusal and interaction.

The meeting came to close with vote of thanks to the Chair by Dr. R.K. Batta, Member-Secretary.

(R. K. Batta)
Member-Secretary, QRT

REPORT OF THE FIELD VISIT OF QRT, ICAR – RCER, PATNA TO FIELD AREAS IN PATNA MAIN CANAL COMMAND UNDER SONE COMMAND, BIHAR

The QRT visited farmers' field in district Patna on 04.10.2006 along with scientists of the institute to review the farmers' participatory research work in resource conservation technologies under USAID/IFAD projects & Multiple uses of water. Following QRT members and Scientists participated in the visit;

1. Dr. S.M. Virmani, Chiarman QRT
2. Dr. R. M. Pandey, Member QRT
3. Dr. A. P. Mishra, Member QRT
4. Dr. M.S. Gill, Member QRT
5. Dr. A. R. Khan, Principal Scientist & P.I. (USAID/IFAD Projects)
6. Dr. S.S.Singh, Senior Scientist & Ex- RWC-CIMMYT Research Scientist
7. Dr. R. K. Batta, Member Secretary

The QRT visited village site – Taret and Pali village in block Naubatpur and village Tarwan and Aspura in block Bikram district Patna.

At village Taret adopted under USAID/IFAD Project the Team saw experimental plots under Zero Till Direct Seeded Rice and extra early pigeon pea (ICPL 88039) covered at large scale. The Team discussed with the Sri Munna Singh, Rakesh kumar & other farmers regarding benefits, constraints and adoption of resource conservation technologies. The QRT also interacted on intervention of *Sesbania* co-culture with rice and use of Leaf Colour Chart (LCC) for N management in rice, which are being promoted under the project. The farmers narrated their experiences about different RCTs like zero till wheat in different modes viz. surface seeded wheat and the intervention of growing maize + potato for crop diversification etc. during rabi season. Sri Rakesh Kumar, a farmer of nearby village Chesi briefed the QRT about adoption of RCTs and tuber crop cultivation in his village through RCT – NATP project of institute.

At village Pali, the activities are being carried out under USAID/IFAD project. The team interacted with the farmers namely Sri Awadesh Sharma and Bade Narayan Upadhyaya who showed zero till direct seeded rice and explained about the benefits of resource saving in puddling, irrigation, transplanting, nursery raising etc. The farmers informed that the area is mainly under wheat cultivation during Rabi season and due to excess moisture, sowing of wheat is normally delayed. The zero till has been found to be a boon for this village and farmers are in the process of purchasing Zero Till Drills.

At village Tarwan, the QRT met farmers Sri Manoj Singh and Anoj Singh. The village is located in tail reach of canal where water availability is less and there are more tubewells. The land consolidation has also been done in this village, which is a rare case in Bihar. The village had started adopting RCT since 2001 under RCTs – NATP Project of the institute. These farmers also work as service providers for zero tillage operation in 6 – 7 villages in the locality. Zero Till wheat, lentil and gram have been adopted in the village. Double Zero Till (rice – wheat system)

is also practiced in the village. Currently the technical help and machine support is given through USAID/IFAD projects. Four to five farmers are also in process of purchasing the Zero Till Drill.

In village Aspura, the QRT met Sri Chandrama Singh who informed that the village is located in head reach of canal and there are very few number of tubewells in the village. It was informed that he works as facilitator for zero tillage technology without having any machine or tractor. In this village various interventions have been carried out under various projects like NATP, DFID, TAP and USAID viz. deep tillage, zero tillage, canal water control through wooden gate, rice – fish farming, integrated farming system, rice nursery solarization, banana cultivation for crop diversification, LEWA in rice and multiple use of water for fish-horti-agri system. The QRT was very much impressed with the Sri Suresh Singh, a small farmer, who is practicing fish – horticulture – agriculture system using canal water seepage as resource and earning income same from 1/8 acre land as compared to one acre normal rice – wheat system. Sri Chandrama Singh informed that by different activities involving Integrated Farming System like dairy, poultry, cropping and rice – fish system, he is able to manage his family from 5 acres land to a respectful status. The team was very much impressed with the farmer.

PROCEEDINGS OF THE MEETING OF QRT OF ICAR RESEARCH COMPLEX FOR EASTERN REGION, PATNA HELD AT HARP, RANCHI FEBRUARY 26-27, 2007

A meeting of QRT, ICAR-RCER was organized at HARP, Ranchi on 26 to 27 February 2007 to review the progress of HARP, Ranchi for the period 2001-05. The following were present:-

Dr. R.M. Pandey-Member, QRT-In Chair
Dr. S.H. Ahmed-Member, QRT
Dr. D.K. Marothia- Member, QRT
Dr. M.S. Gill- Member, QRT
Dr. R.K. Batta-Member Secretary, QRT

The following were special invitees to the meeting:-

Dr. S. Kumar, Head, HARP, Ranchi
Dr. Bangali Baboo, Director, ILRI, Ranchi
Dr. B.N. Singh, Director Research, Birsa Agricultural University, Ranchi
Dr. J.B. Tomar, OIC, NBPGR Base Centre, Ranchi
Dr. G.N. Mishra, Head, CRURRS, Hazaribag
Sh. B. Uday Bhaskar, Manager, NABARD, Ranchi
Dr. Ram Kumar, SRO, CTR&TI, Ranchi
Dr. J.P. Sharma, Senior Scientist, HARP, Ranchi
Dr. P.R. Bhatnagar, Senior Scientist, HARP, Ranchi
Dr. Pradip Dey, Senior Scientist, HARP, Ranchi
Dr. A.K. Singh, Senior Scientist, HARP, Ranchi
Dr. R.S. Pan, Senior Scientist, HARP, Ranchi
Sh. I. Tirkey, Scientist (SS), HARP, Ranchi
Dr. Bikash Das, Scientist (SS), HARP, Ranchi
Dr. B.R. Jana, Scientist, HARP, Ranchi

The QRT had an interactive Session with Farmers, NGOs, Research Organizations and Financial Institutions to discuss the issues for all round development of eastern region in general and Jharkhand in particular. Twenty representatives from leading NGOs including R. K. Mission and 20 farmers attended the Interactive Session in the morning Session. It was felt that following aspects are necessary for all round development:

- Emphasis of research on waste land and water
- Supply of quality seeds and planting materials
- Creation of Groups for Water Market: Forest Department, Water Conservation Department, Birsa Agricultural University, Horticulture & Agro Forestry Research Programme should jointly form a technical support Group.
- Convergence of schemes of Rural Development, NREGS and linkages with training programme of NABARD.

The interactive session was followed by technical sessions in the afternoon. Head, HARP, Ranchi presented the overview of research work done at the Station during last five years (2001 to 2006) before the QRT. The Scientists of HARP made detailed presentations along with future research strategies. Every presentation was followed by a detailed discussion and different suggestions were put forth by the Honourable Members of QRT. Following research and HRD issues were emphasized:

Research issues

- Integration of ongoing research with plant physiology
- Research on soil fertility and water management needs more emphasis
- Farmers involvement for MPTs selection
- Focus on farming system research
- Focus on farming system
- Return on investment needs to be calculated
- Farmers' response through series of PRA exercise after every season should be taken up
- Medicinal & Aromatic plants needs to be incorporated in multi-tier system
- Studies on draught resistance varieties on vegetable crops
- High density orchard should also include studies on root distribution, photosynthetic efficiency and stomata density
- Spore-less mushroom production technology to be standardized
- Impact assessment of technology generated need to be taken up

HRD issues:

The need for the following training programmes was felt essential by the QRT:

- Training of Scientists in the areas of IPR, ISO and other aspects related to world trade
- Training of Scientists in the frontier areas of GIS and remote sensing.

Field Visit

The QRT visited the on-station trials at three farms and nursery of HARP on February 27, 2007 in which different projects were shown to the QRT members. After the visit, the QRT made following observations:-

- The members appreciated the level of field resistance of pea genotypes to the incidence of powdery mildew. The members suggested widening the acceptability of snow pea in eastern India keeping in view its potential as source of food fibre.

- The QRT felt the need to assess the age limit for successful rejuvenation of old and senile mango plants.
- The QRT visited the experiments on development of toposequential water harvesting structures and appreciated the work done in this aspect. The members expressed their concern about social feasibility of the intervention in the farmers' field conditions including stakeholder's right on the profit. The economics of the water harvesting intervention was discussed.

The QRT expressed their satisfaction on overall management of farms and the on going experiments.

The meeting ended with a vote of thanks by Dr. R.K. Batta, Member Secretary, QRT.

PROCEEDINGS OF MEETING OF QRT OF CROP RESEARCH PROGRAMME AT PUSA (SAMASTIPUR) MARCH 15-16, 2007

The following were present:-

Dr. R. M. Pandey, Ex-Director, IIHR, Bangalore	-	Member in Chair
Dr. A. P. Mishra, Vice Chancellor, RAU, Pusa	-	Member
Dr. Dinesh Marothia, Ex-dean, RAU, Raipur	-	Member
Dr. R. K. Batta, Principal Scientist	-	Member Secretary

1. Visit to on-station trials at CRP, Pusa:

QRT visited on-station trials at CRP, Pusa, on 15.3.2007 and discussed the ongoing research projects, and gave spot suggestions. The Committee also discussed the outcomes of concluded projects during the reporting period in particular. The Committee saw the following ongoing projects

- Studies on cropping systems with emphasis on crop diversification for irrigated upland including, studies on pre-*rabi* pigeon pea based cropping systems; and studies on winter maize based diversified cropping systems.
- Long-term manurial trial on fallow-tobacco systems.
- Breeding varieties for high yield & quality in oilseeds, pulses and tobacco including Line x Tester analysis in chewing tobacco to evolve superior varieties for yield and quality; Initial varietal trial of chewing tobacco; and Initial varietal trial on hookah tobacco (*N. rustica*).
- Cultivars improvement programme in chewing tobacco.
- Germplasm collection, evaluation & maintenance of pulses, oilseed and tobacco including Evaluation and maintenance of germplasm of chewing tobacco; and Evaluation and maintenance of faba bean (*Vicia faba*).
- Seed production in agricultural crops and fisheries.

The QRT members expressed overall satisfaction on research trials; and good performance of standing crop under mega seed project. The performance of tobacco crops is excellent. The QRT raised questions about cultivation practices and area under the cultivation, seed replacement, package and practices and trade related activities which were answered to by the scientists.

2. Interaction meeting with farmers, NGOs, representative of partner research institution

The QRT has an interaction with farmers, NGOs, representatives of partners Research Institutions on expectations and fulfillment from CRP Pusa on 15th March, 2007. The following points emerged from the interaction.

- All the farmers/representative/NGOs inquired about the fate of release of new chewing tobacco varieties, availability of quality seed, agronomy practices and plant protection measures in view of merger of CRP with IARI since CRP (previously known as CTRS,

Pusa) was solely engaged in providing all the technical know how of tobacco cultivation to tobacco growers.

- After long interaction with partners, the QRT members expressed their deep concern to protect the interest of tobacco cultivators and also assured them of facilities as usual and that interests of tobacco growers will be protected
- Dr. S. Chawudhary, Head, Wheat Research Station, IARI, Pusa also promised the farmers to extend same facilities as extended by erstwhile CRP.
- Dr. A.P. Mishra, Vice Chancellor, RAU, Pusa has also emphasized the current needs of tobacco growers. Being a cash crop, the socio-economic health of the farmers is solely governed by performance of tobacco, particularly in six districts of North Bihar viz., Samastipur, Muzaffarpur, Madhubani, Vaishali, Purnea and Katihar.

3. Presentation of research results for the period 2001-2005 by scientists of CRP, Pusa and discussion:

The work carried out at CRP, Pusa during the period under review (2001-2005) was presented by Dr. R.D.Singh, Pr. Scientist (Agronomy), ICAR-RCER, Patna. During the presentation, the following issues were raised by QRT team.

- The QRT felt that the long term fertility trails on tobacco may be concluded after certain period of time say 40 years or so. Soil samples of the experimental field must be analyzed at a suitable interval to see the changes in soil fertility status particularly in respect to organic carbon content, other macro and micro nutrients as well.
- The QRT emphasized the need of replacement of tobacco crops in the view of government policies and health concern. Some alternate more remunerative crops viz. medicinal and aromatic plants (M & AP) etc. should be included in cropping sequence and popularized among the tobacco farmers and traders.

4. Visit to farmers' fields and demonstrations under CRP, Pusa:

On 16.03.2007, the QRT visited the fields of Sri Md. Mustaffa, a progressive farmer of village Baghauni - Tajpur (Samastipur) who was associated with tobacco cultivation and attached with CRP, Pusa since more than 35 years. He is the winner of best tobacco farmer award at national label. Sri Md. Mustaffa apprised the QRT that the technical know how provided by CRP, Pusa is a boon for tobacco growers, particularly intercropping technology. The farmers have abandoned monoculture of tobacco and are practicing intercropping of maize, garlic and Rajma as intercrops with tobacco as a main crop. The six varieties released by this centre are a great success and Pusa Tobacco -76 (PT-76) is a leading variety of this state and covers around 70 per cent of total acres under tobacco.

QRT also visited the tobacco fields of farmers and curing sheds were tobacco was being cured and also interacted with labourer engaged in curing. The QRT interacted with around 30 tobacco farmers who participated in the meeting. After the meeting, the QRT felt that:

- Farmers are very much concerned about release/availability of new chewing tobacco variety, since present variety (Lichchvi) was released in 2001 and new a variety is over due.
- The supply of quality seeds of released tobacco variety is also a matter of concern and the QRT suggested that to train the farmer in seed production. Trainings should be organized on regular basis on techniques of tobacco seed production and duration of these trainings may be vary from 5 to 7 days.
- An association of tobacco growers may be formed to tackle the problems related to tobacco right from cultivation to trade. As more than 1.5 lakh farmers are engaged in tobacco cultivation and more than 23,000 ha area is under tobacco cultivation.

The meeting ended with vote of thanks to the chair by Dr. R.K. Batta, Member Secretary, QRT.

REPORT OF THE FIELD VISIT OF QRT TO THE FARMERS' FIELD AND ON-FARM EXPERIMENTS OF RESEARCH CENTER FOR *MAKHANA*, DARBHANGA MARCH 18, 2007.

The QRT team members visited the farmers field and on farm experiments plots of the Research Center for *Makhana*, Derbhanga on 18 March 2007 from 9 a.m to 2 p.m. The QRT team visited Bela, Chuna Bhatti and Gausha Ghat villages. At Gausha Ghat village the Team visited few *Makhana* ponds of the village and had detailed discussion on the ponds of Sri Sheo Jee Shani, on whose ponds the experiments on maximization of production project is going on was conducted. Besides, the owner of the pond Sri Sheo Jee Sahni, other *makhana* growers viz. Suresh Sahni, Mahendra Sahni, Sheo Narayan Shani and Dilip Sahni were also present. The ORT members interacted with the participating farmers. Dr. B.K Jha highlighted the outcome of the one year experiments at the farmers' field. The total production in *Makhana* cum-fish integrated ponds gave significantly high returns to the farmers. The QRT members also enquired about the environment management, ecological and limnological aspects of the *Makhana* ponds. After visiting *Makhana* growing villages & ponds in Bela, Chuna Bhatti, Gausha Ghat the teas returned to ICAR-RCER, Patna in the afternoon.

In the afternoon/evening the team visited *Makhana* Processing Unit of M/s Shakti Sudha Industries at Patliputra Industries Estate Patna. The Team saw the procurement Center, Processing Center and *Makhana* Storing facilities of the unit. Mr. Satyajeet Kumar, M.D of the Unit, made a presentation on value adding and marketing on *makhana*.

APPENDIX – 2

EQUIPMENT COSTING MORE THAN RS.50000/-, PURCHASED DURING 2001-05

Sl. No.	Equipment	Qty.	Amount (Rs.)
	2001-02		
1.	Flow 32 Sap Flow Measurement System	1 No.	588,477.00
2.	GDC 932 AB Plus Atomic Absorption Spectrophotometer	1 No.	886,436.00
3.	Hydrolab MS4A MiniSonda Multiprobe System	1 set	1076,851.00
4.	Photosynthesis & Transpiration Measuring System	1 set	1314,522.00
5.	Penetro meter (EIJKELKAMP, Netherland make)	1 set	115,074.00
6.	Sampler Kit (EIJKELKAMP, Netherland make)	1 set	106,920.00
7.	Infitrometer set (EIJKELKAMP, Netherland make)	1 set	104,688.00
8.	Yanji Shakti 8 Row Rice Transplanter 22T-238	1 set	135,000.00
9.	Electronic Precision Balance alongwith weight & cable	1 set	61,820.00
10.	Hyudralic Conductivity Test Kit	1 set	118,999.00
11.	Plant Moisture System (Pressure Chamber) alongwith access.	1 set	209,376.00
12.	Air Compressor, C2H2 Two Stage Regulator & Exhaust Hood with SS Duct.	1 each	85,000.00
13.	Refrigerated Centrifuge (Model: MP400R) alongwith access.	1 set	148,390.00
14.	Shaping Machine (Model: PGS-600)	1 set	243,400.00
15.	Universal Milling Machine (Model: UM-4)	1 set	679.000.00
16.	Radial Drill Machine (Model: ER615)	1 set	658,579.00
17.	Guillotine Shearing Machine	1 set	410,400.00
18.	Philips LCD Multimedia Projector	1set	374,000.00
19.	Seed Germinator	1 No.	56,970.00
	2002-03		
20.	Nikon Digital Coolpix Camera (E-995)	1 set	86,735.00
21.	Planix 10S Electronic Digital Planimeter	1 No.	77,000.00
22.	Digital Video Camera (Model: DCR-VX 2000E)	1 set	198,000.00
23.	35mm AF SLR Camera	1 No.	60,555.00
24.	Double Beam UV-VIS Spectrometer	1 No.	212,100.00
	2003-04		
25.	Unidata Ultrasonic Doppler Flow Meter	1 No.	88,166.00
26.	Rotavetor	1 No.	72,538.00
27.	Line Quantum Sensor	1 No.	176,407.00
28.	HR 33T-R Thermocouple Psychrometer	1 No.	289,919.00
29.	Single Point Theta Probe with access.	1 set	100,903.00
30.	Chlorophyll Content Meter with access.	1 set	122,768.00
31.	Complete Minimate System	1 set	508,563.00
32.	Electronic Balance	1 No.	70,660.00
33.	Philips ‘e’ Clear LCD Projector (Model: LC 4746)	1 set	267,246.00
34.	Leaf Area Meter	1 set	413,393.00
35.	Philips ‘e’ Clear LCD Projector (Model: LC 4746)	1 set	267,246.00
36.	Complete Weather System	1 set	514,576.00
	2004-05		
37.	Double Beam Scanning UV-VIS Spectrophotometer (Model: UV-	01 set	352,326.00

	520PC) with access.		
38.	Electronic Precision Balance (Sr. No.1122510067)	01 No.	86,250.00
	2005-06		
39.	Digital Moisture Meter (Multi Parameter Soil Sensor – W.E.T. Sensor System).	01 set	97,247.00
40.	Electronic Balance (Anamed make)	01 No.	66,000.00
41.	Nikon Trinocular Research Microscope (Model: E-200) with digital photographic systems.	1 set	333,902.00
42.	Nikon Digital Camera (Model: Coolpix 5400) with 5.0 million effective microscope.	01 No.	55,000.00
43.	Automatic Nitrogen Analyser with access.	01 set	325,431.00

APPENDIX – 3

SUPPLEMENTARY INFORMATION ON PROGRAMMES/REGIONAL CENTRES OF ICAR-RCER

APPENDIX – 3A

LAND, WATER, ENVIRONMENT AND ENGINEERING RESEARCH PROGRAMME (LWEERP), PATNA

1. Mandate of the Research Station/Programme/Division

"To undertake strategic and adaptive research for efficient and integrated management of natural resources to enhance productivity of agricultural production system"

2. Brief description of the AEZ and setting

The jurisdiction of the Programme comprises of 7 states in eastern India viz. eastern U.P., Bihar, Jharkhand, West Bengal, Assam, Orissa & Chhatisgarh. The region is divided into six distinct AEZs as follows.

Northern Plain, hot sub-humid eco-region with alluvium-derived soils:

The region of Northern Indo-Gangetic plain occupies 3.7% of the land area and is characterized by hot to warm summers and cool winters receiving 1000 to 1200 mm rainfall and the growing period ranges from 150 to 180 days. It has deep loamy alluvial soils. Both rained and irrigated agriculture are followed. Poor water management, waterlogging and salinity are the major problems.

Eastern Plateau (Chattishgarh)

Hot sub humid eco region with red and yellow soils and growing period: 150-180 days.

Eastern (Chhota Nagpur) Plateau and Eastern Ghats, Hot Sub-humid Eco-region with Red Loamy Soils

The zone includes Chhota Nagpur Plateau of Bihar, Western part of West Bengal, Orissa, and Bastar region of Madhya Pradesh covering 8.5% of the land area. It has hot summers and cool winters, with a rainfall of 1000 to 1600 mm and 150 to 180 days growing period. The soils are red loamy and non-calcareous. Rainfed fanning is more common, seasonal drought and severe soil erosion are the major problems.

Eastern Plain, Hot Sub-humid with Alluvium derived Soils

The zone covers North-eastern Uttar Pradesh and Northern Bihar occupying 2.8% of the land area. It is characterized by hot summers and cool winters, with 1400 to 1600 mm rainfall. The growing period varies from 180 to 210 days. The soils are mainly alluvium. Rain fed and irrigated fanning are practiced. Flooding, imperfect drainage and salinity are the major constraints.

Bengal and Assam plain

The zone is characterized by sub humid (moist) to humid (inclusion of per humid) conditions with alluvium derived soils and Growing period more than 210 days.

Eastern Coastal Plain

The zone is hot sub-humid to semi-arid climate with coastal alluvium derived soils and length of growing period ranges from 90-210 days.

3. Objectives of the research Programmes

1. Appraisal of natural resources of the region and development of research strategies for their effective development, management, conservation and sustainable and economic use.
2. Develop strategies and appropriate technologies for intensification and diversification of farming system.

4. Achievement of the Programme Prior to 2001

During the IXth Plan the Land. Water, Environment and Engineering Research Programme (LWEERP) functioned as Directorate of Water Management Research (DWMR) for the first four years and as LWEERP during the last year of plan period. The research work at DWMR consisted mainly that at 25 network Water centres of AICRP on management and lead water management research at Headquarters. In addition, AICRP on Diaraland Improvement and AICRP on Ground Water Utilization through Wells and Pumps were also headquartered at DWMR. Some externally funded research projects were also undertaken. The brief achievements of LWEERP are summarised below.

Under AICRP on Water Management, optimum irrigation schedules have been developed for major field crops, like cereals, pulses and oilseeds and also for vegetables, fruit crops and spices at selected centres. Water-use efficient crops and crop sequences have been identified. Design specifications of various surface irrigation methods like border strip, furrow and check basin have been standardized under varying soil and agro-climatic situations in water scarcity areas. Techno-economic feasibility of drip irrigation in fruits and vegetable crops and high water requiring crops such as sugarcane and banana has been established. In hilly and high rainfall areas, technology has been developed for insitu moisture conservation and carry-over of moisture for succeeding rabi crops.

Under lead research on water management at Headquarters, a non-linear statistical model has been developed for describing yield-water relationship of wheat. For irrigation water conservation under different land configurations, water saving of about 67 and 28 per cent was found under raised bed and zero tillage sowing, respectively over conventional sowing practices of wheat in heavy soils of Patna. For efficient water management in rice for raising rice nursery during summer, irrigation water requirements ranged from 26.8 to 33.4 cm under different dates. Optimum grain yield was recorded when rice crop was planted on 29lh June. Highest grain yield was obtained under continuous submergence of 5±2 cm followed by 5 cm irrigation 3 DAD. For using existing sprinkler system at a low pressure for irrigating rice, wheat and other similar close growing crops, an attempt has been made to design a water-distributing device that works at 0.4 kg/cm" pressure. In Boro rice, November sown nursery took 6 days to germinate while it was 11 days for January sown crop. Poly-house grown, January sown rice (cv Gautam) gave highest yield of 4.9 t/ha. For exploring multiple uses of irrigation water, studies on use of a fish pond-cum- secondary reservoir showed that upto 10 t/ha fish harvest can be made as an additional source of income from the same tubewell water meant for irrigation alone by routing irrigation water through a secondary reservoir of 3 25 m capacity.

Under 3 centres of AICRP on Diaraland Improvement, research work was mainly focussed on diagnostic survey, variety improvement cropping system, weed management, water resource development and management. At Sabour. for Ganga Diara, "MSFH-17" variety of sunflower and "Hilly" of pointed gourd emerged as most successful variety. Black gram (fodder) + Gram, sunflower + Carrot and Black gram (fodder) Linseed are most suitable cropping systems. Bamboo tubewells have been successfully adopted by farmers for irrigation during pre-flood and post-flood period. At North Lakhimpur, for Brahamputra Diara, local varieties Padmanath and Panindra yielded highest among deep-water rice varieties. Among toria varieties, M-27 gave highest yield under all dates of sowing treatments. Potato + toria has been identified as profitable cropping system at 80 kg/ha nitrogen level. Application of rice straw + cycocil successfully conserved soil moisture. At Faizabad, for Saryu diara, NDT-46 and NDBG-56 were identified as suitable varieties of tomato and bottlegourd respectively. Optimum row spacing for watermelon was identified as 4 m. Optimum dose of multiplex for tomato was found to be 20 kg/ha.

Under A1CRP on Ground Water Utilization through Wells and Pumps, a computer model (based on PLASM model) has been developed at Ludhiana center to simulate ground water flow under unconfined conditions for Bist Doab Tract, Upper Bari Doab Canal Tract, and south-west Punjab. At Pantnagar, a mathematical model was developed to simulate groundwater behavior. The model was validated and used to predict the ground water status in Ganga-Ramganga interbasin. At Ludhiana, a model was developed to simulate the nitrogenous fertilizer behaviour in a soil plant system. At Rahuri, a computer model has been developed to manage the canal water and groundwater conjunctively. At Ludhiana, Soil-Aquifer Treatment (SAT) was evaluated for renovation of sewage water for safe use for recharge. The technique involves low cost treatment of waste waters for quality acceptable for irrigation. At Pantnagar, Rahuri and Poondi centers, the extent of ground water pollution from agro-based industries e.g. sugar factories, paper and pulp mills tennaries was assessed. Appropriate measures have been suggested to control ground water pollution so that water can safely be utilized for irrigation. Groundwater pollution arising from use of agro-chemicals was evaluated at Ludhiana. Pantnagar and Poondi centers and was found that the level of heavy metals, inorganic and organic contaminants is increasing and has to be controlled timely. At Pantnagar and Jabalpur centers, strategies for performance improvement of diesel and electric pumps at the fanners' fields have been formulated. Performance evaluation of pumps from various manufacturers was undertaken at Ludhiana center.

5. Staffing of the Research Station (existing & sanctioned)

Sl. No.	Name of the cadre	Sanctioned	Existing
1.	Principal scientist	4	3
2.	Sr. Scientist	10	8
3.	Scientist	9	9
4.	Technical	34	13
5.	Administrative	18	Posted in headquarters
6.	Supporting	22	02 (rest posted in headquarters)
	Total	107	35

6. Major areas in which achievements have translated/gone to the field (farmers' fields)

- On-farm Water Management,
- Resource Conservation Technologies
- Multiple Uses of Water
- Gravity and Pressurized Irrigation Systems

7. Area of farmers field covered under new technology/technologies/ components. (Physical areas/quantification)

The following five major technologies have been transferred to farmers.

- ***Optimization of rice transplanting date for efficient rain water utilization & enhanced productivity***

  The technology was adopted in 178 villages in Sone command, (Bihar) covering an area of 10,000 hectares. It has a further potential in 8-10 lakh ha in other Commands (namely Kosi, Gandak and Kiul) in Bihar.

- ***Raising bund height of paddy fields for maximum rainwater conservation***

  The technology was adopted in 20 villages in Sone command (Bihar) covering an area of 800 hectares. This has potential in command area of canal and tubewell irrigation.

- ***Fish-pond-cum-secondary reservoir for economized and multiple uses of irrigation water in agriculture production system in irrigated areas and multiple use of water in seasonally waterlogged areas***

  The technology was adopted in 10 hectare area of RPC-V command of Sone Command Bihar by taking up 20- ponds**.** Participatory management of common property ponds for fish production in Sone Command, Bihar gave encouraging results. Secondary reservoir and multiple use of waterlogged areas well received by farmers & adopted by few. About 200 farmers were trained in four canal commands of Bihar in water management and integrated farming systems in Deptt. of Water Resources, sponsored training programmes. Participatory management of *makhana* water bodies in North Bihar was also taken up.

- ***Resource conservation technologies like, zero tillage, brown manuring, and use of Leaf Colour Chart***

  The technology was disseminated in 5450 ha in 22 districts of Bihar involving 6982 farmers. As a result of success to zero till technology Bihar Govt. sanctioned Rs. 5000/- per zero till machine. Overall different RCTs have potential in 10-12 lakh ha in Bihar.

8. Bottlenecks:

Research Programmes/areas/labs:

- Despite adequate sanctioned manpower strength of ICAR-RCER, many positions are vacant. There is inadequate technical manpower to support scientific manpower.
- The research on environmental issues has not been due to lack of relevant scientific and technical manpower

Extension

- The linkage between SAT's/State Govts. in Eastern region are weak and efforts are required to strengthen the same by launching a networking research on a common platform.

- There is a general lack of awareness among farmers on conservation, management and protection of natural resources.
- Because of lack of consolidation of land holdings the farmers are not inclined to invest in adoption of improved technologies. Because of weak social fabric, the farmers are not able take up community based development works relating to natural resources.

9. Publications

Research Papers

2001-02

1. Chandra, D, Khan, A. R. and Nanda, P.(2001). Performance of different crops in rice fallows in Coastal Orissa , J. Indian Soc. Coastal Agril. Res, 18(1): 36-39
2. Chandra,D., Nanda, P., Upadhyaya, A., Anand, P.S.B. and Kannan, K., Khan, A.R (2001).Management of rainfed lowland rice–a fragile ecosystem in eastern India, Jour. Indian Soc. Coastal Agril. Res, 18 (2) : 81-94.
3. Khan, A. R Chandra, D., Anand, P.S.B., Nanda, P., Roy, Chowdhary, S. and Behera, M. S. (2001). Effect of organic and inorganic sources of nitrogen on rice under different water regimes, Jour. Indian Soc. Coastal Agril. Res, 19 (1-2) :120-123.
4. Singh, S.S. and Khan A.R.(2001). Management of irrigated rice for higher productivity in Bihar plains, Thought, 5(II): 33-36
5. Singh, J.P. and Singh S.S and Singh A. K. (2001) Agri-horti production systems for rehabilitation of sub-humid calcareous sodic lands of north Bihar., J. Farming System Research & Development,7(1&2): 77-81
6. Singh, R. D.(2001). Weed management in rice-wheat cropping sequences in Sikkim, J. Farming System Research & Development, 8(1&2): 143-145
7. Singh, R. D, Singh, S. S. and Munda, G. C.(2001).Effect of Isoproturan and 2-4, D with adjuvant in controlling weed flora of wheat in Sikkim, J. Farming System Research & Development, 8(1&2): 139-142
8. Singh, R. D., Prasad, U. K. and Singh, S. S.(2001). Effect of irrigation on availability and approach of Zn and Fe in rice (Oryza Sativa L.)- based crop sequences, J. Farming System Research & Development, 8(1&2): 42-47
9. Singh, A.K. R.S. Pan, Mathura Rai and V.S.R.Krishna Prasad(2001). Evaluation of promising germplasm of brinjal (Solanum melongena L.), Indian J. of Plant Genetic Resources, 14 (2) :197-198.
10. Upadhyaya, A. (2001). Discussion on Transient drainage to partially penetrating drains in sloping aquifers by K.N. Shukla, H.S. Chauhan, and V.K. Srivastava, Journal of Irrigation and Drainage Engg., ASCE, 127 (4): 262.
11. Upadhyaya, A. and Chauhan, H.S.(2001). Interaction of stream and sloping aquifer receiving constant recharge, Journal of Irrigation and Drainage Engg., ASCE, 127 (5): 295-301.
12. Upadhyaya, A. and Chauhan, H. S. (2001). Falling water tables in a horizontal /sloping aquifer, Journal of Irrigation and Drainage Engg., ASCE, 127 (6): 376-384.
13. Upadhyaya, A. and Chauhan, H.S.(2001). Water table rise in sloping aquifer due to canal seepage and constant recharge, Journal of Irrigation and Drainage Engg., ASCE 128(3): 160-167.

2002-03

14. Bhatanagar, P. R. (2002). Groundwater Utilisation for Irrigation: Problems and Remedial Measures. Indian Farming, 52(7) Oct.:40-44.

15. Chandra, D.,Nanda, P. and Khan A.R. (2002). Chick-pea a promising pulse crop in rice fallows for Orissa . Intensive Agriculture. 20 (1-2):7-9.

16. Khan, A. R., Nanda, P., Singandhupe, R. B. and Chandra, D. (2002). Effect of irrigation on soil aeration in relation to pea-nut production. Achieves of Agronomy and Soil Sci. 48(1): 19-24.

17. Kumar, Sanjeev, Shivani and Singh, Jai (2002). Growth analysis of rainfed groundnut (Arachis hypogaea L.) in Manipur valley under ploymulch condition. Journal of Oilseeds Research 19(2):181-184.

18. Prasad, L. K, Saha, B, Abdul Harris, Rajan K, & Singh S.R. (2002) Critical grain nitrogen content for optimizing nitrogen and water in rice {Oryza sativa). Online Journal of Biological Sciences 2(11):746~747.

19. Rajan, K., Prasad, L.K., Singh. R.D. and Singh, S.R. (2002). Agric. Clinic for Rural Employment. Yojana, New Delhi, May: 36-38.

20. Shivani and Kumar, Sanjeev (2002). Response of Indian mustard to sowing date and row spacing in mid-hills of Sikkim under rainfed conditions. Indian Journal of Agronomy 47(3): 405-410

21. Sikka, A.K. (2002). Participatory watershed management for land and water care : Planning Impact Evaluation and Sustainability and Future. Watershed management, pp. 128-135.

22. Singh. R.D. (2002). Evaluation of periods of weed free maintenance for mustard and potato in Sikkim. Journal of Farming System Research & Development. 8(1&2): 150-151.

23. Singh, S. S., Srivastava, Soni and Singh, A.K. (2002). Comparative performance of Indica and Japonica rice (Oryza sativa L.) varieties under extreme late planted rainfed conditions. Indian Journal of Agronomy 47(1): 50-56.

2003-04

24. Chaudhari, S.K. & Batta R.K. (2003). Predicting unsaturated hydraulic conductivity functions of three Indian soils from particle size distribution data. Aust. J. of Soil Research 41: 1-10.

25. Khan, A. R (2003). Mulching effects on soil physical properties and peanuts production. Italian Jour, of Agronomy (Italy). 6 (2): 113-118.

26. Khan, A. R., Srivastava, R.C., Ghorai, A. K. and Singh, S. R. (2003). Efficient soil solarization for weed control in rainfed upland rice ecosystem. International Agrophysics (Poland). 17(3): 99-103.

27. Kumar, Sanjeev, Shivani & Batta, R.K. (2003). Rhizobium: A potential biofertilizerfor pulses. Agricultural Extension Review 14(6):21-24.

28. Rajan, K., Singh, S.S., Gautam, U.S. & A.B. Pal. (2003) On-farm nutrient management in HYV rice under field-to-field canal irrigation system of Sone command, Bihar. Journal of Farming System Research and Development 9 (1): 94-95.

29. Shivani, Verma U.N. and Kumar Sanjeev (2003). Effect of date of sowing and irrigation levels on water requirement of wheat cultivars. Journal of Farming Systems Research & Development 9 (1): 33-36.

30. Singh A.K., Amagin L.P., Singh S.S. and Singh J.P. (2003). Effect of integrated management on yield, nutrient uptake and nutrient balance in rice-wheat system. J. Farming System Research and Development 9(1): 14-18.

2004-05

31. Singh, R.D. (2004). Crop Weather Relationship in Peanut. J. Farming System Res. Dev., 10 (1 &2): 98-100. Singh, R.D. (2004). Crop Weather Relationship in Soybean. J.Agril.Phy., 3 (1&2): 136-139.

32. Subash N. and Das, P. K. (2004). Rainfall characteristics and probability analysis for crop planning under rice-wheat system in sub-humid (dry) climate). Indian J. Soil Cons. 32(2): 124-128.

33. Subrahmanyam, D. and Rathore, V.S. (2004). 14CO2 assimilation and 14C-photosynthate translocation in different leaves of sunflower. Photosynthetica 42(2): 313-316.

34. Khan, A. R., Chandra, D., Nanda, P, Singh, S. S., Ghorai, A. K. and Singh, S. R. (2004). Integrated nutrient management for sustainable rice production. Arch. Agronomy Soil Sci. (Germany). 50:161-165.

35. Singh A. K., Upadhyaya A., Bhatnagar P. R., Singh M. K., and Dhanphule S., (2004). "Kharif mein jal ka samuchit upyog kaise karien ?", Extension bulletin no. E-57/PAT-40 published under DFID project.

36. Singh A. K., Upadhyaya A., Bhatnagar P. R., Singh M. K., and Dhanphule S. (2004). Nahar Sanchalan mein sahbhagita ka mahatava? Extension bulletin no. E-57/PAT-39 published under DFID project. A multimedia CD developed in the project ToE on PIS, NATP, entitled "Team of Excellence on Pressurized Irrigation Systems", 2004.

37. Singh S. R., Singh A. K., Islam A. and Bharali M. A. (2004). Low Energy Water Application Device (a project publication under ToE on PIS, NATP). Technical bulletin No. R-11/PAT-3, ICAR-RCER, 2004.

38. Singh R.D., Gautam U. S. and Sikka A. K.,(2004). Working paper on optimization of rice transplanting for improving livelihood in eastern region page 1 -25,2004. Under publishing in DFID-UK.

39. Singh, R. D., Gautam, U. S., Chandra, N., Kumar, R. and Pandey, A. K. (2004). Samay se bai sai adhikam gehumn ki paidawar (Hindi), ICAR-RCER, Patna. Ext. Booklet No. E-22/PAT-10.

2005-06

40. Bhatnagar, P.R., Prasad, L.K. and Sikka, A.K. (2005). Fish pond cum irrigation tank (FP-c-TT) enhances fish production. Fishing Chimes, 25 (2): 15-22.

41. Khan, A.R., Chandra, D, Nanda, P. Anand, P.B.S., Singh, S. S., and Singh, R. D. (2004). Response of Ipomoea carnea to rice production as green leaf manuring. Indian Society of Coastal Agricultural Research, 22 (1 &2): 223-225.

42. Kumar Sanjeev and Shivani. (2004). Response of soybean to rhizobium and its residual effect with mulching on succeeding mustard in the medium hills of Sikkim. Journal of Farming System Research and Development, 10 (1&2):58-64.

43. Saha, B.,Prasad, L.K.,Haris,A.A.andBatta, R.K. (2004). Optimization of nutrient application for yield maximization of rice in submerged condition at Bihar. Indian Agriculturist, Vol.48 (1 &2): 1-7.

44. Shivani, Verma, U.N., Kumar, Sanjeev, Pal, S.K. and Thakur, R. (2004). Growth analysis of wheat (Triticum aestivum L.) cultivars under different seeding dates and irrigation levels in Jharkhand. Indian Journal of Agronomy, 48 (4): 282-286

45. Singh, R.D., Khan, A.R., Singh, S.S. and Kumar, Rakesh (2005). Effect of different sowing dates on degree-day requirement of different cultivars of brown sarson (Brassica campestris L). Indian Agriculturist, 48 (3 & 4): 243-247.

46. Islam,A., Raghuwanshi,N.S., Singh, R. and Sen, DJ. (2005). Comparison of gradually varied flow computation algorithms. Journal of Irrigation and Drainage Engineering, ASCE, 131(5):457-465

47. Khan, A. R., Singh, S. S., Chandra, D., Nanda, P, Ghorai, A. K. and Behra, M. S. (2005). Response of irrigation and phosphorus on productivity of black gram (Phaseolus mungo Roxb.) in mono cropped rice system. Agrochimica. (Italy), 49(3-4): 132-139

48. Singh S.S. and Khan A.R. (2005). Managing flood prone ecosystem for rice production in Bihar plains. International Journal of Tropical Agriculture, 23 (1-4): 25-30.

APPENDIX – 3B

CROP RESEARCH PROGRAMME (CRP), PUSA

1. Mandate of the Research Station/Programme/Division

- To undertake strategic and adaptive research on tobacco, pulses and oil seeds for North Bihar.
- To focus research on genetic improvement, agronomic practices and plant protection measures through conventional and biotechnological tools.
- To promote and disseminate appropriate agril. technologies and to provide need based consultancy and advisory support in in the eastern region of Bihar.

2. Brief description of the AEZ and setting

It fall in agro-eco Zone 13 which is hot sub-humid (moist) with alluvium derived sandy loam soils. The centre is receiving 1200 mm mean annual rainfall. The predominant *kharif* crops are rice and maize. Wheat and winter maize are grown during *rabi* season. Tobacco is major cash crops of the region.

1. Objectives of the Research Programmes

- To develop cultivars of pulses, oilseeds, tobacco and other crops suitable for the agro-ecological condition of eastern region.
- To develop location-specific agro-technology for different cropping systems.
- To identificatify of major insect/pests/diseases and develop suitable management practices for important crops.

4. Achievement of the Programme Prior to 2001

The Hookah and Chewing Tobacco Research Station was established in 1950 by the state Govt.. it was taken over by the ICAR during 1965 and named Central tobacco Research Station, Pusa with the administrative control of CTRI, Rajamundry.

5. Staffing of the Research Station (existing & sanctioned) (As on 31.03.2007)

Sl. No.	Cadre	Sanctioned	Existing
1.	Scientific	12	02
	Pr. Scientist	02	-
	Sr. Scientist	05	02
	Scientist	05	-
2.	Technical	15	07
3.	Administrative	06	04
4.	Supporting Staff	17	23
	Total	**50**	**36**

6. Major areas in which achievements have translated/gone to the field (farmers' fields)

- Cropping systems with emphasis on crop diversification for irrigated upland.
- Breeding varieties for high yield in oilseeds, pulses and tobacco.

7. Area of farmer's field covered under new technology / technologies / components. (Physical areas/quantification).

Release of New Chewing Tobacco Variety "Lichchavi" (2001)

- A new chewing tobacco variety "LICHCHAVI" has been released by IVRC for cultivation in all chewing tobacco growing areas of Bihar and U.P.
- Its total average yield is 28 q/ha with 15 q/ha first grade leaf outturn. Two important physical leaf quality parameters e.g. spangling (4.2) and puckering (4.2) scores superior in this variety than the earlier released and established variety e.g. Pusa Tobacco-76 (3.8 & 3.7) and Vaishali Special (3.6 & 3.7). Nicotine content in the cured leaves of this variety is 3.53% superior to Vaishali Special (3.50%).
- Highest cured leaf thickness of 11.00mm has been observed in "Lichchavi" as compared to Vaishali Special (11.00mm) and PT-76 (8.50 mm). The chewing test evaluation scores of this variety was highest (77.44) than PT-76 (68.7) and Vaishali Special (61.2).

Agronomical package and practices developed and disseminated

- Intercropping system – tobacco + garlic, tobacco + rajma
- Package and practices of tobacco variety Lichchavi

8. Bottlenecks

Research Programmes/areas/labs

Despite adequate sanctioned manpower strength of CRP, Pusa, many positions are vacant.

- In scientific cadre, we are facing acute shortage of manpower. As we have only 02 (scientific staff) Senior Scientists including I/c Head at this centre which is one of the main constraints to take up research work as per new mandate set for the Crop Research Programme, Pusa.
- As on today only 05 technical staff are working research support by technical staff is suffering badly due to lack staff. We need at least 15 more technical staff for smooth conducting the research trails in light of revised mandate.
- In administrative cadre we have only 04 over burden staff which hampered the official processing of daily routine work. Fortunately, we have 06 sanctioned posts including one A.A.O. If sectioned post is filled, the efficiency of this office will increase and time taken for official processing may be cut short.
- To execute the field/office work, supporting hand is utmost required. Presently we have only 23 supporting staff looking after the research, official works, garden, bullock and watching. To do the justice with the given workload, we need at least45 more supporting staff on permanent basis

or contractual basis. If the above-mentioned manpower is provided, definitely the quality and quantity of out put of this centre will be improved in a big way.

- The linkage between SAT's/State Govts. in eastern region are weak and efforts are required to strengthen the same by launching a networking research on a common platform.

Extension of technologies

Farmers of the region are facing hard and demanding for regular training on Farming system/ crop diversification / tobacco based framing systems. They are also demanding for regular and systematic training on tobacco seed production and other related techniques, as Crop Research Programme is only center in Bihar is engage in research on tobacco.

9. Publications

Research Papers

1. Singh K.A. (2002). Application of bioterracing for land development in North Eastern Hills of India. *Indian J. Soil Conservation* 30(3): 226-231.
2. Amarnath, S. (2002). Performance of advanced breeding lines of chewing tobacco for quality traits. Tob-Res. 27(2): 130-133.
3. K. Deo Singh, JAV Prasad Rao and A.K. Pandey (2002). Effect of continuous application of NPK fertility status in sandy loan calcareous soil of Bihar. Tob. Res. 28(2): 119-28.
4. Singh, K.A. (2004). Effect of soil depth on early performance and characteristics of roots of some tree species on a hill slope *Indian J. Agroforestry* 6(1): 09-15.
5. K.Deo Singh, A.K. Pandey and JAV Prasad Rao (2004). Influence of different proportions of urea, ammonium sulphate and caster cake on yield and physical quality of characteristics of chewing tobacco in Bihar. Tob. Res. 30(1): 11-15.
6. Amarnath, S., K. Deo Singh and A.K. Pandey (2004). Response of advanced breeding lines of chewing tobacco to varying fertility levels under rainfed and irrigated condtion of north Bihar. Tob. Res. 30(1):22-26.
7. Amarnath, S. (2002). "Lichchavi" Khaini Tambaku Hi Uttam Gunvatta Yukt Yek Nai Kissm (In Hindi): Aadhunik Kissan 32 (10) : 31-34.
8. Singh, K.A. (2002). Tribals Wisdom- A sustainable rice cultivation in Arunachal Pradesh. Indian Farming 52:21-25
9. Singh, K.A. (2002). Prospects of edible bamboo shoot farming in North East India. ICAR News 8(1): 5-8.
10. Singh, K.A. (2002). Application of bioterracing for land development in North Eastern Hills of India. Indian J. Soil Conservation 30 (3) : 226-231.
11. S. Amarnath, A.K. Pandey and A.S. Mahapatra (2003). "Adhiktam Aay ke liye Bihar main Khairi tambaku ki kheti"in Hindi, Soubvenir, Kishan mela/seed day, IARI-RS, Pusa 17th March, 2003.
12. De, L.C., Singh, K.A., Soloi, B. and Geric Bagra (2004). "Commercial farming of unpopular fruit tree species of Arunachal Pradesh." Indian Farming, 53 (10): 22-23 & 29.
13. Singh, K.A. and Vishwakam (2004). Farm women in Adi Tribe of Arunachal Pradesh." Indian Farming. 53 (12): 05-06.

10. Commentary of the QRT

1. The center needs to strengthen plant breeding work on tobacco, since almost no breeding work has been done during the period. There are about 1.5 lac tobacco growing farmers in Bihar alone. There is a need of high yielding varieties of tobacco superior to PT 76.
2. The experiments under CRP should be undertaken after obtaining perception of farmers. The involvement of a social scientist, for the purpose, is essential.
3. Farmers may be encouraged to produce their own seed. The center should encourage and train farmers for seed production of tobacco at farmers' field only. Regular seed production programme may be of at least 5 days duration. For this purpose, farmers may be charged nominal fee which they will be wiling to pay.
4. The Center should promote seed production at large scale at farmers' fields under its own supervision.
5. There is a need of forming Tobacco Growing Farmers' Associations for participatory seed production.
6. The tobacco processing is still being done by traditional methods. The center should develop modern processing techniques.
7. The center should train some more technicians in cultivation and processing of tobacco. No health hazards are seen in tobacco processing.
8. The possibility of adoption of drip irrigation in tobacco may be explored.
9. For reducing the water requirement of tobacco, planting of tobacco on raised beds may be practiced.
10. Medicinal and aromatic plants may not be included for intercropping of field crops.
11. The center should analyze nutrient content of plant samples in intercropping studies of tobacco with other crops e.g. garlic.
12. The economists of the Complex should plan studies on economics of growing all crops including tobacco.
13. Since the center is now being merged with Wheat Research Station, IARI, Pusa, the research work on tobacco may be continued by IARI and supply of tobacco seeds to farmers may be ensured. This was a strong sentiment expressed by tobacco growing farmers during the interaction meeting with QRT.
14. In view of the merger of CRP, Pusa with Wheat Research Station, IARI, Pusa, the Center should continue its programme on oilseeds, pulses and diversified cropping system under Crop Research Programme from Patna.
15. Women participation in tobacco cultivation may be ensured to address gender issues.

APPENDIX – 3C

HORTICULTURE AND AGRO-FORESTRY RESEARCH PROGRAMME (HAFRP), RANCHI

1. Mandate of the Research Station/Programme/Division

"To undertake strategic and adaptive research for efficient and integrated management of natural resources to enhance productivity of horticultural crops and agro-forestry in different agro-ecological zones of the eastern region".

2. Brief description of the AEZ and setting

Eastern Plateau

- Hot sub humid sub-tropical eco-region with red laterite soils and growing period : 150-180 days.

Eastern (Chhota Nagpur) Plateau and Eastern Ghats, Hot Sub-humid Eco-region with Red Loamy Soils:

- It includes Chota Nagpur Plateau of Jharkhand, Western part of West Bengal, Orissa, and Bastar region of Chhatisgarh covering 8.5% of the land area.
- It has hot summers and cool winters, with a rainfall of 1000 to 1600 mm and 150 to 180 days growing period. The soils are red loamy and non-calcareous. Rainfed farming is more common, seasonal drought, severe soil erosion and acidic soil are the major problems.

Bengal and Assam plain

- Hot sub humid (moist) to humid (inclusion of per humid) eco region.
- Alluvium derived soils and Growing period : 210 + Days

3. Objectives of the research Programmes

- To conduct research, extension and project planning for development of horticulture and agro-forestry suitable for different agro-ecological region in eastern region.
- To develop technology on rain water harvesting and multiple use of water for development of horticulture and agro-forestry
- To develop and transfer improved production technologies on horticulture and agro-forestry
- To produce and supply genuine planting material of different fruits and vegetables in largescale
- Function as information portal for horticulture and agro-forestry development in the region

4. Achievement of the Programme Prior to 2001

- Under collection, characteristion, evaluation and utilization of Germplasm, a total of 2958 germplasm lines including fruits (771), vegetables (1836) and ornamental plants (351) have been collected and are being utilized in breeding programme to develop biotic and aboitic resistant varieties.

- The Station has evolved 16 varieties in different horticultural crops including viz., Swarna Roopa in litchi; Swarna Alaukik and Swarna Rekha in pointed gourd; Swarna Shree, Swarna Mani, Swarna Shyamli and Swarna Pratibha in brinjal; Swarna Poorna, Swarna Sheetal and Swarna Ageti in cucumber; Swarna Manjari and Swarna Uphar in ridge gourd; Swarna Lata and Swarna Priya in French bean and Swarna Lalima and Swarna Naveen in tomato. These varieties are gaining popularity for their high yield, better quality, disease and pest resistance.
- Stable and high yielding promising varieties for different maturity periods, flavour, quality and usages for different purposes have been identified for mango, litchi, guava, banana, pineapple, citrus, anola, passion fruit, jack fruit, custard apple, papaya and bael.
- Identification of Suitable varieties/hybrids for important vegetable crops for this region have been identified for tomato, brinjal, capsicum, chilli, cabbage, cauliflower, okra, onion, pea, French bean, pole bean, cowpea, parwal, watermelon, cucumber, bottle gourd, bitter gourd, pumpkin and ridgegourd.
- The Station has also evolved 21 elite lines/hybrids in different vegetable crops which are being tested/evaluated under All India Coordinated Vegetable Improvement Project (AICVIP).
- Under development of agro-techniques in fruit crops high density planting of banana cv. Dwarf Cavendish at a spacing of 1.4 x 1.4 m accommodating 5,100 plants/ha has resulted in higher economic yields whereas high-density planting of guava at a spacing 2.5x2.5x5.0m accommodating 1060 plants per ha resulted in the maximum yield. In litchi cv. China, a fertilizer dose of 500g nitrogen, 500g phosphorous and 300g potassium per plant per year was found to be most suitable for junior adult bearing plants growing under sub-humid plateau region of Eastern India. In litchi cultivars Shahi and China, Double hedge row planting at a spacing of 4.5 x 4.5x 9 m, accommodating 329 plants/ha as compared to 123 plants in traditional method resulted in nearly three times higher yield than that in case of traditional method of planting.
- Under development of agro-technologies in vegetable crops, intercropping of cowpea with okra gave 31 to 53 percent increased okra equivalent yield. Similarly planting of 4 rows of onion 15 cm apart between 2 rows of tomato (30 x 100 cm) gave 36 percent higher tomato-equivalent yield and higher returns without affecting there quality of tomato. In cabbage, intercropping with coriander or fenugreek enhanced the yield (16%) and also restored the soil fertility. In cabbage (cv. Pride of India), application of N P K : 180:60:50 with a plant spacing 45 x 30 cm recorded 28 percent higher yield.
- Under soil amelioration studies for vegetable crops, soil application of lime at the rate of 3.4 t/ha and molybdenum 1.5 kg/ha or ammonium molybdate as foliar spray (0.2%) four times at 12 days interval increased curd weight and curd diameter of cauliflower cv. Pusa Snowball-1. Application of lime increased the yield by 12 percent and improved the soil pH, available molybdenum in soil and also increased molybdenum, calcium and magnesium in leaf tissue of cauliflower. Soil application of 1.5 kg B/ha during rainy season was found sufficient for 3 successive crops of cauliflower in overcoming brown rot and to boost yield.
- Under standardization of plant protection measures, powdery mildew in pea caused by *Erysiphe pisi* could be managed by preponement of sowing date in September and October. The disease could be controlled by spraying calexin (0.05%). Powdery mildew of cucumber caused by *Erysiphe chichoracearum* could be controlled by spraying karathane (0.1%) and powdery mildew of bottle gourd caused by *Sphaerotheca fuligena* could be controlled by spraying Topsin M-70 (0.1%).

- In fruit crops, shoot gall psylla, a serious pest of mango could be effectively managed with three sprays of quinalphos (0.05%) starting from 1st week of August followed by 3 applications of 2, 4-D (80 ppm) starting from gall appearance stage at 10 days interval.
- Under NATP on Development of Hybrids in Vegetable Crops (Tomato and brinjal): tomato elite lines and hybrids were screened for early blight, bacterial wilt, root knot nematode resistance: male entity, and marker character. Twelve lines and 23 hybrids were observed to be resistant to early blight while 22 hybrids were resistant to bacterial blight. It is Interesting that the 10 hybrids were found common and resistant to both the diseases. Three marker characters viz. potato leaf, witty and hainyness were used for NCP study. In brinjal 53 elite lines and 73 hybrids were screened for phomopsis blight resistance in which 4 lines and 7 hybrids were found resistant. Similarly 14 lines and 5 hybrids were noted resistant lo bacterial wilt. None of the tomato or brinjal lines were resistant to root know nematodes. However, 4 lines and 2 hybrids recorded resistant to shoot and fruit border infestation. Seed multiplication of hybrids was done for multi-location testing.
- Under "Jai Vigyan National Science and Technology Mission on Household Food and Nutritional Security" subproject "Horticulture and vegetable gardening for food and nutritional security in Tribal Hilly and Backward regions" ten cultivars/genotypes of mango, litchi and jackfruit have been evaluated. Litchi cultivar Shahi recorded maximum yield (117.67 kg/tree) whereas jackfruit genotype 9/6 yielded the maximum number of fruits (30) and 816 recorded the maximum fruit weight (6.5 kg/fruit). Four genotypes of litchi from BCKV: Kalyani and 3 varieties of mango (Sipia, Bathua and Jarda) from RAU. Pusa also have been collected. Evaluation of two cultivars of pineaple at Barapani. 10 cultivars of banana at Kahikuchi. 4 cultivars of ber at Godhra. Cultivar Goma Kirti performed significantly better with respect to plant height, stem girth, plant spread, success and survival than Umran and Gola.
- Nursery management of fruit crops and vegetable seed production has been in progress. In total 92K lines of mango through stone grafting and 5250 air layers of litchi have been prepared and ten thousand mango seedlings have been raised for grafting in the different cultivars at HARP, Ranchi. Ber and pomegranate also have been in progress at CHES, Godhra. Nearly 1000 acid lime seedlings have been produced and 300 seedlings were sold to growers at CHES, Chethali. Arecanut and black pepper plants at CPCRI (RS). Mohitnagar and AAU. Kahikuchi have been in progress. Planting of setts of different size of elephant foot yam to standardize the propagation technique have been completed at CPCRI (RS), Bhubaneshwar.
- Significant increasing yield of marketable pest-free cabbage heads have been achieved by IPM Technology when 2 rows of mustard were planted after every 22 rows of cabbage (cv. Pride of India). Significant reduction in percentage borer infestation in tomato was observed in plot where marigold has been planted as trap crop after every 8 rows of tomato. Encouraging results has also been observed in managing the sweet potato weevils at Keonjhar. Semliguda and Udaygiri by adopting the IPM package.
- Seventeen villages in 3 districts of Jharkhand have been adopted for demonstration by Ranchi centre. Tomato cv. CHRT-4 and CHDT-2 perform well at farmers' field. Brinjal cv. Swarna Mani and Swarna Shree were liked by the farmers and by local consumers. A total of 15 demonstrations of parwal 23 of litchi, 20 of brinjal, 20 of tomato and 10 of mango have been given by the HARP, Ranchi. Guava as a filler crop with mango and litchi was demonstrated. Farmers have been identified to give demonstrations at Lucknow and Chethali. On-farm trials of sweet potato with 2 varieties (Gauri and Pusa Safed) at 3 locations in Orissa (Keonjhar, Udayagiri and Semiliguda) have given encouraging results with respect to yield. Frontline demonstrations with 4 cvs of sweet potatoes (Shankar, Shree Bhadra and Pusa Safed) are also under progress in

tribal belt of Orissa. At Shillong, six different potato growing circles have been identified in east Khasi Hills.

- Under NATP on 'Sustainable management of plant-biodiversity1, diverse germplasm of pumpkin (2), cucumber (1), bitter gourd (1) and ridge gourd (1) collected from lower and central parts of Assam were evaluated and characterized for yield and its contributing traits. Eighteen brinjal germplasm lines were transplanted in the field for evaluation and characterization. The cuttings of 10 parvval germplasm lines were planted in the field gene bank for evaluation and characterization. Among the evaluated materials, one round fruited line of pumpkin was very distinct in respect of its smaller size (average fruit weight 400g).

- An extensive survey was conducted in litchi growing areas of Muzaffarpur. Samastipur and Vaishali districts of Bihar during fruiting season (June-July, 2001) which resulted in identification of six superior genotypes. The air layered plants of these genotypes were collected during September, 2001. Among the identified materials, two genotypes VN-3/1 and VN-3/6 were found to be very promising in respect of their heavy bearing habit, attractive red coloured fruits and resistance to fruit cracking and litchi mite infestation.

- The bud woods of 11 identified genotypes of aonla were collected during September, 2001 from Sultanpur (2), Pratapgarh (3), Allahabad (3), Mirzapur (2) and Faizabad (1) districts of Uttar Pradesh. All the germplams lines were budded on the root stocks in the nursery. The genotype VN/HS-Aonla-5 was very promising in respect of its heavy bearing habit and bigger sized (average fruit weight 75 g) greenish yellow fruits. One germplasm of lime was also collected from Allahabad in this survey.

- Under NATP on 'Improvement in Productivity and Development of Sustainable Production System for Litchi', litchi genotypes collected from different regions are being maintained in the field gene bank of respective Centres. Litchi orchards of districts Udham Singh Nagar and Nainital were surveyed by GBPUA&T, Pantnagar. Leaf andsil samples from different orchards of Ranchi, Gumla, Bishunpur of Jharkhand ; Sabour, Samastipur, Muzaffarpur and Sitamarhi of Bihar and Udham Singh Nagar and Nainital of Uttaranchal have been collected for standardization of leaf nutrient status. China variety showed strong tendency towards biennial bearing and this year was the "Off year". Under Ranchi condition, minimum duration for panicle initiation and flowering was recorded with root exposure either between 150 cm and 200 cm away from the trunk up to 30 cm depth or 90 and 150 cm away from the trunk up to 60 cm depth and filling up of the channel in both the cases after 15-20 days with recommend doses of nutrient. However, maximum duration for panicle initiation (48 days) and flowering (30 days) was recorded in control plots where normal practices were followed. At Samastipur, duration of flowering was minimum (20.50 days) when the root was exposed between 150 cm and 200 cm away from the trunk up to 60 cm depth and filling up of channel after 15-20 days with recommended doses of nutrients. At Pantnagar, shoot emergence was observed during October to December and panicle emergence during January. At Ranchi, minimum duration for panicle initiation (43 days) was recorded when 15 cm long branches (shoot) along with fruits were removed followed by 1% KI spray or by removing 20 cm long branches (shoot) along with fruits followed by 3% KNO_3 spray. Duration of flowering varied from 24.33 days of 30.00 days in different treatments. At Samastipur, the trees failed to flower this year due to strong biennial bearing tendency. Under Ranchi condition, amongst the 17 varieties/genotypes of litchi studied. China took minimum (15 days) while Rose Scented took longest duration (25 days) to attain 100% flowering.

- Under NATP on "Development of fruit based land use systems in watershed" for standardization of intercrops for bearing mango, the experiment was conducted in a 16 year old orchard with five intercrops viz. black gram, cowpea, French bean, niger and turmeric-Mango recorded the highest

mean increment in tree height with black gram (3 - 3.9 cm) followed by turmeric (13.5). The maximum trunk girth increase was observed with cowpea. The maximum spread of tree in N-S and E-W directions and tree canopy volume (1767 m3) were observed with turmeric intercropping in the first year of experimentation.

- For standardization of multiple cropping system for litchi rainfed intercropping of paddy, arhar, brinjal and cowpea recorded 3.308, 2.168, 2.833 and 8.208 q/ha yield with litchi having no filler and 3.125, 1.958, 2.793 and 7.333 q/ha yields, respectively under litchi having filler crop (guava) planted in between. The maximum paddy equivalent yield of 33.00 q/ha was recorded with arhar intercropping which was significantly higher than the paddy equivalent yields recorded with brinhal (6.65 q/ha) and cowpea (21.75 q/ha) intercropping and paddy also.
- Under NATP on 'Rejuvenation of existing mango orchard' questionnaire was prepared and farmers were interviewed in Ranchi and adjoining areas. One orchardist having sufficient number of unproductive plants of cultivar Langra was selected in Ormajhi Block of Ranchi. Pruning of 108 trees was done as per treatment schedule in December – January, 2001. Pasting of cut ends was done immediately. The fertilizer treatment has been applied as per schedule in July, 2001.
- Under IPGRI ADB Project "Conservation and use of native tropical fruit biodiversity in Asia" and Country Project 'Conservation and use of diversity in litchi in India' outline for diversity mapping of litchi has been prepared. Distribution of litchi genotypes in North Bihar has been studied. It has been observed that in Muzaffarpur, Samastipur, Motihari, Darbhanga and adjoining areas of Bihar, Shahi and Rose Scented (early type) and China and Purbi (late maturing) has occupied the major area. Other cultivars which are rarely visible in the region are Kasba and Bedana. In Sabour and adjoining area the variety Rose Scented and China are predominantly grown whereas in Udham Singh Nagar and Ram Nagar district of Uttaranchal the Rose Scented and China are the commercial cultivars. Field Gene Bank of litchi at HARP Research Farm at Churu (Ranchi) has been established in about 4 ha area. A total of 53 genotypes of litchi have been augmented from different litchi growing belts of the country.

5. Staffing of the Research Station (existing & sanctioned)

Sl. No.	Name of the cadre	Sanctioned	Existing
1.	Principal scientist	2	01
2.	Sr. Scientist	5	06
3.	Scientist	8	03
4.	Technical	33	33
5.	Administrative	12	10
6.	Supporting	49	38
	Total	**109**	**91**

6. Major areas in which achievements have translated/gone to the field (farmers' fields)

- Multi-tier cropping system
- Development of disease resistant high yielding varieties of horticulture crops
- Rejuvenation of existing old and senile orchards in mango
- Soil amelioration and nutrient management
- Rainwater harvesting

7. Area of farmers field covered under new technology/technologies/ components. (Physical areas/quantification)

An estimated area of five thousand ha is covered under improved technologies developed at HARP. The potential of the technologies are mentioned below

Multi-tier cropping system for horticultural crops

The technology has potential of covering 10000 ha in five years in Jharkhand. The technology is made bankable by NABARD and included as policy instrument to implement the model through **Mukhya Mantri Udyan Yojna** in Jharkhand.

Development of disease resistant high yielding varieties of horticulture crops

32000 ha potential wilt affected area in Jharkhand can be brought under cultivation of these varieties. This can yield Rs.70,000/acre against Rs.30,000/acre under traditional varieties. 40000 ha potential area of high yielding varieties in Jharkhand can be brought under cultivation of these varieties. Some of these varieties are suitable for Bihar, HP, J&K, Uttranchal, M.P., Maharashtra, Karnataka, Kerala, Rajasthan, Andman & Nicobar Islands NE states

Rejuvenation of existing old and senile orchards in mango

The technology has potential in 5000 ha affected area in Jharkhand.

Soil amelioration and nutrient management

The technology has potential in 40,000 ha area out of 1.6 lah ha area under vegetable production in Jharkhand alone.

Toposequencial rainwater harvesting for multiple uses of water in uplands

The technology has potential of increasing area under horticulture crops in 14,000 ha in Jharkhand.

8. Bottlenecks:

- Unavailability of scientific manpower support in critical areas such as entomology, post-harvest technology, floriculture, biotechnology, plant physiology, soil and water engineering, animal science and fishery science is a major hindrance for conducting research in farming system mode.
- Inadequacy of manpower in soil science, social science, fruit science is bottleneck for conducting detail studies under different experiments
- Limited manpower and logistic support is a major hindrance in the frontline demonstration and conduct of on-farm research
- Lack of infrastructure for farmers' training is a limiting factor for the farmer's capacity building programmes.
- Shortage of supporting and technical manpower and inadequate transportation facility is also limiting effective management of the five experimental farms situated at distant locations.

9. Publications

Research papers

2001-02

1. Nath, Vishal, Mathura Rai and Baleswar Singh(2001). Horticultural bio-diversity in Santhal Pargana, Ind. J. Plant Genetic Resources, 14 (1) : 92-98.
2. Pan, R.S., A.K.Singh and Mathura Rai(2001). Genetic variability in dolichos bean, Indian J. of Plant Genetic Resources, 14 (2) : 220-222.
3. Rai, Mathura, N. N. Reddy and V.S.R.Krishna Prasad (2001). Variation pattern in litchi under Indian conditions, Ind. J. Hort., 58 (3) : 218-223.
4. Rai, Mathura and V.S.R.Krishna Prasad(2001). Partition of yield contributing attributes in mango (Mangifera indica), J. of Res. (BAU), 13 (2) : 183-186.
5. Rai, Mathura N.N.Reddy and V.S.R.Krishna Prasad,(2001). Genetic variation and its relationship with yield components in mango cultivars grown under eastern Indian condition, Ind. J. Hort. 58 (4) : 314-320.
6. Singh, A.K. R.S. Pan, Mathura Rai and V.S.R.Krishna Prasad (2001). Evaluation of promising germplasm of brinjal (Solanum melongena L.), Indian J. of Plant Genetic Resources, 14 (2) :197-198.

2002-03

7. Rai, Mathura, Das, B., Nath, V. and Singh, H.P. (2002). Changes in yield pattern during junior adult bearing stage of litchi cultivars in plateau region of eastern India. Orissa Journal of Horticulture 30 (1)8-12.
8. Rai, Mathura, Das, B., Nath, V., Kumar, M. and Rai, R.K. (2002). Fruit characteristics of litchi genotypes under Chotanagpur conditions. Orissa Journal of Horticulture. 30 (2):1-5.
9. Rai, Mathura, Dey, P., Gangopadhaya, K.K., Das, B., Nath, V., Reddy, N.N. and Singh H.P. (2002). Influence of nitrogen, phosphorus and potassium on growth parameters, leaf nutrient composition and yield of litchi (Litchi chinensis). Indian Journal of Agricultural Sciences. 72(5):132-136.
10. Rai, Mathura, Nath, V., Das, B. and Jana, B.R. (2002). Genetic variability in fruit character of litchi under eastern Indian conditions. Progressive Horticulture 34(1):39-43.
11. Singh, R.V. (2002) Response of rainy season tomato to N P fertilization and plant spacing in the eastern plateau region. Accepted in the Indian Journal of Horticulture.

2003-04

12. Nath V., Bikash Das, Rai, Mathura, Dey, P., Kumar, S. and Kumar, Manoj (2003). Mango based cropping system for uplands of sub-humid plateau region of eastern India. Progressive Horticulture.35(2):142-145
13. Nath, V., Bikash Das, Rai, Mathura and Kumar, Rajesh Rai (2003), Centre opening induces stereo fruiting in litchi cv. Shahi. Progressive Horticulture. 35(2):219-220
14. Rai, Mathura, Dey, P., Nath, V., Bikash Das, Kumar, Rajesh Rai, Rai, Ashok and Kumar, Manoj (2003). Yield and quality of litchi: Improved by in situ water harvesting. ICAR News, 9(2):5

15. Rai, Mathura, Nath, V., Bikash Das and Rai, Ashok (2003). Growing degree day's requirement of mango cultivars under sub-humid plateau region of eastern India. Orissa Journal of Horticulture. 31(2):13-17.

16. Rai, Mathura, Nath, V., Bikash Das, Rai, Ashok and Kumar, Manoj (2003). Evaluation of jackfruit genotypes for yield and quality attributes under Eastern Indian conditions. Orissa Journal of Horticulture .3 (1):1-6.

17. Rai, Mathura, Singh, A.K., Pan, R.S. and Prasad, V.S.R.K. (2003). Combining ability of quality and yield in tomato (Lycopersicon esculentum Mill.). Veg. Science, 30 (1): 21-24.

2004-05

18. Rai, Mathura, Nath, V., Bikash Das and Rai, Ashok (2003). Growing degree days requirement of mango cultivars under sub-humid plateau region of eastern India. Orissa Journal of Horticulture. 31(2):13-17

19. Rai, Mathura, Nath, V., Bikash Das, Rai, Ashok and Kumar, Manoj (2003). Evaluation of jackfruit genotypes for yield and quality attributes under Eastern Indian conditions. Orissa Journal of Horticulture.3(1):1-6

20. Rai, Mathura, Dey, P., Nath, V., Bikash Das, Kumar, Rajesh Rai, Rai, Ashok and Kumar, Manoj (2003). Yield and quality of litchi: Improved by in situ water harvesting. ICAR News, 9(2):5

21. Nath, V., Bikash Das, Rai, Mathura and Kumar, Rajesh Rai (2003), Centre opening induces stereo fruiting in litchi cv. Shahi. Progressive Horticulture. 35(2):219-220

22. Nath V., Bikash Das, Rai, Mathura, Dey, P., Kumar, S. and Kumar, Manoj (2003). Mango based cropping system for uplands of sub-humid plateau region of eastern India.Progressive Horticulture.35(2):142-145

23. Das, Bikash, Vishal Nath and P.Dey.(2004) Investigations on flushing and panicle emergence in litchi under sub-humid sub-tropical plateau region of Eastern India. Indian J. Hort. 51(1):1-5

24. Singh, A.K., Rai, Mathura, Pan, R.S. and Prasad, V.S.R.K. (2002). Combining ability of quantitative characters in brinjal (Solanum melongena L.). Vegetable Scinece, 29 (2): 127-130.

25. Singh, A.K. and Singh, Akhilesh (2003). Seed production of onion as influenced by potassium and its method of application. Ind. J. Hort., 60 (3) : 287-289.

26. Singh, A.K. (2003). Variability and correlation studies for certain metric traits in French bean (Phaseolus vulgaris L.). The Hort. J., 16 (2) : 99-101.

27. Rai, Mathura, Singh, A.K., Pan, R.S. and Prasad, V.S.R.K. (2003). Combining ability of quality and yield in tomato (Lycopersicon esculentum Mill.). Veg. Science, 30 (1) : 21-24.

28. Pan, R.S., Prasad, V.S.R.K. and Rai, Mathura (2002). Stability of yield and its components in garden pea (Pisum sativum L.). Haryana J. Hort. Sci. , 31 (1&2) : 68 -71.

29. Prasad, V.S.R.K., Rai, Mathura and Pan, R.S. (2002). Diversity pattern, elucidating choice of parents for hybridization from exotic tomato (Lycopersicon esculentum Mill.) gene pool. Ind. J. Pl. Gen. Res., 15(2) : 140-142.

30. Sharma, J.P. and Kumar, S. (2004). Effect of crop rotation on population dynamics of Ralstonia solanacearum in tomato wilt sick soil. Indian Phytopathology 51 (1).

2005-06

31. Bhatnagar, P.R., Prasad, L.K., Sikka, A.K. and S.R. Singh. Fish Pond-cum-Irrigation Tank (FP-c-IT) Enhances fish production. Fishing Chimes, vol 25 (2): 15-22
32. Dey, P., Nath, V., Das, Bikash and Sikka, A.K. (2005). In situ water harvesting and mulching as resource conservation techniques to boost yield and quality of litchi in Chotanagpur plateau. Proc. National Conference on Resource Conserving Technologies for Social Upliftment, published by CSWCRT&I, Dehradun. pp. 471-473.
33. Jana, B.R., Mathura Rai, Bikash Das and Vishal Nath (2005) Genetic variability and association of component characters for fruit yield in papaya. The Orissa Journal of Horticulture. 33(1):90-95
34. Nath, Vishal, Bikash Das, P. Dey, Mathura Rai, manoj Kumar and Ashok Rai (2005) Orchard management practices for litchi in eastern India-in situ water harvesting and moisture conservation for improving fruit yield and quality. Progressive Horticulture.37(1): 56-62
35. Nath, Vishal, Devendra Pandey, Bikash Das (2005)Diversity of bael (Aegel marmelos Corr.) in east central India. Indian Journal of Plant Genetic Resources. 16(3):222-225
36. P. Dey, Mathura Rai, S. Kumar, Vishal Nath, Bikash Das and N.N. Reddy (2005). Effect of biofertiliser on physico-chemical characteristics of guava (Psidium guajava) fruit. Indian J. Agri. Sci. 75 (2): 95-96.
37. Pan, R.S., Krishna Prasad, V.S.R. and Mathura Rai (2004) Genetic variability in vegetable cow pea (Vigna unguiculata (L.) Walp.).Journal of Research, (BAU), 16(2):289-292
38. Patel, V.B., S.N. Pandey, S.K. Singh and Bikash Das (2005) Variability in Jamun (Syzygium cuminii Skeels) accessions from Uttar Pradesh and Jharkhand. Indian Journal of Horticulture.62(3):244-247

10. Commentary of the QRT

1. The HARP has collected a large number of germplasm of different horticultural crops. In order to prevent their loss and preservation, there is a need for strengthening the existing field gene bank facility.
2. The institute has released one litchi cultivar having resistance to fruit cracking. Attempts should be made to reduce the excessive vegetative growth in litchi and to promote more flowering.
3. Since area expansion in horticulture crops under rainfed scenario is difficult, there is a need to develop drought resistant varieties of fruits.
4. In production technology of horticulture crops, high density orcharding is required under shrinking land resources. There is a need to get more production per unit area through high density planting. Related problems in high density planting namely reduced photosynthesis, intermingling of root systems, interception of light and reduced translocation of nutrients from roots to leaves need special studies.
5. There is a need to produce high quality planting material of vegetables and fruits at large scale. Model/satellite nurseries may be established for the purpose.
6. There is a need to develop technology for dehydration of edible mushrooms in view of its highly perishable property and related market problems.
7. The component of honey production in litchi is missing and may be strengthened.

8. Since post harvest losses amount to 30-40 % in horticulture crops, there is a need to strengthen post harvest technology research component by providing one scientist of post harvest discipline.

9. The centre has disseminated its technology in over 5000 ha area at present. There is a need to conduct its participatory technology assessment.

10. There is a need to promote community based vegetable production nurseries during rainy season.

11. There is a need to develop crop yield modeling and prediction of water requirement of orchards using remote sensing and GIS.

12. There is a need to develop protective cultivation technologies for fruits and vegetable crops.

13. There is a need of training of scientists in WTP, IPR, Information and Space Technology, ISO 9000.

APPENDIX – 3D

SOCIO-ECONOMIC & EXTENSION RESEARCH PROGRAMME (SEERP), PATNA

1. Mandate:

Socio-economic evaluation and impact assessment of agricultural technologies for the Eastern Region. The programme has no any separate mandate other than the Institute.

2. Brief description of the AEZ and setting

The jurisdiction of the Programme comprises of 7 states in eastern India viz. eastern U.P., Bihar, Jharkhand, West Bengal, Assam, Orissa & Chhatisgarh. The region is divided into six distinct AEZs as follows.

Northern Plain, hot sub-humid eco-region with alluvium-derived soils:

The region of Northern Indo-Gangetic plain occupies 3.7% of the land area and is characterized by hot to warm summers and cool winters receiving 1000 to 1200 mm rainfall and the growing period ranges from 150 to 180 days. It has deep loamy alluvial soils. Both rained and irrigated agriculture are followed. Poor water management, waterlogging and salinity are the major problems.

Eastern Plateau (Chattishgarh)

Hot sub humid eco region with red and yellow soils and growing period: 150-180 days.

Eastern (Chhota Nagpur) Plateau and Eastern Ghats, Hot Sub-humid Eco-region with Red Loamy Soils

The zone includes Chhota Nagpur Plateau of Bihar, Western part of West Bengal, Orissa, and Bastar region of Madhya Pradesh covering 8.5% of the land area. It has hot summers and cool winters, with a rainfall of 1000 to 1600 mm and 150 to 180 days growing period. The soils are red loamy and non-calcareous. Rainfed fanning is more common, seasonal drought and severe soil erosion are the major problems.

Eastern Plain, Hot Sub-humid with Alluvium derived Soils

The zone covers North-eastern Uttar Pradesh and Northern Bihar occupying 2.8% of the land area. It is characterized by hot summers and cool winters, with 1400 to 1600 mm rainfall. The growing period varies from 180 to 210 days. The soils are mainly alluvium. Rain fed and irrigated fanning are practiced. Flooding, imperfect drainage and salinity are the major constraints.

Bengal and Assam plain

The zone is characterized by sub humid (moist) to humid (inclusion of per humid) conditions with alluvium derived soils and Growing period more than 210 days.

Eastern Coastal Plain

The zone is hot sub-humid to semi-arid climate with coastal alluvium derived soils and length of growing period ranges from 90-210 days.

3. Objectives of research Programme:

Study of present socio-economic & technological status of eastern region

- Socio-economic survey
- Existing status of agricultural technologies.
- Identification of constraints
- Constraint analysis
- Formulation of socio-economic institution and policy guidelines for governance of resource management through public private partnership in research, extension, production and marketing

Development of suitable extension strategies for speedy diss mination of agricultural technologies

- Development of suitable extension model/strategy
- Testing of model/strategy
- Study on Value chain in agriculture
- Development of Livelihoods indices, parameters & measurement scale
- Access to: credit, market, technology and information
- Analysis of different information delivery systems developed and strengthening service delivery system through ICT (e-credit, e-information, e-market support)

Socio-economic evaluation and impact assessment of agricultural technologies

- Socio-economic evaluation of agricultural technologies
- Impact assessment of agricultural technologies on socio-economic parameters

Assessment, refinement and dissemination of agricultural technologies

- Assessment of agricultural technologies - Refinement of agricultural technologies

Liaisoning between farmers and agricultural development agencies

- Conducting training programmes, kishan gosthies, kishan diwas, farmers' fair, exhibitions, etc.
- Organizing in-service training programmes
- Maintaining linkage with various stake holders

4. Achievements of the Programme Prior to 2001:

- Under the CEAD-TIFAC funded project, six critical constraints responsible for low productivity of rice and wheat in the commands of RP Channel-5 and Majholi distributaries were identified. Removal of these constraints in participatory mode resulted in a bumper yield of 6 to 7 t/ha of paddy as against traditional harvest of 1.6 to 3.0 t/ha
- A large scale on farm trials on 800 hectare to assess the on-farm performance and acceptability of various technologies at the tail end of the Patna canal of the Sone canal System was undertaken. A benchmark survey covering 49 villages was also conducted for impact assessment.

- By adopting improved transplanting technology the seed rate of rice reduced from 30 kg to 10 kg per acre.
- Timeliness of rice planting increased the utilization of rainwater from 40-50% to 80-100% and doubled the production.
- Advancing the date of transplanting of rice has increased the crop yield, and expanded duration of rice crop.
- Amwan Swablambi Milk cooperative society was established and linked to Patna Dairy project. It provided employment to 31 rural youths.
- The women Milk corporative society at Nisarpura has been revitalized which resulted into increase in marketable surplus milk from 80 liters to 200 liters per day.
- Bamboo stick and iron-bar mounted poly house has been developed and successfully grown seedlings of tomato, capsicum & papaya to promote off-reason growing of vegetables seedlings to capture early market.
- Construction of Pusa bin for safe storage of grains has been demonstrated and four people have been trained to construct Pusa bin.
- Existing old Water Users Association (WUAs) have been revitalized and the irrigated area has been increased from 800 acres to almost 2400 acres.
- Under the NATP funded TAR through IVLP project, a number of interventions were made in the farmer's field. The results of the interventions showed: (i) 26 to 34.2% of water saving by tube well and 21.3 to 31.4% from canal source was achieved by adopting border irrigation method. (ii) The effect of fungicidal spray was negligible (3.3%) due to insignificant incidence of disease. (iii) Farmers were benefited due to early availability of vegetable seedling from poly-house, fetching good price in the markets. (iv) The availability (from Mid- January and onwards) and feeding of green fodder increased milk yield (15-59%, average 35%), saved cattle feed (120 kg/month/ cattle), and improved health of the animals.
- Apart from the research, Socio Extension Research programme has also organized training camps, Kisan Gosthi, Exhibition and various extension activities in different parts of Bihar for dissemination of latest agriculture production technologies. It has organized 118 training camps, and Kisan Gosthies on different aspects of agricultural production system during 1998 – 2001 and 6447 farmers were trained in these programmes.

5. Staffing of research station (existing & sanctioned):

Post	Sanctioned	Existing	Vacant
Scientific	10	4	6
Technical	8	3	5
Administrative	2	1	1
Supporting	2	0	2
Total	**22**	**8**	**14**

6. Major areas in which achievements have translated/gone to the field (Farmers' fields) & Area of farmers field covered under new technologies/components. (Physical areas/qualification)

Name of Technology		Adoption (Area./no. of farmers)	Estimated net benefits
1.	Optimization of date of transplanting of Rice	225 farmers in 150 ha.area	Rs 11,000/ha
2.	Resource conservation technologies in wheat (Zero tillage in wheat)	6982 farmers in 5450 ha. area	Rs 1600/ha
3	Mushroom Production	100 persons	Rs 400/ person
4	Multiple uses of water	10 farmers	Rs 40,000/ha
5.	Weed management in wheat	250 farmers	Rs 3200/ha
6	Nutrient management in Rice-Wheat	300 farmers	Rs 3400/ha

7. Bottlenecks:

- Inadequate no of scientists/staffs in the programme.
- Unavailability of dedicated vehicle for extension purpose.
- Unavailability of dedicated telephone with STD facility in the programme.

8. Publications

Research Papers

2001-02

1. Singh, S.K. and Gautam, U.S. 2001. "Prospect of IPM for sustainable Rice production in 21st Century in Bihar", National Symposium on Integrated Pest Management (IPM) strategies in Rice production system on 15-17 March, 2001.
2. Singh, S.R., Kumar Ujjwal, Gautam, U.S., Rahman*, A*. 2001. "A System's Approach to approach to enhance crop productivity in central Bihar." Published by Bihar's strategic direction for economic development'' Page 1 to 16.
3. Gautam, U.S., Singh, A.K. and Ujjwal Kumar*,* 2001. "Land and Water Management Through Participatory Modes: Strategies For Extension Workers", Proceedings of National Seminar on "Water and Land Management including CAD for socio-economic upliftment of NE Region, November 22-23, 2001, Guwahati pp-166-168.
4. Ujjwal Kumar, U.S. Gautam and S.S. Singh, "Socio-economic Scenario of Rice-Wheat Based Farming System in Sone Canal Command, Bihar." 2001, Extended Summary: National Symposium on Farming Systems Research in New Millennium, October 15-17, 2001, Project Directorate for Cropping Systems Research, Modipuram, Meerut.

2002-03

5. Gautam, U.S., Singh, S.S., Ujjwal Kumar, and Pal, A.B. 2002. Economics and Dissemination of Zero Tillage Wheat under Participatory Research IVLP through TAR in Sone Canal Command, Bihar. Proceedings of International Workshop on Herbicide Resistance Management and Zero Tillage in Rice –Wheat Cropping System held on 4-6 March 2002 at CCS Haryana Agricultural University, Hisar. pp. 101-102.
6. Singh, S.S., Gautam, U.S., Subhash, N., Ujjwal Kumar, Malik, R.K., Singh, S.K., and Singh, J.P.2002. Potential and Constraints of Zero tillage-sown Wheat in Sone Command, Bihar. Proceedings of International Workshop on Herbicide Resistance Management and Zero Tillage in Rice –Wheat Cropping System held on 4-6 March, 2002 at CCS Haryana Agricultural University, Hisar. pp. 99-100.
7. Gautam, U.S., S.S.Singh, and Ujjwal Kumar. 2002. Creating Favourable Soil and Plant Environment in Field to- Field Irrigation system of Sone Canal Command, Bihar for Sustainable Agriculture. Abstract, National Symposium on Agriculture in Changing Global Scenario. February 21-23, 2002, IARI, New Delhi.
8. Gautam US, Singh SS, Kumar Ujjwal and Pal AB 2002. Performance of on-farm border irrigation of wheat in Sone Command of Bihar. Extended summaries, Vol-2, second international Agronomy Congress on Balancing Food and Environmental Security- A Continuing challenge. November 26-30, 2002, New Delhi.
9. P. K. Das, Manibhushan, Abhay Kumar, Sanjay Tiwary, Girish Panchariya and Amlendu Shekhar (2002) "Irrigation water resources information system incorporating spatial data", Abstract published in the Proceedings of ISPRS technical commission VII symposium on *Resource and environmental monitoring* held at NRSA, Hyderabad during December 3 – 6, 2002, pp. 71.

2003-04

10. Kumar, U. and Gautam US, 2003. Reduction of water related conflict through participatory communication in Sone Command Area, Bihar. **Abstract**, International Seminar on Communication & Sustainable Development in Agriculture, BHU, Varanasi, January 07-09 2003.
11. Singh, S.S., Gautam, U.S., Kumar, U. and Pal,A.B. 2003. Dakshini Bihar mein gehun ki satahi buwai par adhyyan. 8th Rastriya vigyan sangoshthi Jabalpur, 17-19 January, 2003
12. Kumar, U, Gautam,U.S. Singh, S.S. and Pal,A.B. 2003. "Nahar Sinchit dakshini Bihar mein ageti Kismon ke dhaan ki prajatiyon ka chayan". 8th Rastriya vigyan sangoshthi,Jabalpur, 17-19 January, 2003.
13. Gautam, U.S., Singh,S.S. Kumar,U. and Pal,A.B. 2003. "Sone nahar ke sinchit Kshetra mein gehun ki samaya aiwanm der se buwai hetu nai kismoan ki upyogita". ". 8th Rastriya vigyan sangoshthi, Jabalpur, 17-19 January, 2003
14. Rajan, K. Singh, S.S., Gautam, U.S. and Pal A. B. 2003. On-farm nutrient management in HYV rice under field-to-field canal irrigation system of Sone Command, Bihar. J. Farming Systems Research & Development 9(1): 94 – 95
15. Srivastava, S. C., Sen, C. and Reddy, A. R. 2003. "An Analysis if Pulses in Eastern Uttar Pradesh". Agriculture Situation in India.p: 771-775

2004-05

16. Gautam U. S., Kumar Ujjwal, Singh S. S., Subhash N., Singh Kartikey and Kumar Rakesh "Zero Tillage Technology for Rice cultivation in south Bihar" ICAR RESEARCH COMPLEX FOR EASTERN REGION, PATNA, page 1-5, communicated 2004.
17. Gautam U. S., Kumar Ujjwal, Singh S. S., Subhash N., Singh Kartikey and Kumar Rakesh "Surface seeding technology under wheat cultivation" ICAR RESEARCH COMPLEX FOR EASTERN REGION, PATNA, page 1-3, communicated 2004
18. Kumar Ujjwal, Gautam U. S., Singh S. S., Subhash N., Singh Kartikey and Kumar Rakesh "Zero Tillage technology in wheat cultivation" ICAR Research Complex for Eastern Region, Patna, page 1-5, communicated 2004
19. Rajan K., Gautam U. S., Kumar Ujjwal and Pal A. B., "On farm nutrient management in rice-potato-fodder maize cropping system in Sone Canal command of South Bihar" ICAR Research Complex for Eastern Region, Patna, abstract published in National Symposium on Recent Advances in Rice-based Farming Systems- 17-19 November 2004.
20. Singh R.D., Gautam U. S. and Sikka A. K., "Working paper on optimization of rice transplanting for improving livelihood in eastern region" page 1-25, 2004. Under publishing in DFID-UK.
21. Gautam U. S., Singh R.D., Chandra N. and Sikka A. K., "Working paper on constraints analysis for improving livelihood" page 1-22, 2004 under publishing DFID-UK.
22. Singh,S.S.,U.S.Gautam, Kumar Ujjwal, Rajan, K. and Bhatnagar, P.R. (2006). Minimization of technological gap in irrigated rice crop by Technology Assessment and Refinement(TAR) through IVLP in Sone command , Bihar. International Journal of Tropical Agriculture, 24(1-2):7-11.
23. Kumar, A., Kumar, Ujjwal, Singh, A. K., Gautam, U. S., Chandra, N. and Thakur, P. K. (2006). Production and marketing of cauliflower seed in Bihar. International Journal of Tropical Agriculture, 24(1-2):315-321.
24. Kumar,Sanjeev,Shivani, Kumar, A. and Kumar, Ujjwal (2006). Nutritive Value and economic analysis of Baby Corn (Zea mays L.). International Journal of Tropical Agriculture, 24(1-2):35-39.
25. Kumar,Sanjeev,Shivani, Kumar, Ujjwal, Kumar, A. and Manibhushan (2006). Soil properties, nutrient dynamics and economics of winter maize ((Zea mays L.) as effected by tillage and irrigation in north Bihar. International Journal of Tropical Agriculture, 24(1-2): 187-197.
26. Bhatnagar, P.R., Gautam, U.S., Kumar, Ujjwal, Singh,S.S. and Rajan, K. (2006). Participatory assessment of fishpond for multiple uses of irrigation water. International Journal of Tropical Agriculture, 24(3-4):461-467.
27. Kumar,Ujjwal, U.S.Gautam, S.S.Singh and Kartikey Singh (2005). Socio-economic Audit of ZT Wheat in Bihar. Zero Tillage-The Voice of Farmers. Edited by R.K.Malik, R.K.Gupta, Ashok Yadav, P.K.Sardana and C.M.Singh. pp. 62-65.
28. Gautam,U.S., S.R.,Singh, Ujjwal Kumar & S.K Sinha,.(2005). System approach to Enhance rice-wheat productivity in Sone Command.. Development initiatives for farming community: Extension Strategy, edited by Baldev Singh and Rabindra Nath Padaria, ISEE.pp247-256.
29. Singh, S.R, Ujjwal Kumar, U.S.Gautam, , S.K Sinha., A. Rahman (2002).Partners' Meet (2002). Groundwater Development to enhance surface and Rain Utilization and Agricultural Productivity in Southern Bihar Water Utilization and Agricultural Productivity in Southern Bihar. IWMI-Tata Water Policy Research Program. pp. 1- 32.

30. Kumar, Ujjwal, U.S.Gautam, S.S.Singh, N.Subhash, Kartikey Singh and Rakesh Kumar (2005). Zero tillage technology in wheat cultivation. In: Proceedings of the Workshop "Accelerating the Adoption of Resource Conservation Technologies in Rice –Wheat Systems of the Indo-Gangetic Plains" held at CCSHAU,Hisar.pp. 239-244.

31. Gautam, U.S., Ujjwal Kumar, S.S.Singh, N.Subhash, Kartikey Singh and Rakesh Kumar (2005). Surface seeding technology in wheat cultivation. In: Proceedings of the Workshop "Accelerating the Adoption of Resource Conservation Technologies in Rice –Wheat Systems of the Indo-Gangetic Plains" held at CCSHAU,Hisar. pp.245-246.

32. Gautam, U.S., Ujjwal Kumar, S.S.Singh, N.Subhash, Kartikey Singh and Rakesh Kumar (2005). Zero tillage technology for rice cultivation in South Bihar. In: Proceedings of the Workshop "Accelerating the Adoption of Resource Conservation Technologies in Rice –Wheat Systems of the Indo-Gangetic Plains" held at CCSHAU,Hisar pp. 247-251.

33. Abhay Kumar, P.S. Rawat, Sanjeev Kumar, V. Bhasin, and S. C. Sharma "Angora rabbit farming in temperate region of Himachal Pradesh" Paper accepted for publication in International Journal of Tropical Agriculture, Vol. 24 No. 4, 2006, pp 131-138.

34. Abhay Kumar, Ujjwal Kumar, A. K. Singh, U. S. Gautam, N. Chandra & P. K. Thakur "Production and marketing of cauliflower seed in Bihar" Paper accepted for publication in International Journal of Tropical Agriculture, Vol. 24 No. 2, 2006, pp 79-85.

35. U. S. Gautam, A. K. Singh, Abhay Kumar, and Ujjwal Kumar (2004), "Training Manual on Communication Strategies and Skill Development for Participatory Irrigation Management".

APPENDIX – 3E

LIVESTOCK AND FISHERIES IMPROVEMENT AND MANAGEMENT PROGRAMME (LFIMP), PATNA

1. Mandate of the Research Station/ Programme/ Division

To undertake strategic and adaptive research for efficient integrated management of natural resources to enhance productivity of agricultural production systems comprising of agricultural and horticultural crops, agro-forestry, livestock, avian and fisheries in different agro-ecological zones of the eastern region. The LFIMP has no separate mandate and activities of the programme are related to the institute mandate mentioned above.

2. Brief description of the AEZ and setting

The institute has jurisdiction over six (6) Agro-ecological regions as below

AEZ 9. Northern plain, hot, sub-humid eco-region with alluvium derived soils

AEZ 11. Eastern Plateau (Chhattisgarh region), hot, sub-humid eco-region with red and yellow soils

AEZ 12. Eastern (Chota Nagpur) Plateau and Eastern Ghats, hot, sub-humid eco-region with red loamy soils

AEZ 13. Eastern plain, hot sub-humid with alluvium derived soils

AEZ 15 Assam and Bengal Plains, hot humid (inclusion sub-humid) eco-region with alluvium derived soils

AEZ 18 Eastern coastal plain, hot sub-humid eco-region with alluvium derived soils

The LFIMP is working within these AEZ having its HQ located in AEZ 9.

3. Objectives of the Research programme

The ICAR – RCER has made a modest beginning in Livestock and Fishery Improvement and Management Programme with the joining of one scientist in August 2003. Besides research activities, developmental work was undertaken on priority for creation of infrastructural facilities like animal houses, procurement of laboratory equipments & farm development for establishment of livestock and fisheries research base at new complex site.

The programme started with the objective to develop and evaluate technologies for breeding, feeding and health care of livestock, poultry and fishery suitable to the climate of Eastern Region.

4. Achievement of the programme prior to 2001

Since the LFIMP came into existence only in August 2003, no achievement could be reported for the period.

5. Staffing of the research station (existing and sanctioned) (up to 31.03.2006)

Category of staff	Sanctioned strength	In position	Vacant
Scientific	12	3	9
Technical	15	2	13
Administrative	2	Nil	2
Supportive	12	Nil	12

6. Major areas in which achievements have translated/ gone to the field (farmers' fields)

- Organized farmers' training programme for productive utilization of waterlogged areas through multiple water use systems
- Undertaken on farm aquaculture and livestock practices under Technology Acceleration Programme
- Consultancy is given on scientific practices of animal husbandry and fishery to the farmers and entrepreneurs interested in livestock and/ or fishery enterprises and its commercialization. Technology is made available to certain farmers for Goatery, Poultry and Piggery.

7. Area of farmers' fields covered under new technology/ technologies/ components (Physical areas/ quantification)

- Development of commercial livestock and poultry farms at farmers' field [broiler (2), duck (1), goat (1) and pig (1)].
- Disease diagnostic services were provided to 186 farmers.

8. Bottlenecks

- **Research programmes/ areas/ labs**

  Lack of infrastructural facilities and personnel are the main bottlenecks of the programme

- **Extension of technologies**

  Lack of infrastructural facilities and personnel are the main bottlenecks of the programme for Extension of technologies

9. Publications

Research Papers

2004-05

1. Das, D. N., Sarkar, M., Chatterjee, A., Barari, S. K. and Ahmed, M. (2004). Studies on sex ratio of yak calves in Arunachal Pradesh. *Indian Veterinary Journal*, **81**: 830 – 831.
2. Kaushal, D. K. and Sikka, A. K. (2004). Fish farming in Bihar – current status and future perspectives, *Applied Fisheries & Aquaculture*, **IV**: 67 – 69.
3. Sharma, V. K. and Kaushal, D. K. (2004). Ecological Based Management of Urmila Sagar Reservoir of Rajasthan, *Applied Fisheries & Aquaculture*, **IV**: 47 – 50.

4. Yadav, B. P. S. (2004). Feeding strategies of swine for on farm and commercial production in India. In, Technology for Commercialization of Animal Production System. Animal Nutrition Society of India.

2005-06

5. Das, S. K., Sarkar, A. B., Buzarbaruah, K. M., Yadav, B. P. S. and Verma, N. D. (2005). Effect of housing, floor space and breed on growth and feeding of broiler rabbit. *Indian Veterinary Journal*, **82**: 227 - 228

6. Yadav, B. P. S., Sahoo, S. K. and Gupta, J. J. (2005). Performance of growing pigs on deoiled rice polish based ration, *Indian Journal of Animal Nutrition*, **22 (3)**: 141 – 143.

APPENDIX – 3F

RESEARCH CENTER FOR *MAKHANA* (RCM), DARBHANGA

1. Mandate of the Research Station/Programme/Division

- To conduct basic, strategic and applied research for increasing the production, productivity and standardizing the processing technology.
- To serve as a repository of the agro-diversity and scientific information on *makhana*.
- To disseminate, the improve technology of *makhana*.
- To collaborate with relevant national international agencies for achieving the mandate.

The mission of the Centre is "To explore develop economic opportunities in aquatic agriculture, natural, and community resource through innovative research and development programmes on *makhana* that benefit the people involved in *makhana* cultivation post harvest, processing, marketing, export and consumption".

2. Brief description of the AEZ and setting

Agro-eco Region13- eastern plains, hot sub-humid (moist) eco region with alluvium derived sandy loam soils. The centre is located in Gandak command receiving1200 mm mean annual rainfall most common *kharif* crops are rice and maize. Wheat and winter maize are common *rabi* crops. The region includes 4 major *makhana* growing districts namely Darbhanga, Madhubani, Purnea and Katihar. Fourteen districts of north Bihar in the region represent typical *makhana* growing areas of the country.

3. Objectives of the research Programmes

- To generate appropriate agriculture technologies which can help in raising the economic status of poor *Makhana* growers (downtrodden fisherman community) through higher yield, more and better employment, value adding to the commodity, improving socio-economic condition & efficient marketing and imports.
- To conduct mission mode basic & applied research for overall development of the wetland areas adopting total system approach through enhancing productivity of water. Special emphasis is laid on minimizing drudgery of down-trodden especially women folks engaged in *Makhana* popping.

4. Achievement of the Programme prior to 2001- Not applicable since the Programme started in 2002.

5. Staffing of the Research Station (Existing & Sanctioned)

S. No.	Designation	Sanctioned	Existing
1.	Principal Scientist	02	1
2.	Sr. Scientist	05	--
3.	Scientist (Sr. Scale)	02	1
4.	Scientist.	05	-
5.	Technical	14	-
6.	Administrative	7	-
7.	Supporting	10	-
	Total	**45**	**2**

6. Major Areas in which Achievements have translated/ gone to the field (Farmers field)

- *Makhana* Industry: Bihar is the major *Makhana* producing state which accounts for over 90 of the *Makhana* production of the country (Table 3.4). Madhubani, Darbhanga, Sitamarhi, Saharsa, Katihar, Purnia, Samastipur, Supaul, Kishanganj and Araria districts are major producers of *Makhana*. The popped seeds of *Makhana*, either roasted or otherwise, are used in preparation of various kinds of delicious sweets and recipes. It contains 14 per cent easily digestible protein, 76 per cent carbohydrate, 0.1 per cent fat, 0.5 per cent toal minerals, 0.9 per cent phosphorus and 1.4 per cent mgfe/100 gm. It also contains useful medical properties.
- In 2006, the State Investment Promotion Board (SIPB) has approval white ball revolution project of Rs. 70 crore, initiated by Shakti Sudha Industries, which has already started operation. About 4 lakh farmers of *Makhana* will be integrated in this backward-forward linkage project. One lakh hectares of Chaur land for expansion of *Makhana* cultivation are available in the State.
- The methodology for organic cultivation of *makhana* in small, medium and large pond was standardized and package of practices published.
- Over 60 demonstration in farmers field were conducted of scientific cultivation of *makhana* in 1 acre/2 acre and big ponds.
- Agro industry based on *makhana* was conceived, formulated and established in public, private partnership mode producing over half a dozen products.
- Methodology for *makhana*-cum-fish culture standardized and popularized among fishermen community.
- The Center rendered consultancy to M/s Shakti Sudha Industries, Patna for formulation and commercialization of *Makhana* based ready to eat *makhana* products like *Makhana* snaks, Kheer, Flaks, Sabai, Mango *Makhana* mix and *Makhana* flour.
- The Center rendered Technical support to NABARD for promotion of Horticulture crops

7. Area of Farmers Field covered under new technology

A large Number of farmers (1450 Nos.) have been benefited by various transfer of technology programme organized at the Center & on Farmer resulting in increase in productivity, area & production of *Makhana* & establishment of a large state of the art Agro Industry based on *Makhana* employing more then 70 personnel directly & over 300 indirectly. Four district in Bihar already covered in intensive *Makhana* growing product.

8. Bottlenecks

- Research Programmes: Lack of scientific/ technical/ Administrative/Finance/ Supporting staff.
- Extension of Technology: Lack of Personnel.

9. Publications

1. Jha, B.K. and Jee, Janardan (2004). Conservation of an endangered aquatic plant species *Euryale ferox Salisb*. Proceedings of *First Indian Horticultural Congress* pp. 376-377 Nov, Pusa New Delhi.

2. Jee, Janardan (2005). Possibilities & potential of *makhana* cultivation in India. Presented in International Conference on fish & aquaculture held at UAS, Banglore on 8-12th November, 2005.

3- >k] cky d`".k] th] tuknZu ,oa dkS'ky] /khjsUnz dqekj ¼2005½& fcgkj ds lkekftd & vkfFkZd mn; esa e[kkuk dk egRo] Agricultural Today, 1 (4) : 22 and 25.

10. Commentary of the QRT

1. The status on *Makhana* cultivation should be thoroughly documented including all aspects of cultivation in collaboration with the other institutions like RAU, Pusa. The review of earlier work on *Makhana* cultivation should be documented.
2. The work on survey, collection, introduction, cataloging and exchange of germ plasm and their characteristics using molecular techniques should be strengthened.
3. To create variability, printing the profile of protoplasm for fusion, somachonol vaccination, mutation and callous culture may be undertaken.
4. There is a need for breeding varieties of *Makhana* for high yield potential, resistant to biotic and abiotic stress having good quality for processing and export.
5. There is a need to develop complete package for shallow water and deep water bodies (Chaurs and Mauns) under different wetland ecosystems for *Makhana* cultivation.
6. There is a need for production of elite and genuine planting material for *Makhana* growers.
7. There is a need to expand the mandate of the Centre by including other aquatic crops like water chestnut and lotus.
8. Production of large number of planting material resistant to diseases through modern techniques of tissue culture may be undertaken.
9. Periodical analysis of biochemical properties specially heavy metals of water bodies may be undertaken to estimate heavy metal uptake by *Makhana* crop.
10. Physiological studies on seed germination and seed dormancy and related aspects may be taken up and standardized.
11. There is a need to develop and standardize appropriate harvesting and post harvest technologies for harvesting, grading, packing, storage and marketing.
12. Infrastructure facility may be created for grading, storage, processing of *Makhana*.
13. A systematic blending between ITK and modern technology for processing may be developed.
14. Studies on integration of *Makhana* with allied aqua enterprises activities along with comparative economic analysis including (marketing for domestic and export) may be undertaken.
15. There is a need to develop linkage between national and international agencies with institutes working on similar problems.
16. There is a need to develop community based Common Property Rights Management along with micro finance.
17. Development of Regular training schedules for whole year may be developed for *Makhana* growers and other stakeholders.

18. It is essential to interact with stakeholders, govt. and *Makhana* cultivators to facilitate designing of leasing policy for *Makhana* multiple water bodies.

19. Capacity building of scientists/staff to be encouraged. Scientists should also to be trained on various aspects like WTO, Patient, IPR, TRIPS, Hazard analysis and ISO 9000.

20. Vacant scientific posts should be filled at the earliest.

APPENDIX - 4
MAJOR RESEARCH THEMES AND PROJECTS ON TIME SCALE OF ICAR-RCER

Theme	Projects	2007-2012	2012-2017	2017-2025
Resource Inventorization	Status and characterization of eastern region for natural resource management	√		
	Effective utilization of modern tools and techniques like remote sensing, GPS & GIS for baseline survey, planning and monitoring	√	√	
	Resource inventorization of field, horticultural and aquatic crops including *makhana*, fish, animal resource and socio-economics	√	√	
	Constraint identification and prioritization	√		
	Bio-informatics approaches for resource inventorization	√	√	
Development of quality cultivars of agricultural, horticultural and aquatic crops	Plant genetic resource management in field, horticultural, *makhana* and other aquatic crops	√	√	√
	Development of Molecular maps for desirable characters in different agricultural and horticultural crops.	√	√	
	Improvement for desirable traits (high nutrition quality, transportation, processing and export) of horticultural crops.	√	√	√
	Methodologies for biosafety of transgenics.		√	√
	Development of drought tolerant and water use efficient traits of field and horticultural crops	√	√	
	Collection, conservation and evaluation of MPTs	√	√	√
Integrated location-specific, multi-commodity farming system involving field crops, horticulture, aquatic, livestock, fisheries, crops and other enterprises	Development of fish based IFS models for waterlogged areas	√	√	√
	Development of livestock based IFS models for different category of farmers	√	√	√
	Development of horticulture based IFS models for household food and nutritional security for eastern plateau	√	√	√
	Development of crop based IFS models for irrigated Indo-Gangetic Plains	√	√	√
	Development of location-specific agro-forestry models for fuel, fodder, energy, bio-diesel and allied enterprises like lac, beekeeping and sericulture	√	√	√
	Development of crop diversification models under different ecosystems	√	√	
Production techniques for field, horticultural	Standardization of agronomic practices in field crops.	√	√	
	Standardization of production technologies in horticultural crops including INM, canopy management, floor management and cropping system	√	√	√

Theme	Projects	2007-2012	2012-2017	2017-2025
agro-forestry and aquatic crops like *makhana*	Identification, evaluation and promotion of medicinal & aromatic plants for better economic returns as pure or inter crops including small holders' herbal garden	√	√	
	Standardization of production technologies for *makhana* production	√	√	√
	Standardization of integrated plant protection technologies for insect pests, disease, nematodes, rodents and birds	√	√	√
	Development of commodity and location specific organic farming system of agri and horticultural crops.	√	√	√
Integrated water management	Conjunctive use models for rain/surface/ground water for enhanced water productivity	√	√	
	Specific crop/horticulture based water management for precision agriculture.	√	√	√
	Participatory on-farm water management in irrigated commands	√	√	√
	Development of methodology for assessing water productivity	√	√	
	Performance evaluation of canal irrigation in irrigation commands		√	√
	Water quality assessment and amelioration measures for arsenic, fluoride problems	√	√	√
	Waste water reuse and peri-urban agriculture		√	√
Multiple uses of water	Development of suitable multiple water use models for irrigated/rainfed/flood prone and water logged areas.	√	√	√
	Improving water productivity through multiple uses of irrigation water in conjunction with fishery/aquaculture sector including *makhana*	√	√	√
	Awareness and utilization of common property resource for multiple water use.	√	√	
Rain water harvesting and watershed management.	Develop and demonstrate integrated watershed management and water harvesting systems in uplands of eastern plateau region	√	√	√
	Develop and demonstrate watershed based IFS for livelihood improvement		√	√
	Monitoring and impact assessment of watershed projects		√	√
Development, testing and popularization of resource conservation technologies	Acceleration and evaluation of RCTs in eastern region	√	√	
	Long term impacts of RCTs eg. Zero tillage on water and nutrient use efficiency and hydrology and water regime		√	√
Management of flooded and flood prone and water congested areas	Assessment of hydrology and management of *tal*, *chaur* and *diara* lands	√	√	√
	Water productivity through integrated management of diverse production system in such areas.		√	√
Risk analysis and management	Ecology, fishery biology and fish production dynamics of flood plain wetlands		√	√
	Vulnerability, adaptability and preparedness for climate change, drought and floods	√	√	√

Theme	Projects	2007-2012	2012-2017	2017-2025
	Risk analysis for commodity export from pest free zones.			√
	Development of forecasting tools and Decision Support System for different crop production processes		√	√
	Develop models and Decision Support System for water resource management/PIM	√	√	
Animal husbandry and fisheries practices and potentials	Database and evaluation of indigenous breeds of livestock and poultry	√	√	
	Potential and identification of fish genetic resources	√	√	
Feeds and feeding of livestock and fisheries	Survey and identification of feeds and fodders	√	√	
	Evaluation of high yielding fodders and techniques for fodder and byproduct enrichment	√	√	√
Livestock and fish production	Development of technologies for improving livestock production	√	√	√
	Development of low cost seasonal aquaculture	√	√	√
	Identification of suitable aquaculture technologies for inland water system	√		
	Livestock-crop-water interactions including livestock water productivity	√	√	
Animal and fish health management	Development of suitable package of practices for optimum health	√	√	√
	Survey and categorization of reproductive disorders and their management	√	√	√
Post-harvest technology and value addition of agricultural, horticultural and aquatic produce.	Development of efficient harvesting, handling and storage technologies for fruits, vegetables, flowers and *makhana*	√	√	√
	Development of suitable processing technologies and value addition for fruits, vegetables and *makhana*	√	√	√
	Market intelligence		√	√
Plant & Seed material production	Seed production of vegetables, ornamental, medicinal and aromatic crops and selected field crops	√	√	√
	Production and propagation of fruit crops like litchi, mango, guava, aonla and jackfruit	√	√	√
	Production of quality fingerlings	√	√	√
Technology assessment, refinement and dissemination	Development of participatory process for technology development and assessment	√	√	
	Participatory methods for technology assessment, refinement and dissemination	√	√	√
	Study on the empowerment of women in the society with special reference to development and dissemination of farming system technology	√	√	
Socio-Economic and policy research	Environmental/ resource economics of farming system, watershed project and irrigation/water management projects	√	√	√
	Changing trends in different farming system in Eastern region	√	√	

Theme	Projects	2007-2012	2012-2017	2017-2025
	Formulation of socio-economic institution and policy guideline for governance of resource management and public private partnership in research, extension, production and marketing		√	√
	Study on Value chain in agriculture.		√	√
Transfer of technology	Popularizing the low-cost and no cost technology among farmers	√	√	√
	Participatory action research in farming system, watershed management, water management and acqua- culture	√	√	√
	Analysis of different information delivery systems developed and the strengthen service delivery system through ICT (e-credit, e-information, e-market support)	√	√	√
	Organising Kisan Mela, Kisan Diwas, Kisan Goshti, Exhibitions etc. for technology transfer	√	√	√
Human resource development	Capacity building of scientists and technical personnels	√	√	√
	Organizing training programmes for various stakeholders	√	√	√
	Organizing national and international seminars, symposiums and workshops	√	√	√
	Organizing brainstorming meetings and liaisoning with line department of state/ central government	√	√	√
Intellectual Property Right	Strategies for protection of varieties and planting materials Implication and application of PPV and FR act, 2001, other IPR law, Seed act, Biodiversity act	√	√	√
Networking research	Promote networking research through establishment of a consortium at the institute headquarters	√	√	√
	Conducting networking research on water productivity programme on water and food in Indo-Gangetic Basin	√	√	√
	Coordinating research activities in the Indo-Gangetic Basin under the CGIAR Challenge programme	√		

ACRONYMS

ADB	Asian Development Bank
AEZ	Agro-Ecological Zones
AICRP	All India Coordinated Research Project
AICVIP	All India Coordinated Vegetable Improvement Project
BAU	Birsa Agricultural University
BCKV	Bidhan Chandra Krishi Vishwavidyalaya
CADA	Command Area Development Authority
CBIP	Central Board of Irrigation and Power
CEAD	Center for Environment and Agricultural Development
CG	Consultative Group
CGIAR	Consultative Group on International Agricultural Research
CHES	Central Horticultural Experimental Station
CIFA	Central Institute of Fisheries and Aquaculture
CIFRI	Central Inland Fisheries Research Institute
CNRM	Centre for Natural Resource Management
CPCRI	Central Plantation Crop Research Institute
CPWF	Challenge Program on Water and Food
CRIDA	Central Research Institute for Dryland Agriculture
CRP	Crop Research Program
CRRI	Central Rice Research Institute
CSWCRTI	Central Soil & Water Conservation Research & Training Institute
CTRI	Central Tobacco Research Institute
CTRS	Central Tobacco Research Station
CV	Coefficient of Variation
CWC	Central Water Commission
DAS	Days After Sowing
DFID	Department for International Development
DMSI	Dry Matter Stress Index
DSI	Drought Stress Index
DSP	Deep Summer Ploughing
DST	Department of Science and Technology
DWMR	Directorate of Water Management Research
EFC	Expenditure Finance Committee
FLD	Front Line Demonstration
FYM	Farm Yard Manure
GB	General Bodies
GBPUA&T	Govind Ballabh Pant University of Agricultural & Technology
GFCC	Ganga Flood Control Commission
GIS	Geographical Information System
GM	Green Manure
HACCP	Hazard Analysis and Critical Control Point
HARP	Horticulture and Agro-forestry Research Program
HQ	Headquarter
HRD	Human Resource Development
IARI	Indian Agricultural Research Institute
IASRI	Indian Agricultural Statistics Research Institute
ICAR-RCER	ICAR Research Complex for Eastern Region

ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
ICT	Information Communication Technology
IDE	International Development Enterprise
IFAD	International Fund for Agricultural Development
IIHR	Indian Institute of Horticultural Research
IIPR	Indian Institute of Pulses Research
IIT	Indian Institute of Technology
IIVR	Indian Institute of Vegetable Research
IMC	Institute Management Committee
IMD	India Meteorological Department
INARIS	Integrated National Agricultural Research Information System
INCID	Indian National Committee on Irrigation and Drainage
IPGRI	International Plant Genetic Resources Institute
IPM	Integrated Pest Management
IPR	Intellectual Property Right
ISO	International Standard Organization
IVLP	Institute Village Linkage Program
IWMI	International Water Management Institute
J&K	Jammu & Kashmir
JRF	Junior Research Fellow
KIIT	Kalinga Institute of Industrial Technology
KVK	Krishi Vigyan Kendra
LCC	Leaf Colour Chart
LFIMP	Livestock and Fisheries Improvement and Management Program
LWEERP	Land Water Environment and Engineering Research Program
MoWR	Ministry of Water Resources
MPT	Multi Purpose Trees
NAARM	National Academy of Agricultural Research and Management
NAAS	National Academy of Agricultural Sciences
NABARD	National Bank for Agricultural and Rural Development
NATP	National Agricultural Technology Project
NBPGR	National Bureau of Plant Genetic Resources
NBSSLUP	National Bureau of Soil Survey and Land Use Planning
NCAP	National Centre for Agricultural Economics and Policy Research
NGO	Non-Government Organization
NHB	National Horticultural Board
NIH	National Institute of Hydrology
NRM	Natural Resource Management
NRSA	National Remote Sensing Agency
NRSP	Natural Resources Support Program
NTFP	Non-Timber Forest Products
OPTALL	Optimal Allocation of Canal Water
PDCSR	Project Directorate for Cropping System Research
PRA	Participatory Resource Appraisal
QRT	Quinquennial Review Team
RA	Research Associate
RAU	Rajendra Agricultural University
RCM	Research Centre on *Makhana*
RCT	Resources Conservation Technology

SAU	State Agricultural University
SEERP	Socio-Economics and Extension Research Program
SFC	State Farm Corporation
SHG	Self Help Group
SRC	Staff Research Council
SRF	Senior Research Fellow
SWOT	Strengths Weakness, Opportunity and Threat
TIFAC	Technology Information Forecasting and Assessment Council
USAID	United States Agency for International Development
WTO	World Trade Organization
WUA	Water Users' Association
YSR	Yield Stability Ratio
ZT	Zero Tillage
ZTDSR	Zero Tillage for Direct Seeded Rice

The quadrangle in the ICAR RCER building

ICAR RESEARCH COMPLEX FOR EASTERN REGION

ICAR Parisar, P O - B. V. College,
PATNA 800 014, (BIHAR), India
Tel: 0612 2223962, Fax: (91) 0612 2223956
Website: www.icarer.ernet.in