

## **7. PERSPECTIVE**

As described in the scenario section, widening gap between water supply and water demand, declining water quality, soil erosion and land degradation, and erosion of biodiversity add critical dimensions to land, water, and vegetation management problems. Changing life style and dietary consumption patterns, and changing market scenario with the entry of multinationals and national ventures, call for added emphasis on diversified land use and crop diversification. Agricultural productivity in India must improve continually. Growers/producers will need to diversify away from basic cereals to cash crops, fruits, vegetables, livestock, fisheries and value added agricultural products. Eastern region known as low productivity-high potential region holds promise to improve livelihoods of resource poor farmers of the region by overcoming existing yield gaps and utilizing potential of untapped natural resources by integrating crops, fruits, vegetables, livestock, fisheries, aquatic crops, alternate livelihood options and micro enterprises into an Integrated Farming System (IFS). A networking and partnership model involving NARES, Developmental Agencies, NGOs, Panchayati Raj Institutions and Private Organizations/Institutions is called for implementing the IFS and also for improving service delivery system. The component perspectives are described in this section.

### **Enhancing agricultural water productivity**

Reduced diversion of water for agriculture and increased food requirements by 2025 would require immediate attention of researchers, planners and practitioners to enhance productivity of water. There is a direct relationship between increasing water productivity and the need for future water development. The more productive agriculture becomes, the less would be the need for water resources development. Additional new sources for development of water resources are difficult to exploit since suitable sites for dams are fewer, irrigation development is cost prohibitive and environmental concerns are strong. Studies indicate that if average agricultural water productivity increases by 70 per cent from present level, no more increase in water diverted for irrigation will be required by 2025. It will also not be necessary to expand area or improve cropping intensity, and no additional infrastructure development for irrigation may be required. There would, however, be the need to improve and add infrastructure to provide for more water control and rational management of existing water resources. Pathways for enhancing agricultural water productivity at different levels would involve emphasis on (i) Enhancing marketable yield per unit of water transpired through crop varietal improvement, (ii) Reducing outflows (drainage, seepage and percolation) and non-productive depletions (evaporation from soil and water, weeds), (iii) Increasing non-irrigation inflows (rainfall, stored water, marginal quality water, waterlogged/drainage water), (iv) Increasing the effective use of water from the storage, (v) Using not yet committed flows, and (vi) Reallocating and co-managing water (multiple use) among uses.

### **Improving productivity of rainfed agriculture**

Eastern region being largely dependent upon rainfed agriculture, despite the annual rainfall being adequate across all agro-eco systems, agriculture production suffers from water stress on one hand and excess runoff and water congestion causing floods on the other hand. Land degradation continues unabated due to mismanagement of land and water. Therefore, rain water management through storage

and recycling of runoff will be the key for controlling soil erosion and sustaining horticulture, crop, livestock and fisheries production system in rainfed plains and plateau areas. Adoption of appropriate technologies on toposequential water harvesting systems such as construction of Jalkunds, plastic lined tanks, wells, sub-surface water harvesting, check dams etc will lead to increased agricultural productivity in the eastern region. Research efforts will be directed towards evolving cost effective and socially acceptable water harvesting structures for promoting horti-based integrated farming system. The Complex will endeavour to develop alternate cropping systems for drought prone areas, uplands and plateau regions for avoiding crop failure and risk minimization.

Integrated watershed management has now been accepted as the most rational approach to avoid deterioration of ecosystem, restoration of degraded lands, efficient water harvesting and improving the overall productivity of the rainfed areas. This paradigm shift will be further strengthened and promoted through watershed based farming system research especially in the hills and plateau areas of eastern region by developing model bio-industrial watersheds for enhancing income, employment and livelihood opportunities.

### **Promoting conjunctive use of surface and ground water in canal commands**

There is lack of conjunctive use of canal and ground waters in canal commands and ground water potential is underutilized. The utilization of developed ground water potential remained poor due to erratic power supply, small and fragmented land holdings and more dependence on rain and unreliable surface water supplies. Ground water markets are however picking up in West Bengal and parts of U.P. and Bihar. Emphasis will have to be laid on participatory water management and value addition of water through multiple uses to enhance efficiency and water productivity of rain, surface and ground waters by enlarging the scope of existing Participatory Irrigation Management (PIM) to Participatory Water Management (PWM) in canal commands.

### **Water and energy saving technologies**

Eastern region is rich in water potential as compared to other parts of the country. Crops like sugarcane, banana and rice have limited scope in water deficit areas. Sugarcane and banana are, therefore, gaining importance in eastern region (particularly sugarcane) with policy support of local government, especially in Bihar. Strategic research on water management for these crops pertaining to less water use, low energy application and quality production is required to sustain the emerging cropping in eastern India so that story of depleting water resources in other parts of the country is not repeated. Research in water saving irrigation methods, including micro irrigation would be required to sustain the emerging water needs of sugarcane, banana. Nexus between water and energy, and increasing energy crisis requires attention to evolve water and energy-efficient irrigation systems. There is also a need to develop low energy water application device for small holders for irrigating rice, wheat, close growing crops, fruits and vegetables. This would have special significance for horticultural crops in plateau region.

### **Managing flooded, flood prone and waterlogged areas**

Recurrent floods resulting in crop failures are common in the eastern region. Alternate cropping strategies for partially/completely damaged crops need to be worked out for mitigating the sufferings of

affected people. A vast stretch of area is permanently or seasonally waterlogged and/or faces serious drainage congestion problem owing to flat topography. Canal irrigated areas are dotted with canal induced waterlogging. The flooded and flood prone areas are characterized with tal, diara, chaur and mauns (ox bow lakes). These areas offer great potential and challenge for their productive utilization through appropriate farming system including fisheries, aquaculture, makhana etc. Perennial and seasonal water bodies abounding in the region are not being effectively and productively utilized for fishery and aquaculture following multiple water-use and farming system approach. Production system management in such hydromorphic environment including flood plains has not received needed research attention. The Complex would address these issues in future.

### **Promoting decision support systems**

It is essential to anticipate, analyze and address complexities and interactions of soil, water, crop, climate, insect and pest infestation and epidemics on agriculture production. Frequent floods and droughts, disease and insects infestation and climate change pose serious challenges and call for remedial measures/management and preparedness strategies employing modern tools and techniques. The complex will endeavour to develop Decision Support Systems through optimization / simulation / mathematical modeling / forecasting techniques using GIS and remote sensing technologies to facilitate decision making in land and water management, crop prediction process, pest management and anticipated climate change impact.

### **Exploiting multiple uses of water**

Multiple uses of water employing use of available water resources for more than one purpose or production system is inevitable to produce more food with less water by integrating crops, horticulture, forests, fisheries, livestock, household enterprises, domestic needs etc. These provide challenging opportunities for increasing water productivity and livelihood opportunities at various scales ranging from farm to basin scales under irrigated, rainfed, waterlogged conditions and using poor quality water in rural and peri-urban areas. Irrigation and water harvesting infrastructures, village common property resources though recognized for providing water for agricultural production, their role in providing water for other uses has often been inadequately addressed. There is a need to develop multiple use models for different agro-hydrological conditions to suit various categories of small and marginal farmers to improve their livelihoods.

In addition, multiple uses of rain, surface and ground water, and poor or degraded water or waste water also will secure attention. Development of water bodies based horticultural production system like pond based fruit production system in flood prone areas and coastal areas; pisciculture and Makhana cultivation in water logged areas of north Bihar; water harvesting structures based horticultural production systems in uplands; and makhana, fish and other aquatic crops in low and wetlands will assume importance.

### **Management of poor quality waters**

With increasing agricultural intensification, pollution risk from the use of fertilizers and other agro-chemicals is likely to increase. Increasing urban population and industrialization will produce more sewage flows and industrial effluents, which will cause greater stress on environment. These poor

quality waters as well as drainage water from agricultural lands have to be used in agriculture to reduce stress on available fresh water sources and on the environment. Developing and adopting techniques for the use of poor quality waters in agriculture will essentially be addressed in future.

The ground waters in eastern region suffer from Arsenic and Fluoride contamination causing serious health hazard to plant, animal and human population of the region. Higher concentration of fluoride (> 1.50 mg/l) is recorded in the many districts of Bihar, West Bengal, Jharkhand and eastern U.P. districts along both sides of the Hooghly river in West Bengal are affected by Arsenic contamination in ground water. Few districts of Bihar have also been affected by Arsenic toxicity in ground water. The research efforts would be focused on understanding the soil-aquifer interactions for release, spread and retention of these toxic elements for framing strategies for mitigating their adverse impact in partnership with State Departments, WALMI and Regional Centre of National Institute of Hydrology, Patna.

### **Acid soils management**

In eastern region excessive leaching of bases from red and lateritic soil due to heavy rainfall render the soil acidic in reaction. High soil acidity is a serious constraint for successful crop production in the eastern hills and plateau region. Appropriate focus will be given towards management and reclamation of acidic soils as per recommendations of ICAR funded long term project on Acid Soil Management being carried out at BAU, Jharkhand.

### **Development of quality cultivars and integrated pest and disease management of agricultural crops**

There is an urgent need to develop suitable high yielding, disease and pest resistant location-specific varieties of important oilseed, pulses, fruits, vegetables and medicinal and aromatic plants to meet the global competition in view of WTP, PVP, IPR and TRIPS guidelines. Emphasis will be given to develop quality cultivars specially in fruits and vegetable crops using facilities and expertise available at HARP, Ranchi Center of the Complex. In eastern region, the crops are prone to a number of insect pests and diseases. Increased application of pesticide and other chemical control measures result in resurgence of resistant strains of pests, environmental pollution and other health hazards and higher cost of cultivation. Development of integrated pest and disease management techniques, biological pest control and judicious application of chemical control measures will receive attention.

### **Management of genetic resources for enhanced horticultural production**

Strengthening of genetic resource management programme for identification, collection, conservation, characterization of suitable genotypes of different horticultural crops and their target specific utilization would require concerted efforts. Enrichment of germplasm of different horticultural crops from different sources is of utmost importance. At present, commercial production is restricted to a small number of fruits such as, Mango, Litchi, Banana and Guava. But minor fruits such as, pomegranate, ber, bael, jamun, strawberry, passion fruit, custard apple have not been tried on commercial scale. Similarly, in case of vegetables drumstick, minor gourd like spine gourd, small gourd and different leafy vegetables have not been commercialized due to lack of improved varieties. Fast growing information technology and modern communication networks have already increased awareness in the world communities about rich variability in exploitable horticultural plant species.

Some lesser known fruits like tamarind and chironji and minor gourds and drumstick in vegetables have already attracted the palate of the people in distant corners of the globe. Utilization of such traditional and underutilized horticultural crops will assume importance. The increasing controversy regarding patenting of plant genotypes demands DNA finger printing of available genotypes in the region. Mango, Litchi, Banana, Papaya and guava, suffer great losses due to different stresses. Searching for host, resistant to biotic and abiotic stresses would be rewarding to develop cost effective production technology. Traditional breeding methods have failed so far to develop resistant lines. The Complex will endeavour to develop resistant varieties of these crops through biotechnology tools.

#### **Availability of high quality planting material and seeds**

For expansion of area under horticultural crops in eastern region, a large number of quality planting materials of different fruit and other important horticultural crops is required. There is a need for standardization of large-scale, disease free plant multiplication techniques. Availability of large-scale breeder, foundation, certified and truthfully labeled seeds will be imperative to meet the growing needs of domestic and export market needs of vegetable crops. Human Resource Development and Public-Private Partnership issues will be addressed in this sector. In order to meet requirements for implementing schemes like National Horticulture Mission and expanding area under National Rural Employment Guarantee, efforts will be required for developing faster multiplication techniques.

#### **Market orientation of horticultural production**

International trade of horticultural produce and products is expected to grow very fast in view of the post WTO scenario. With the large-scale inflow of high quality horticultural produce from other countries into the region, there will be immense pressure on the horticultural producers of the region for intensification of quality management programmes in their production system. Export requirements of horticultural produce and products are expected to grow very fast which will also require R&D preparedness for quality improvement of horticultural produce from the region. Again, the recent upcoming scenario of supermarkets such as Wallmart, Reliance Fresh, Bharti Agro etc. warrants development of state-of-art technologies for market oriented production of high quality fruits, vegetables, flower etc. Research will need to be intensified on protected cultivation and precision farming for production of quality produce and their prolonged availability periods.

#### **Futuristic post harvest technology, bio-fortification and value addition**

Post harvest losses of fruits and vegetables account for about 30 per cent of total loss. The poor shelf life of these crops is a major constraint in their production system. Bringing out refinements in production techniques like staking, raised bed production, use of plastic tunnels, shadenets etc can help in reducing the pre and post-harvest losses. Sustained efforts need to be made to standardize packages for enhancing shelf life. Research on developing suitable and economical post-harvest technologies for processing, preservation and value addition of important horticultural products including aquatic crops like Makhana would assume priority. Bio-fortification of horticultural crops to combat nutritional deficiency among the rural people will receive major thrust. Income potential of indigenous produce can be enhanced by value addition. Therefore, technologies need to be developed for horticultural enterprise such as post-harvest handling of produce, processing and value addition for gainful employment to the

rural people. This would require partnership, linkages and networking with other research institutions of CSIR and private institutions/corporate sectors.

### **Development of agro-forestry**

The plateau and hill region in the eastern states are rich in forest resources. However, continuous pressure on forest land due to expanding human habitation resulted in rapid decrease in forestland leading to land degradation. This has necessitated a reduction in the pressure on the existing forest land and development of man-made plantations to fulfill the requirement of forest products. Agro-forestry is an efficient production system for enhancing the forest resources and improving the sustainability of the ecosystems in which multipurpose trees are a major component. Generation of scientific information on fast growing forest species and their suitability for intercropping with various agri-horticultural crops will help in supplementing the fuel, fodder and timber needs.

### **Development of makhana and aquatic crops**

Development of new high yielding short duration, disease tolerant varieties of Makhana will enhance guri production in intensive Makhana growing areas from a present level of 30 q/ha to 60 q/ha. The area increase under Makhana will be doubled by energizing the waste water bodies presently unused and suitable for aquaculture production. Concerted efforts are required to develop production system, integrated farming system with crop, fish and horticultural enterprises under aqua-terrestrial eco-system, crop production technology with improved cultivars, value added Makhana pop and other suitable products, by products in various kind of recipes, snacks, health food, health drinks and confectionaries.

### **Livestock management**

The Complex envisages developing and evaluating technologies for breeding, feeding and health care of livestock, poultry and fisheries suitable for the climates of eastern region. The livestock research will focus primarily on improvement of production and productivity of livestock employing scientific management practices, improved feeding and prophylactic and curative health care management. Livestock will form an integral part of diverse Integrated Farming Systems integrating livestock with crops, horticulture and fisheries to support livelihood of rural households. Since the region is prone to frequent floods and droughts, suitable livestock management strategies will be developed for protecting livestock and for risk minimization. Crop-livestock-water interactions including livestock water productivity aspects need attention. Opportunities in the world market will push demand for milk and animal products on a higher rate. Since, India is emerging as a major new market for agriculture export, processing and value addition will be in high demand. Postproduction processing, storage and marketing system have to be channelized. Bank and other financial institutions also have to be persuaded for micro financing in livestock sector. Formation of SHGs and farmers' co-operatives will play an important role in this endeavour.

### **Fodder production**

A deficit of about 65 per cent green and 25 per cent dry fodder is projected based on the Working Group Report on Animal Husbandry and Dairying of the Planning Commission (2002). Keeping in view the increased livestock population, and significant growth for milk and other animal products by 2025,

the demand of grain and fodder for animal feeding will be increased. At the same time, there will be increased demand for round the year fodder availability to increase the economic returns. Since, per capita land holding will decline and agrarian structure will be transformed, high yielding and nutritious fodder varieties will be introduced and distribution of seed and slips will be intensified. Enrichment of low quality roughages and improvement of agro-industrial byproducts for livestock feeding would be needed. Fodder production in rainfed condition will be given importance. Economic rations for livestock based on locally available feed resources would be needed. Model fodder farms for demonstration to farmers will be required.

### **Fishery management**

The region has congenial environment and scope for inland fish production. The eastern region contributes 52.4 per cent of total inland fish production in India. The region has 1.1 million ha total water area constituting reservoirs, ponds, tanks and beels, oxbow lakes etc. besides 15046 km length of rivers and canals for fisheries production. The region has immense potential for culture and export of shrimp. Value addition and quality control of fish products require emphasis. Since, the region is potential rice grown area, fish production can be enhanced by practicing rice-fish culture. Research on fish culture in flood prone areas, waterlogged areas like chauras, mauns (oxbow lakes) for enhancing economic returns and employment generation will be given importance. Other aquaculture activities like pearl culture, ornamental fish culture will also need emphasis.

### **Integrated farming system models for improving livelihoods**

Globalization, cost competitiveness and environmental audit call for most efficient use of input resources such as energy, water, agro-chemicals and manpower for enhancing productivity through increased resource-use efficiency and total factor productivity. Besides food security, nutritional security and livelihood security have emerged as major issues and call for integrated resource conservation and management through need based Farming System Approach.

Monoculture production system prevalent in different parts of eastern region is often unprofitable owing to less efficient resource utilization and risk of ecological calamities in the region. Due to changing rainfall pattern, area of rice under upland and to some extent in midlands during kharif season and due to temperature problem wheat area in winter season is being replaced by maize. Government policy is also supporting establishment of poultry feed industries and other products based on maize. Quality Protein Maize is in eastern U.P., Bihar and West Bengal during kharif as well as rabi season is therefore becoming a boon to the poor. Increasing cropping intensity through crop diversification, such as maize in north Bihar and U.P. will be a major thrust area.

Developing appropriate multi-commodity based integrated farming system dovetailing with the available agroclimatic resources and local socio-economic needs and preferences would assume great significance. Major thrust of the Complex will, therefore, be on developing integrated, location-specific multi-commodity farming systems having synergistic interaction of horticultural, crop and agro-forestry based cropping system with fishery and animal components to enhance the income of resource poor farmers of the eastern region. The enterprise combinations will include Makhana based, Litchi based, vegetable based, floriculture based cropping systems for irrigated conditions; mango based, Aonla

based, agroforestry based, medicinal plants based cropping systems for rainfed conditions; coconut based, banana based cropping system for coastal region; makhana, fish and banana based cropping system for flood prone and waterlogged areas; agro-forestry based cropping system for hill, forest and plateau regions.

### **Commercialization of technologies and intellectual property rights**

To make the agricultural system profitable and sustainable under competitive post WTO scenario, IPRs and TRIPS, precise technology package need to be developed incorporating efficient use of inputs for quality production under different eco-regions in eastern India. Development of cultivars of field and horticultural crops fulfilling the quality standards and CODEX will assume immense importance. A shift in the breeding strategy from only high yielding cultivars resistant to different biotic and abiotic stresses to cultivars with high yield, resistance having qualities for palatability, appearance, nutritional and medicinal values and fulfilling to the specific needs of different industries is needed. The technologies developed by the Complex shall be assessed for their potential for commercialization. The commercialization will form the base of all researchable issues for future technology generation. A model for calculation of costing of technology keeping in view the target group to be addressed will be taken into consideration for efficient commercialization. Protocol and modalities for IPR issues, brand forming, standards for national and international marketing will be developed. Market intelligence mechanism for assessment of demand of commodities and appropriate technologies will be given due emphasis.

The Complex will, therefore, play a major role in assessment and refinement of policy on science and technology for IPR and biosafety related issues to safeguard the interest of the farmers of eastern region. The key areas that could be effectively linked and integrated in it could be sanitary and phytosanitary regulations, risk assessment and management, quarantine and trade; food quality and food-safety standards, harmonization/implementation of regulations; intellectual property rights, plant-breeders' rights, farmers' rights; regulations and ethics of development and sharing of biotechnology and biotechnological projects; environment assessment and management; and internationalization of environmental costs in pricing and trade.

### **Promoting public-private partnerships and network/consortia**

The challenges of agriculture in eastern region have to be met through sustained efforts on research and developmental issues in which all stakeholders of progress and prosperity are involved. Partnerships are increasingly recognized as viable strategy for achieving goals of agricultural research and development. New forms of partnership especially between public and private entities are increasingly seen as an effective way to ensure wider participation and for diverse interest considerations. The Complex envisages participation of Public, Private, NGOs, Semi govt. organizations, SAUs, ICAR Institutes etc. especially on integrated farming system aspects, service delivery etc. in a network/consortium mode from planning to implementation programme of appropriate technologies.

## **Income and employment generation**

Agricultural research for development of agriculture will need to be focused towards National Agriculture Policy and policies of the government to ensure employment generation and livelihood improvement. 'Food for Work' programme is envisaged to generate employment in 150 hot spot districts for livelihood improvement. Our research and developmental efforts should find ways to suggest opportunities for creation of assets for generating self employment in rural and peri-urban areas through agri-horti-fishery-livestock based multi-commodity and allied activities. This could also serve as a means for exploiting non-traditional commodities and areas for alternate sources of food, nutrition and livelihoods for rural poor and unemployed youth.

## **Livelihood improvement of tribals in eastern plateau**

Intensification of backyard garden activity through judicious introduction of fruit crops like jackfruit, papaya and improved varieties of vegetable crops can address the need for balanced diet for rural household as well as provide supplemental income to the rural women. Integration of other allied enterprises like backyard poultry, duckery cum fish culture, goatery, dairy, piggery, apiary, sericulture, lac cultivation, mushroom cultivation etc in existing production system can effectively address issues on livelihood of tribal population. Development of aquaculture holds promise for effective utilization of large number of seasonal water bodies that remain so far untapped in the tribal dominated region of eastern India. The region is observed as backward zone for milk production, however there is a potential and scope for milk, egg and meat production due to higher coverage of forest. Thus development of resource based farming system models to harness synergy between different production systems will be needed for sustainable livelihood support of tribals. In the era of market globalization, there is an urgent need for empowering the tribals in the areas of social institution building, market orientation and access to available institutional support. In this respect, capacity building of target groups and development of policy guidelines for tribals would be imperative.

## **Futuristic service delivery system**

Improvement in agriculture service delivery system is vital for extended agricultural services like knowledge, inputs, information etc. to farmers. There is a need to reduce government dependence on service delivery except in core areas where government leadership is essential. Innovations in participatory technology development and innovations towards service delivery have shown encouraging trends. Whereas, the government support for service delivery through government institutions will exist, there is a need to diversify and strengthen the local stakeholder organizations like NGOs, SHGs, Private Entrepreneurs and other local level community institutions. There is a need to promote an efficient service delivery system where the information, skill and logistics will be available to largest segments of farming community. The Complex proposes to contribute towards strengthening public-private partnership, people-state-NGO-triangular contribution, and cyber extension through Information Communication Technologies (ICTs). The Complex will develop research programmes to evaluate the effectiveness of these service delivery mechanisms in terms of reliability, quality, timeliness

and access. The major focus will be to minimize the dependence on government institutional support and to rely on local participatory community organizations for effective service delivery including linkages.

### **Policy issues research**

Policy research will be an integral part of the ICAR-RCER mission. In order to disseminate agriculture technology to the farmers, socio-economic constraints in adoption of biophysical solution will be identified and principles and policy guidelines will be developed for integration of production technologies with socio-economic environment. Major emphasis will be given for socio-economic characterization of the region for identification of removable production constraints. Through its research and outreach activities and development of suitable service delivery system/mechanism, the policies shall be promoted to reduce poverty, improve food security and nutrition and alleviate pressure on fragile natural resources. Taken together these activities will create a formidable matrix for advancing sustainable agricultural development in the eastern region. Participatory technology development and dissemination approach needs emphasis.

### **Human resource development in core and frontier areas**

The Scientific, Technical, Administrative, Financial and Auxiliary personnel play an important role in execution of research plans and developmental activities. The agricultural research scenario all over the world is changing very fast. In view of the global changes, the research in the eastern region has to be made more efficient and relevant. To equip personnel in state-of-the-art technology skill, expertise and knowledge, regular HRD programmes will be conducted, which will include National and International Training Programmes in cutting-edge Technologies and frontier areas viz. biotechnology, bio-informatics, information and communication technology, remote sensing, behavioral science and research management skills, integrated farming system research, water productivity assessment, multiple use, climate change impact modeling, risk analysis and management, IPR issues, integrated water management, integrated aquaculture management and socio-economic and policy research at reputed organizations in developed countries.

### **Approach envisaged for realizing perspectives**

In order to transform the 'low-productivity-high potential' eastern region into 'high productivity' region, the complex would 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. For rainfed and plateau ecosystems areas, watershed based approach would be adopted. For irrigated eco-system command area approach would be followed. For flooded, flood prone and for coastal ecosystem, multiple water use approach would be appropriate. A new business model of partnership involving ICAR Institutes, SAUs, CG Centres, NGOs, Private Institutes, and State Agencies in a network/consortia approach is envisaged. The model involves development of core competence in specific areas, namely, land and water management, horticulture, and makhana for research on component technologies and integrated

farming system. The convergence would be achieved through networking and consortia in the areas of integrated agriculture, processing and value addition, policy research and service delivery. In order to implement the proposed business model, the complex would require (i) separate funds for core research on component technologies, (ii) provision of funds for Networking and linkages, and (iii) Fund allocation for HRD & training in core competence areas.

## 8. ISSUES

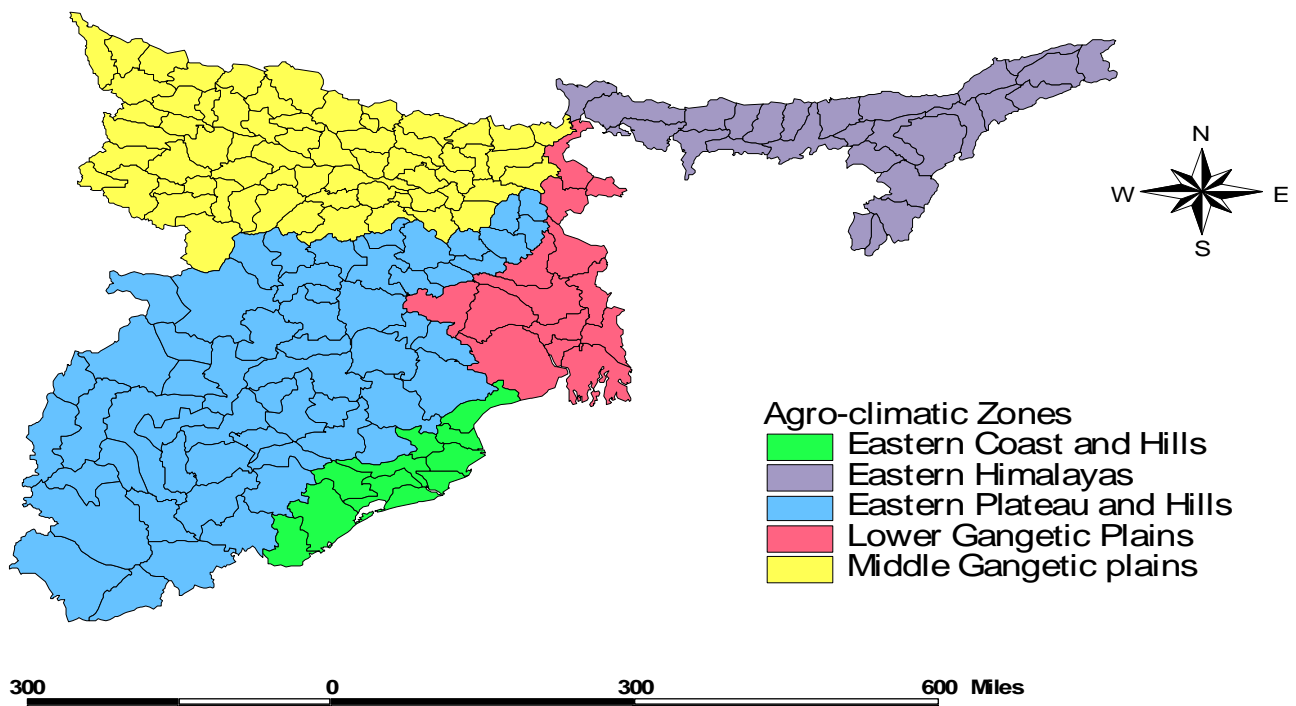
- Resource poor farmers with lowest per capita income, lowest per capita land availability and small and fragmented farm holdings
- Low seed replacement rate and low fertilizer use
- Poor infrastructure, roads, communication, power supply, storage, processing and marketing facilities for agricultural 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 waterlogging 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 waterlogged 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
- Lack of policy research for inclusion into regional and national policy formulation and public-private partnership

### Setting research priorities for eastern region

Based on the 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 and Government Policies, prioritization of researchable issues for networking research in the eastern region, a research prioritization exercise was conducted.

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 (Fig 7), .



*Fig. 7 Agro-climatic zones of eastern region of India*

The prioritized researchable issues of the eastern region are presented in Table 5.

**Table 5. The agro-climatic zonewise prioritized researchable issues for the eastern region**

Researchable 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

The prioritized issues have led to the formulation of the programmes, which are described in the following section.

**9. PROGRAMMES AND PROJECTS ON TIME SCALE AND FUND REQUIREMENTS**

Theme	Projects	2007-2012	2012-2017	2017-2025	Fund Requirement for XIth Plan (Rs. In Lakhs)
<b>Resource inventORIZATION</b>	Status and characterization of eastern region for natural resource management				10.00
	Effective utilization of modern tools and techniques like remote sensing, GPS & GIS for baseline survey, planning and monitoring				30.00
	Resource inventORIZATION of field, horticultural and aquatic crops including makhana, fish, animal resource and Socio-economics				15.00
	Constraint identification and prioritization				10.00
	Bio-informatics approaches for resource inventORIZATION				40.00
<b>Development of quality cultivars of agricultural, Horticultural and aquatic crops</b>	Plant genetic resource management in field, horticultural, makhana and other aquatic crops				40.00
	Development of molecular maps for desirable characters in different agricultural and horticultural crops				75.00
	Improvement for desirable traits (high nutrition quality, transportation, processing and export) of horticultural crops				20.00
	Methodologies for biosafety of transgenics				
	Development of drought tolerant and water-use efficient traits of field and horticultural crops				60.00
	Collection, conservation and evaluation of MPITs				5.00
	Development of fish based IFS models for waterlogged areas				15.00
<b>Integrated location-specific, multi-commodity farming system involving field crops, horticulture,</b>	Development of livestock based IFS models for different category of farmers				350.00
	Development of horticulture based IFS models for household food and nutritional security for eastern plateau				25.00

<b>Theme</b>	<b>Projects</b>	<b>2007-2012</b>	<b>2012-2017</b>	<b>2017-2025</b>	<b>Fund Requirement for XIth Plan (Rs. In Lakhs)</b>
<b>aquatic, livestock, fisheries, crops and other enterprises</b>	Development of crop based IFS models for irrigated Indo-Gangetic plains				40.00
	Development of location-specific agro-forestry models for fuel, fodder, energy, bio-diesel and allied enterprises like lac, Beekeeping and sericulture				25.00
	Development of crop diversification models under different ecosystems				35.00
	Standardization of agronomic practices in field crops				20.00
	Standardization of production technologies in horticultural crops including INM, canopy management, floor management and cropping system				90.00
<b>Production techniques for field, horticultural, agro-forestry, and aquatic crops like makhana</b>	Identification, evaluation and promotion of medicinal & aromatic plants for better economic returns as pure or inter crops including small holders' herbal garden				5.00
	Standardization of production technologies for makhana production				5.00
	Standardization of integrated plant protection technologies for insect pests, disease, nematodes, rodents and birds				50.00
	Development of commodity and location-specific organic farming system of agri and horticultural crops				10.00
	Conjunctive use models for rain/surface/ground water for enhanced water productivity				10.00
<b>Integrated water Management</b>	Specific crop/horticulture based water management for precision agriculture				40.00
	Participatory on-farm water management in irrigated commands				20.00

Theme	Projects	2007-2012	2012-2017	2017-2025	Fund Requirement for XIth Plan (Rs. In Lakhs)
<b>Multiple uses of water</b>	Development of methodology for assessing water productivity				10.00
	Performance evaluation of canal irrigation in irrigation commands				
	Water quality assessment and amelioration measures for arsenic and fluoride problems				20.00
	Waste water reuse and peri-urban agriculture				
<b>Multiple uses of water</b>	Development of suitable multiple water use models for irrigated / rainfed / flood prone and waterlogged areas				25.00
	Improving water productivity through multiple uses of irrigation water in conjunction with fishery/aquaculture sector including makhana				25.00
	Awareness and utilization of common property resource for multiple water use				8.00
<b>Rain water harvesting and watershed management</b>	Develop and demonstrate integrated watershed management and water harvesting systems in uplands of eastern plateau region				60.00
	Develop and demonstrate watershed based IFS for livelihood improvement				
	Monitoring and impact assessment of watershed projects				
<b>Development, testing and popularization of resource conservation technologies</b>	Acceleration and evaluation of RCTs in eastern region				30.00
	Long term impacts of RCTs e.g. zero tillage on water and nutrient-use efficiency and hydrology and water regime				
<b>Management of flooded and flood prone and water congested areas</b>	Assessment of hydrology and management of <i>tal, chaur</i> and <i>diara</i> lands				20.00
	Water productivity through integrated management of diverse production system in such areas				

<b>Theme</b>	<b>Projects</b>	<b>2007-2012</b>	<b>2012-2017</b>	<b>2017-2025</b>	<b>Fund Requirement for XIth Plan (Rs. In Lakhs)</b>
<b>Risk analysis and management</b>	Ecology, fishery biology and fish production dynamics of flood plain wetlands				
	Vulnerability, adaptability and preparedness for climate change, drought and floods				30.00
	Risk analysis for commodity export from pest free zones				
	Development of forecasting tools and Decision Support System for different crop production processes				
<b>Animal husbandry and fisheries practices and potentials</b>	Development of models and Decision Support System for water resource management/PIM				20.00
	Database and evaluation of indigenous breeds of livestock and poultry				2.50
	Identification of fish genetic resource and their potential				2.50
	Survey and identification of feeds and fodders				19.00
<b>Feeds and feeding of livestock and fisheries</b>	Evaluation of high yielding fodders and techniques for fodder and byproduct enrichment				17.50
	Development of technologies for improving livestock production				75.00
<b>Livestock and fish production</b>	Development of low cost seasonal aquaculture				3.50
	Identification of suitable aquaculture technologies for inland water system				3.00
	Livestock-crop-water interactions including livestock water productivity				3.00
<b>Animal and fish health management</b>	Development of suitable package of practices for optimum health				40.00
	Survey and categorization of reproductive disorders and their management				5.00

<b>Theme</b>	<b>Projects</b>	<b>2007-2012</b>	<b>2012-2017</b>	<b>2017-2025</b>	<b>Fund Requirement for XIth Plan (Rs. In Lakhs)</b>
<b>Post-harvest technology and value addition of agricultural, horticultural and aquatic produce</b>	Development of efficient harvesting, handling and storage technologies for fruits, vegetables, flowers and makhana				108.00
	Development of suitable processing technologies and value addition for fruits, vegetables and makhana				15.00
	Market intelligence				
<b>Plant &amp; Seed material production</b>	Seed production of vegetables, ornamental, medicinal and aromatic crops and selected field crops				40.00
	Production and propagation of fruit crops like litchi, mango, guava, aonla and jackfruit				25.00
	Production of quality fingerlings				10.00
<b>Technology assessment, refinement and dissemination</b>	Development of participatory process for technology development and assessment				16.00
	Participatory methods for technology assessment, refinement and dissemination				16.00
	Study on the empowerment of women in the society with special reference to development and dissemination of farming system technology				3.00
<b>Socio-Economic and policy research</b>	Environmental/ resource economics of farming system, watershed project and irrigation/water management projects				3.00
	Changing trends in different farming system in eastern region				5.00
	Formulation of socio-economic institution and policy guidelines for governance of resource management and public private partnership in research, extension, production and marketing				
	Study on value chain in agriculture				

<b>Theme</b>	<b>Projects</b>	<b>2007-2012</b>	<b>2012-2017</b>	<b>2017-2025</b>	<b>Fund Requirement for XIth Plan (Rs. In Lakhs)</b>
<b>Transfer of technology</b>	Popularizing the low-cost and no cost technology among farmers				10.00
	Participatory action research in farming system, watershed management, water management and aqua- culture				15.00
	Analysis of different information delivery systems developed and the strengthening service delivery system through ICT (e-credit, e-information, e-market support)				10.00
<b>Human resource development</b>	Organising Kisan Mela, Kisan Diwas, Kisan Goshti, Exhibitions etc. for technology transfer				10.00
	Capacity building of scientists and technical personnel				15.00
	Organizing training programmes for various stakeholders				10.00
	Organizing national and international seminars, symposiums and workshops				9.00
	Organizing brainstorming meetings and liaisoning with line department of state/ central government				4.00
<b>Intellectual property rights</b>	Strategies for protection of varieties and planting materials				5.00
	Implication and application of PPV and FR act, 2001, other IPR law, Seed act, Biodiversity act				
<b>Networking research</b>	Promote networking research through establishment of a consortium at the institute headquarters				25.00
	Conducting networking research on water productivity programme on water and food in Indo-Gangetic Basin				30.00
	Coordinating research activities in the Indo-Gangetic Basin under the CGIAR Challenge programme				
	<b>Total</b>				<b>1848.00</b>

The major share of the funds needed for execution of the programmes envisaged in the Perspective Plan will be borne by the Indian Council of Agricultural Research (ICAR). Based on the availability of the funds, the research and development will be taken up in a prioritized manner considering the current needs and prevailing situation. Since the Complex is a new institute, adequate additional funding for infrastructural development will be required.

In addition to ICAR grants, funds will also be generated through competitive grants from outside funding agencies such as DST, MoWR, INCID, MoRD, NHB etc. and international agencies such as CGIAR institutes, ACIAR, DFID, USAID, IFAD, and Challenge Programme on Water & Food (CPWF) etc. for short term projects. The funds will also be generated from farm revenue through sale of farm produce, consultancy, and contract research, and organization of short courses.

## 10. LINKAGES

Sl. No.	Programmes	Proposed linkages with	
		National organizations	International organizations
1	Resource inventorisation	IIHR, NBPGR, NIH, MoWR, BoES, WTCER	USAID, IWMI, IFPRI, IRRI, CSIRO, WRI
2	Development of quality cultivars of agricultural, horticultural and aquatic crops	NBPGR, NBFGR, CRRI, CIFRI, IIHR, CIFA, IVRI	IRRI, IPGRI
3	Integrated location-specific, multi-commodity farming system involving field crops, horticulture, aquatic, livestock, fisheries, crops and other enterprises.	SAUs, PDCSR, WTCER	ICARDA, WFC, ICRAF, ACIAR, CSIRO
4	Production techniques for field, horticultural, agro-forestry and aquatic crops like makhana	CRIDA, SAUs, IVRI, IARI, IIVR, IIPR, IIHR.	CIMMYT, IRRI, CSIRO
5	Integrated water management	CADAs, NIH, CWC	IWMI, UC, CSU, Texas A&M

6	Multiple uses of water	WTCER, CIFRI, MoWR, CIFA, CRRI	IRRI, IWMI, IFPRI, WFC, MRC
8.	Rain water harvesting and watershed management	WTCER, MoWR, SAUs, CSWCRTI	ICARDA, ICRAF, CIAT, ACIAR, IWMI
9	Development, testing and popularization of resource conservation technologies	IARI, SAUs, PDCSR, DWR	CIMMYT
10	Management of flooded and flood prone and water congested areas	WTCER, SAUs, SADs, MOWR, GFCC, NIH, IIP&DM	IWMI, IRRI, DMI
11	Risk analysis and management	CRIDA, IARI, IIT Delhi, IITM, NIH, IMD	IWMI, IFPRI, WMO, FAO, SIWI.
12	Animal husbandry and fisheries practices and potentials	SAUs, IVRI, NBPGR, NBFGR	ILRI, WFC, CSIRO
13	Introduction and evaluation of package for aquaculture	CIFA, CIFRI, CRRI, RAU	WFC, AIT
14	Animal nutrition	IVRI	ILRI
15	Livestock and fish production	IVRI, CIFA, CIFRI	ILRI, WFC
16	Animal and fish health management	IVRI, CIFA, CIFRI	ILRI, WFC
17	Plant seed material production	SAUs, SADs, IIVR, IIPR, IIHR	IBPGR
18	Technology assessment, refinement and dissemination	SAUs	CIAT
19	Socio-economic and policy research	NCAP, DSE, SAUs	IFPRI, IWMI, UR, UEA,
20	Transfer of technology	SAUs, NRCW	CIAT
21	Human resource development	NCAP, NAARM, IASRI	CG Centers
22	Intellectual property rights	NCAP	CGIAR
23	Networking research	SAUs, WTCER, CSWCRTI, CRIDA	IWMI, IRRI, IFPRI, CIAT, ILRI

## **11. CRITICAL INPUTS**

Since the Complex is a new institute, the infrastructural facilities including the new Complex building are being developed. It will require critical input to initiate research work in due course of time. The Complex envisages to act as a Consortium to promote networking research in eastern region. It would require critical inputs of funds and manpower. Although, sanctioned scientific manpower strength of the institute appears to be adequate, more than 50 per cent positions have not been filled up. Positioning of the manpower as per the sanctioned strength would be the most critical input. Further, the strength of present scientific/technical/administrative manpower may also require to be increased to timely achieve the enhanced objectives and mission of the Complex by 2025.

## **12. RISK ANALYSIS**

### **Existing risks**

The agriculture and allied practices in eastern region are largely rainfed supplemented by limited irrigation. Farming in this region is prone to the risk of extremities of climate, meagre exploitation of natural resources and mismanagement and is constrained by lack of improved technologies and awareness, poor input supply, poor socio-economic condition and farm policies.

Inadequate exploitation of land and water resources leads to low productivity, which in turn creates excess pressure on single commodity based production systems. Mismanagement of resources also leads to permanent loss of resource itself. Poor socio-economic status of the region is the biggest impediment towards improved livelihoods.

Lack of awareness of new hybrid varieties of cereal and horticultural crops may lead to continuation of indigenous package of practices leading to indiscriminate use of inputs. It is a major threat towards formulation of viable farm policies. Use of indigenous animal breeds is a common feature of the region and these are prone to perennial diseases with the risk of low yield. Poor food processing and marketing facilities of farm commodities is the biggest constraint for developing export oriented agri-business in the region.

### **Anticipated risks**

With the use of high yielding varieties, breeds, high-density plantations and intensive propagation for increased productivity, there will be manifold increase in the demand for water for irrigation, fertilization, crop regulation practices, plant protection, processing, refrigeration and value addition. This has to be weighed against decreased anticipated availability of water for agriculture against other

competing uses. The increased use of fertilizers, weedicides and pesticides per unit area pose threat of environmental pollution. Besides, there shall be increased demands on energy for mechanization of agriculture. Moreover, natural calamities like outbreak of any sudden resistant strain or mutant strain of pests, droughts, floods, cyclones, extreme temperatures, hailstorms etc. are the anticipated risks of future. With increase in productivity per unit area and total production, there shall be tremendous pressure on packaging, transportation, storage and market management. In order to manage the anticipated risks, the Complex needs support of ICAR on the proposed technical programs of research and development with sufficient budgetary provision, trained manpower and decentralization of responsibilities.

### **13. REVIEW**

A continuous review of research, infrastructural development and scientific achievements is an essential requirement for setting up the course to achieve scientific excellence. Annual review of research programmes will be done by Director, ICAR-RCER, Staff Research Council and Research Advisory Committee (RAC) under the overall supervision of Deputy Director General (NRM) and Director General, ICAR. The research work accomplished will be compiled and printed annually by ICAR-RCER. A Quinquennial Review Team (QRT) of outside experts, duly constituted by the ICAR every five years, will carry out review of achievements and inadequacies, and suggest steps with regard to strengthening of infrastructure and overall improvements. The recommendations and suggestions of RAC and QRT will serve as a guidepost in the pursuit of research and for undertaking needed actions. An appropriate information system will be developed and maintained to meet the specific needs of ICAR/Govt. A social audit is contemplated on the impact of research every 5 year by an independent body.

### **14. RESOURCE GENERATION**

Budgetary allocation from Government, though constantly increasing over the years, may not be adequate to sustain the proposed research programme outlined in this document. There will be a need for mobilizing additional resources from internal resource generation as well as external non-Government sources in order to adequately meet the demand of the research programmes. The 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 securing competitive grants from international programmes 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 Forests, Ministry of Food Processing. 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 6.

**Table 6. Resource generation (Rs. in Lakhs)**

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

## 15. OUTPUTS

- Database on biophysical and socio-economic aspects for the eastern region created, maintained and made available in public domain.
- Twenty varieties of fruits and vegetables released.
- Molecular mapping of five major vegetables and two major fruits completed.
- Integrated location-specific multi-commodity farming system models involving field crops, horticulture, aquatic crops, livestock, fisheries, and other enterprises in rainfed, irrigated, water stagnated and flooded ecosystem developed and demonstrated.
- Multiple uses of water to improve the productivity of water at research farm and at least 50 farmers' field developed and demonstrated.
- Mango, aonla and litchi based multi-tier cropping system in eastern region refined under farmers' field conditions.
- Resource conserving technologies (RCTs) and water management practices demonstrated, refined and upscaled and outscaled.
- Cost, energy and resource efficient irrigation systems developed and demonstrated.
- Integrated watershed management and toposequential water harvesting system in uplands of eastern plateau region developed and demonstrated.
- Conjunctive use of rain, surface and ground water in the canal command area developed and demonstrated.
- Water management practices for important fruits and vegetables in eastern plateau conditions developed and demonstrated.
- Methodology for assessing water productivity developed and demonstrated.
- Impact, vulnerability and adaptations to climate change and climatic variability studied through modeling.
- Techniques for livestock, fodder and its by-product enrichment developed and evaluated.
- Technologies for improving livestock production developed.
- Low cost aquaculture technologies suitable for inland water system developed and demonstrated.
- Suitable package of practices for optimum livestock health developed

and demonstrated.

- Efficient post-harvest technologies for fruits, vegetable, and makhana for value addition developed.
- Technical backstopping provided to makhana processing units.
- Forecasting index for prediction of flowering and yield in litchi developed and demonstrated under farmers' fields.
- Seed production of vegetables and selected field crops and production of planting material of fruit crops doubled in XI Plan.
- Participatory process for technology development and assessment developed and documented.
- Impact of developed technologies assessed.
- Information and service delivery system developed and demonstrated.
- About 200 numbers of Communication materials (folders, leaflets, bulletins, etc.) for farmers, field functionaries, officials and policy makers published and distributed.
- Farmers, field functionaries, NGOs and other stakeholders sensitized towards new technologies developed by the Complex.
- Productivity of rice, wheat, fruits and vegetables, fish and livestock and resource-use efficiency enhanced in target areas.
- Inter-departmental linkages established and/or strengthened for mutual complementarity and supplementarity.
- Networking and consortium research undertaken in farming systems, service delivery, value addition, climate change and livelihood improvement.
- At least one research paper per scientist per year published, 10 Nos. of technologies commercialized, 10 Nos. of contract research projects and/or consultancy projects undertaken.
- Twenty five numbers of sponsored short courses/training programmes per year organized.
- Laboratory-cum-office building, farm development, construction of residential quarters and establishment of KVK undertaken.

## 16. OUTCOME

- Promising varieties of different crops released by the Institute made popular and widely adopted.
- Crop and land use diversification achieved with increase in crop diversification index by 30 per cent.
- Increase in area and number of farmers/stakeholders under multi-enterprise integrated farming system by 50 per cent in the target area.
- An overall increase in agricultural productivity (i.e. crops, vegetables, fruits, livestock, and fish) by about 40 per cent in target area.
- Underutilized or unutilized water bodies / waterlogged areas productively and efficiently utilized through multiple water use.
- Employment generation enhanced by 30 per cent in target area.
- Enhanced income generation by about 50 per cent in target area.
- Improved technologies popularized and adopted in wider area in eastern region.
- Better self-employment opportunities created and rural youth guided for self employment.
- Developed technologies made bankable and included as policy instrument by the Government for its outscaling.



