भाकृअनुप
ICAR

Vision 2030

ICAR Research Complex for Eastern Region

ICAR Parisar, P.O. Bihar Veternary College
Patna-800 014, Bihar

www.icarrcer.org

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ICAR Research Complex for Eastern Region,
ICAR Parisar, P.O. B.V. College, Patna- 800 014, Bihar

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Contents

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FOREWORD

The diverse challenges and constraints as growing population, increasing food, feed and fodder needs, natural resource degradation, climate change, new parasites, slow growth in farm income and new global trade regulations demand a paradigm shift in formulating and implementing the agricultural reseach programmes. The emerging scenario necessitates the institutions of ICAR to have perspective vision which could be translated through proactive, novel and innovative research approach based on cutting edge science. In this endeavour, all of the institutions of ICAR, have revised and prepared respective Vision-2030 documents highlighting the issues and strategies relevant for the next twenty years.

The eastern region of the country, a "Low Productivity-High Potential" region, holds promise for a second Green Revolution through holistic management of land, water, crops, biomass, horticulture, livestock, fishery and human resources. The region, though endowed with rich natural resources, lacks in capitalizing on these resources for betterment of agriculture. The Council established the ICAR Research Complex for Eastern Region in 2001 to fulfil the technological needs for improving agricultural growth in eastern part of the country. In addition to developing improved varieties of several crops for Eastern India, the Institute has also made a modest beginning in the development of location-specific integrated farming system models for rainfed, irrigated and water logged ecosystems of this region.

It is expected that the analytical approach and forward looking concepts presented in the *'Vision 2030'* document will prove useful for the researchers, policymakers, and stakeholders to address the future challenges for growth and development of the agricultural sector and ensure food and income security with a human touch.

Dated the 30th June, 2011 **(S. Ayyappan)**
New Delhi

Preface

ICAR Research Complex for Eastern Region (ICAR-RCER), Patna is multicommodity and multidisciplinary institute. In view of changing agricultural scenario, emerging opportunities of research, new government policies and broad based mandate of the Complex, the Vision- 2030 has been prepared. It is crafted on the lines of an approved format, collates all the basic information on mission, mandate, achievements, impact, future scenario, emerging issues, perspective and strategies of the institute during the next 20 years.

Eastern region is endowed with natural resources, however, its potential could not be harnessed in terms of improving agricultural productivity, poverty alleviation and livelihood improvement. There is a large gap between potential and productivity of major crops, horticulture, fisheries etc. The region has about 69% marginal farmers. Small and fragmented landholdings limit, by and large, the adoption of latest farming practices. The region has about 7.5 million ha area under acidic soils. Likewise, sodic soils occupy an area of 3.81 million ha. Hence, soil salinity/acidity, lowest per capita income, ever-increasing human population and thereby highest population density per sq km, poor infrastructure facilities for storage, processing and marketing etc., are some other factors responsible for poor agricultural growth to a great extent. Ground water utilization in eastern region is very meagre, particularly in Assam plains, Bihar, Chhattisgarh, Odisha and Jharkhand. Appropriate technologies to encourage use of ground water, in combination with other practices will, however, increase cropping intensity and lead to remarkable production gains. Further, water productivity is very low (0.21-0.29 kg/m^3) in most states of eastern region. The region also lacks in quality animal breeds, feeds and fodder, and adequate animal health care mechanism.

A sizeable part of the cultivated area in eastern region does not have provision for assured irrigation, therefore, even short drought spells adversely affect the stability of agricultural production. The region suffers from various biophysical constraints such as water congestion and flooding during kharif. Plateau areas, characterized by nutrient – poor red, yellow and lateritic soils, undulating topography and high rainfall, are subjected to run-off, soil erosion and land degradation. Keeping these facts in view, technology integration, scaling up and framing of demand driven productivity enhancing research agenda, in a network mode, using both conventional and frontier technologies ensuring scientific management of natural resources and production sustainability is essentially required since agriculture in eastern region is, by and large, diverse and risk prone. Research priorities need to be re-oriented accordingly so as to address diverse researchable issues and also to achieve the target of food security. To cater the R & D needs of 407.10 million people, occupying 71.84 m ha area, ICAR-RCER needs to be strengthened further in terms of scientific man-power and infrastructural facilities, particularly during 12^{th} Five Year Plan.

I take this opportunity to express my indebtedness to Secretary, DARE and D.G. ICAR, Dr. S. Ayyappan, for his encouragement and guidance in bringing out this document. I express my sincerest thanks to Dr. A.K. Singh, DDG (NRM), Dr. P.S. Minhas, A.D.G. (Soil & Water Management), and members of RAC for their keen interest, professional input and support while preparing the Vision document. Inputs from all the Heads of the Divisions and Research Centre of ICAR-RCER are thankfully acknowledged. While the Vision 2030 captures and reflects the collective wisdom of ICAR-RCER scientists, I specially wish to place on record the significant contribution of Dr. R.D. Singh, Dr. A. Dey and Dr. A.K. Singh in compiling and editing the draft.

June 20, 2011

(B.P. Bhatt)
Director

Preamble

The eastern region comprising of plains of Assam, Bihar, Chhattisgarh, eastern UP, Jharkhand, Odisha and West Bengal (Fig. 1) is inhabited by about 33.64% of the country's population, and occupies about 22.5% of the country's geographical area. The average population density is 1927 persons/km^2 area, which is 5-fold higher than the national average and more than 80% population is rural. In general, the region can be divided into 3 distinct physiographical units namely (i) plains of eastern UP, Bihar, West Bengal, and Assam; (ii) hilly and plateau regions in eastern UP, Bihar, Jharkhand, West Bengal, Odisha, Chhattisgarh, and Assam; and (iii) coastal plains of West Bengal and Odisha.

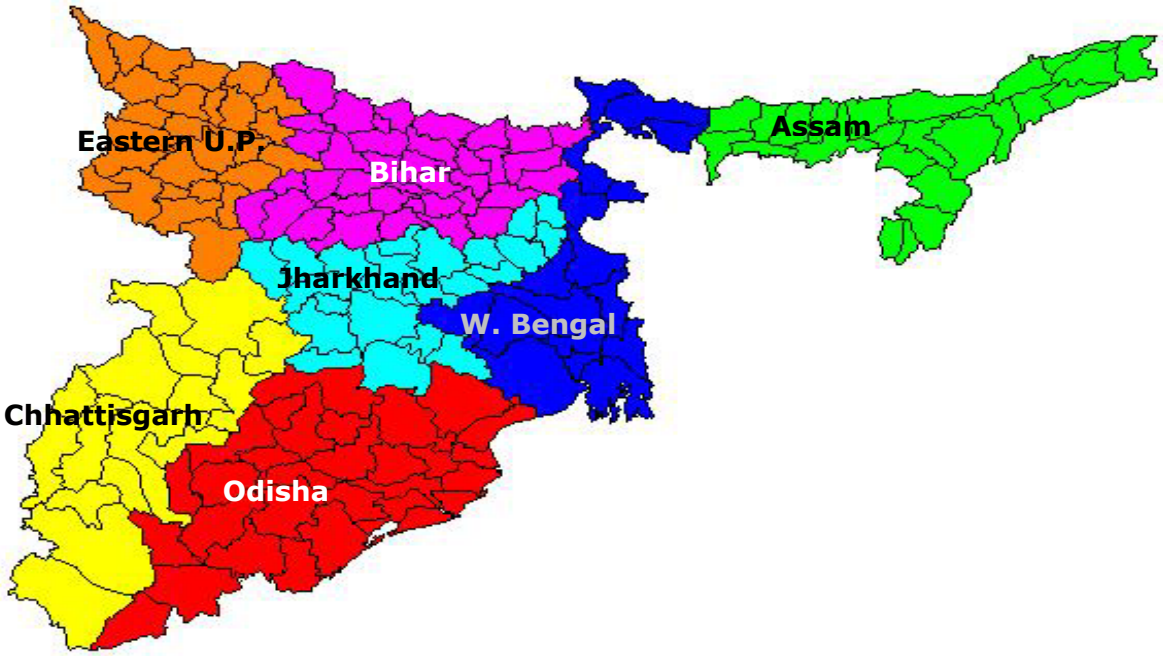


Fig. 1 Geographical spread of eastern region

The pace of human population growth coupled with fast economic growth has posed a considerable impact on agriculture, livestock and fisheries production in almost all the areas of the country. The eastern region is inhabited by resource poor people with small land: human ratio. The climate of the region is tropical, hot and humid except in hilly areas with high rainfall. The average annual rainfall varies from 1025 mm to 2823 mm. Even though the region receives high precipitation, surface and ground water resources are utilized to a minimum level and, therefore, large proportion of the cultivated area does not receive any irrigation water. The farmers still depend on the vagaries of the monsoon for crop production.

Livestock production is becoming the prioritized area in agriculture and land use planning. The demand driven growth would also benefit the millions of landless and marginal landholders who possess three fourth of the livestock wealth.

The complex has broad based mandate in view of emerging opportunities of research in frontier areas, initiatives for regional cooperation, globalization, and cost competitiveness. In order to achieve 4% growth rate in agriculture, emphasis will be given on multi-disciplinary research in a program matrix involving land and water management, crop improvement, horticulture, agroforestry, livestock & poultry, fishery & aquaculture, makhana and other aquatic crops, agro-processing, socio-economics, gender and policy issues. A network and consortium approach is envisaged to achieve mission of the complex through partnership and collaboration with SAUs, ICAR Institutes and NGOs. The complex has four divisions viz. Division of Land and Water Management (DLWM), Division of Crop Research (DCR); Division of Livestock and Fishery Management (DLFM) and Division of Social Sciences at head quarter, Patna besides Research Centre on Horticulture & Agroforestry at Ranchi and Research Center on Makhana at Darbhanga.

The present document is prepared after several rounds of discussion with the scientists of the complex, state level consultation on prioritization of researchable and extension issues for agricultural development in network mode, and incorporating the opinion and recommendations of the RACs, IRCs and IMCs besides scientific analysis, projected scenarios by 2030 and status of problems and prospects.

Agricultural Scenario

Cereals and Pulses

Our present agriculture concerns are multifaceted and multidimensional. Some notable challenges include population pressure on land, fragmented distribution of operational holdings, land degradation, imbalanced use of nutrients, low productivity, low level of mechanization, low fertilizer consumption, climate change, non-remunerative prices and post harvest losses. The targets comprise of (i) food grain production to be doubled in ten years, so as to make India hunger free, (ii) special emphasis on optimum land utilization in order to achieve a quantum increase in agricultural production, (iii) allied sectors like livestock, dairy, poultry, fisheries to be promoted and production of oilseeds and pulses to be raised substantially. The challenges ahead in agricultural sector consist of development of (i) sustainable agriculture, (ii) food and nutritional security, (iii) cost effective technology generation and transfer of technology, (iv) enhancement in resource use efficiency, (v) provision of incentives for agriculture, (vi) promotion of investments in agriculture, (vii) strengthening of institutional infrastructure, (viii) better risk management, (ix) corporate agriculture, and (x) tapping the potential of eastern region and introduction of management reforms.

The eastern region has a rich resource base for intensive and diversified agriculture. Average size of farm holding ranges from 0.7 to 1.6 ha, while for small and marginal farmers, it ranges from 0.3 to 0.5 ha. As most of the cultivated area in the region does not have provision for assured irrigation, even a short spell of drought adversely affects the stability of agricultural production, thereby resulting in low productivity. The coastal areas are also vulnerable to sea-water intrusion and cyclones. So far in soil types are concerned, eastern region has highest area under alluvial soils (40.5%), followed by red and yellow soils (25.45%), red and sandy soils (13.60%) and tarai soils (6.05%).

Out of total geographical area of 71.84 million ha, the net sown area is 31.40 million ha in eastern region. The average productivity of rice, varies from 1.20 t/ha in Chhattisgarh to 2.53 t/ha in West Bengal. The gap between present and potential yields ranges between 1.0 t/ha in Chhattisgarh to 2.92 t/ha in eastern Assam. In case of wheat, average productivity varies from 1.54 t/ha in Jharkhand to 3.0 t/ha in eastern UP indicating that wheat productivity is 30% less in eastern region than the national figures. The maize productivity, however, is at par with the national average of 2.41 t/ha. The pulse productivity has been recorded to be 0.7 t/ha in eastern region compared to national average of 0.66 t/ha. Climate change scenario has indicated that, by the year 2080, there would be sharp decline in rice yield, however, rabi maize yield is anticipated to increase by more than 30%.

With the decadal growth rate, the expected human population in eastern region would be about 579.02 million by the year 2030. The current food grain production has been estimated to be 65.71 million tonnes (63.39 million tonnes of cereals and 2.32 of

pulses). The projected total food grain requirement would be 111.60 million tonnes by the year 2030. Likewise, the oilseed requirement is projected to be 7.81 million tonnes by the year 2030 as against of 1.33 million tonnes being produced currently. These figures indicate that we shall be in a position to increase our productivity from present level of 2.09 t/ha to 3.80 t/ha. Hence, the efforts will be made to bridge this gap through development of stress/constraint countering research agenda, scaling up of water productivity, expansion of RCT in Indo Gangetic Plains in network mode, framing up of forward looking research agenda on biotechnology, capacity building of scientists and other stakeholders in the areas of innovative technology generation and use.

Horticulture

Horticultural scenario of the eastern region is undergoing a sea change in recent years. Fruits and vegetable crops cover more than 70% of the total area under horticulture. The area under fruit trees is 1.20 million ha with average productivity of 10.37 t/ha compared to national average of 11.22 t/ha. The last decade has witnessed about 31% increase in the total fruit production due mainly to 27% increase in area under fruit cultivation. However, the productivity did not increase because a large proportion of plateau region has low fertile soils with poor water holding capacity and moisture stress particularly during lean period. Per capita availability of fruits in the eastern region is about 68.1 g/day, which is much below than the dietary requirement of about l20 g/day/capita. Considering a decadal population growth rate of 22%, the annual requirement of fruits by 2030 will amount to 26.8 million tonnes.

The area under vegetable production is 3.98 million ha with average productivity of 15.61 t/ha compared to national average of 16.17 t/ha. The vegetable productivity increased by 37% during the last decade. This can be attributed to large-scale introduction of improved varieties of different vegetable crops alongwith adoption of high input based production technologies. At present, the per capita vegetable consumption in eastern India is 341.20 g/day, which is at par with ICMR recommendations. The annual requirement of vegetables by 2030 will amount to 66.9 million tonnes.

To expand area under horticulture, there is a need for mass production of quality seed and planting material. With introduction of high yielding varieties and improved input based production technologies in vegetable cultivation, the productivity level is expected to reach about 23 t/ha by 2030, which will result in a total vegetable production of about 111.4 million tonnes. Minimizing the post harvest losses by 15%, there will be a surplus of about 28.35 million tonnes of vegetables in the region by 2030. This will warrant intensive post harvest management activities for maintaining the profit level of vegetable growers in the region.

Livestock

The eastern region supports 31.14% of the livestock population of India. The density of livestock in the region is very high (230.53 per sq. km.) compared to national average of 161.14 per sq. km. The cattle holding in the region varies from 73 to 284 nos. per 100 households, with highest in Assam and lowest in Bihar. Buffalo holding varies between 7 and 99 with lowest in West Bengal, Assam and Odisha. However, small ruminants holding per 100 households is highest in Assam (100) and lowest in eastern UP (51). Black Bengal goat, known for its high fecundity, is native to eastern region. Established sheep breeds like Balangiri, Ganjam, Shahabadi, Chhottanagpuri and Garole are well suited to the agro-climatic zones of eastern India. Two prominent poultry breeds belonging to Asiatic class namely Brahma and Chittagong are assets of Assam and Bengal. This region also holds a unique breed of pig – 'Ghungroo'. Nevertheless, presence of a large number of non-descript breeds of livestock results in low productivity. Milk production per animal in the region is 0.952 to 2.91 (indigenous cattle), 3.31 to 7.04 (crossbred cattle) and 2.05 to 5.44 kg/day (buffalo), respectively. On average, the region supports 20.87% milk, 24.88% meat and 14.97% egg production of the country.

Among various categories of livestock, the region has highest population of non-descript type of cattle (44.92%), followed by goat (31.0%) and buffalo (13.32%). The projected fodder requirement has been worked out to be 77.85 million tonnes for dry roughages and 63.90 million tonnes for green fodder, respectively. However, the availability is 76.20 million tonnes of dry fodder and 7.69 million tonnes of green fodder, indicating a deficit of about 88% in green fodder requirement.

Prevalence of infectious diseases like FMD, HS, BQ, RD, Degnala etc., reproductive problems like anestrous and repeat breeding among livestock ultimately results in low production. The poultry sector in the region is badly affected by Birds Flu. Lack of infrastructural facilities for rapid disease diagnosis has posed major threat for the livestock sector as a whole alongwith distantly located veterinary clinics.

In spite of large number of livestock population, per capita availability of milk in the region is near half (158.74 g/day) of the national average of 263.0 g/day. The availability of eggs per capita is 22 nos. in the region as against of 51 nos. for India. Likewise, meat availability is 1.70 kg/capita/yr compared to national average of 3.20 kg/capita/yr. Considering vast population of non-vegetarian in the region, meat, fish and egg production need to be increased. The milk production on national level has increased by 19.0% in last five years (2003-04 to 2007-08). It is encouraging to see that the growth rate of milk in the region has exceeded 1.5- fold as compared to national level during the same period. However, growth rate of egg production between 2003-04 and 2007-08 in the region is much lower (19.68%) than that of national level (32.48%). There is a reverse trend in growth rate of meat production as a whole in the region. The decadal livestock population growth rate in eastern region is well above the national average of 17.64%.

Fisheries

The states of eastern region contribute around 55% of total inland fish production in India while marine fish production is limited only to Odisha and West Bengal (10% of the total production). The region has about 2.73 million ha water area constituting reservoirs, ponds, tanks and beels, oxbow lakes, brakishwater etc. besides 15046 km length of rivers and canals for fish production. Eastern region, with rich water endowments holds promise to raise production and productivity of vast water resources and rich cultivable species diversity. The average annual growth rate of fish production in Assam, Bihar (includes Jharkhand), MP (includes Chhattisgarh), Odisha and West Bengal is 3.36, 4.88, 10.73, 3.59 and 4.01%, respectively, during 2007-08.

The present fish production from the region is about 2.44 million tonnes, which is able to provide about 6.6 kg/capita of fish against the standard nutritional requirement of 11.0 kg/capita. To bridge the gap between requirement and availability of fishes, additional 2.16 million tonnes of fishes are required. The projected fish demand by 2030 is estimated to be 7.02 million tonnes (Table 1). The present fish seed availability is around 7,310 million fry against the requirement of 14,749 million fry. Likewise, the projected demand of fish fry for the region by 2030 is estimated to be 21,071 million.

Table 1. Projected demand of livestock products and fish by 2030 in eastern region

State	Population (million)	Milk production (million tonnes)	Meat (million tonnes)	Egg (million nos.)	Fish (million tonnes)
Eastern UP	115.0	9.26	1.08	5999.2	1.39
Bihar	162.38	13.04	1.52	8443.58	1.96
Assam	41.01	3.29	0.38	2132.25	0.53
West Bengal	118.57	9.52	1.11	6165.63	1.43
Jharkhand	49.34	3.96	0.46	2565.72	0.59
Odisha	54.49	4.37	0.51	2833.28	0.66
Chhattisgarh	38.38	3.08	0.36	1995.90	0.46
Eastern India	**579.17**	**46.52**	**5.42**	**30135.56**	**7.02**

Note: Projections have been made as per ICMR recommendations

Makhana

Makhana crop has the potential to ensure food and nutritional security besides generating employment opportunities. It is a high value commodity, commercially cultivated only in Bihar and certain parts of eastern India. Makhana also grows as a natural crop in the static water bodies of wetlands, ponds, lakes in Madhya Pradesh, Rajasthan, Jammu & Kashmir, Tripura and Manipur. Besides stagnant water bodies, it is also cultivated in paddy fields and low-lying areas. Cultivation of makhana is highly

cumbersome, labour intensive and involve human drudgery while sweeping bottom of the water body for seed collection. It is followed by processing of raw seeds, which is equally a painstaking activity. Fishermen community is mainly involved in makhana cultivation.

There are also some constraints of makhana production namely non – availability of improved varieties/cultivars, non-availability of agro-techniques, lack of knowledge of pests, diseases and their management, difficult harvesting methods, indigenous /traditional methods of post harvest and processing, poor and disorganized marketing, almost negligible export and lack of value addition.

About 25000 ha area is under makhana cultivation in Bihar with an average productivity of 0.53 t/ha. However, the target is set to increase the productivity to 0.99 t/ha covering an area of 100000 ha by 2030. The complex also proposes the horizontal expansion of makhana-fish-water chestnut based farming system besides post harvest and value addition in makhana.

Agriculture and Economy

According to socio-economic characterization, the districts in the eastern region have been classified into four different categories: very good, good, average and poor. Maximum districts of the region fall under poor and average category. Employment in agricultural sector is limited and a large proportion of the population still remains below the poverty line and suffers from malnutrition. On the basis of socio-economic conditions, Planning Commission has identified 150 disadvantageous districts in the country and highest no. of backward districts are confined in eastern region (69 nos.) with highest in Odisha (18 nos.) and lowest in eastern U.P. and Assam (3 districts in each state), respectively.

Technology Assessment, Refinement and Dissemination

To bridge the gap between the technologies developed at research stations and its adoption by stakeholders especially by farmers, technology assessment, refinement and dissemination is utmost important. Technology dissemination is always been a challenging task to cover a large and diversified group of farmers. With competiveness in agriculture, farmers want timely and authenticated information and advice at their doorstep. Hence, the institute emphasizes agricultural research to be focused on participatory process for technology assessment, refinement and dissemination with emphasis on women empowerment in agriculture.

Livelihood Improvement of Resource Poor Farmers

Intensification of backyard farming activity through judicious introduction of improved varieties of vegetable and fruit crops can address the need of balanced diet for rural households. Integration of other allied enterprises like backyard poultry, duck cum fish culture, goatery, dairy, piggery, apiary, sericulture, lac cultivation, mushroom cultivation etc in existing production system can effectively address issues on livelihood of resource poor farmers. Development of aquaculture holds promise for effective utilization of large

number of seasonal water bodies that remain untapped in the eastern India. Development of resource based farming system models to harness synergy between different production systems will be needed for sustainable livelihood support of the poorest of the poor. In the era of market globalization and competiveness, there is an urgent need for empowering the women 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 the weaker section would be imperative.

Strengthening 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 are involved. Partnerships are increasingly recognized as viable strategy for achieving goals of agricultural research and development. The institute envisages participation of public, private, NGOs, semi govt. organizations, SAUs, ICAR Institutes etc. especially on integrated farming system aspects, service delivery, market access and supply chain in a network/consortium mode from planning to implementation programme of appropriate technologies.

Improve Access to Information and Knowledge

Eastern region has the potential to usher another green revolution. Besides technological appropriateness, challenges lie in availability of advisory services (knowledge, information, linkages etc.) to the resource poor farming communities. Extension or advisory services are more diversified, more technology intensive and more demand driven which makes the task very difficult for the extension workers. Hence, the Complex proposes to contribute towards strengthening public-private partnership, people-state-NGO-triangular contribution, and cyber extension through Information and Communication Technologies (ICTs). It is also envisaged to develop the research programmes in such a way that effectiveness of these service delivery mechanisms in terms of reliability, quality, timeliness and access could be evaluated. 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. Efforts shall be initiated to improve knowledge management system so as to act as an efficient clearing-house of technology, knowledge and information in agriculture and allied sectors.

National Agricultural Research System

The institute has a broad based mandate in view of emerging opportunities of research in frontier areas, initiatives for regional cooperation, globalization, and cost competitiveness. Vision Document 2030 has been prepared keeping in view the target of 4% growth in agriculture sector in the eastern region. The major research focus would be on multi-disciplinary research in a program matrix involving all the components of agriculture including gender and policy issues in a holistic manner. The research activities and proposed programmes beyond 2011 are based on the assumption that manpower and facilities as proposed in the document would be available.

Mandate

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

Ever since the complex came into existence, it identified major research thrust areas in view of the natural resource endowments and the constraints faced in agricultural development. As a result of the research, demonstration, dissemination and adoption by the farmers, the XIth Plan targeted productivity levels of rice, wheat, fish and fruits as 3.5-4.5 t/ha, 3.0 t/ha, 2-1-2.6 t/ha and 13.5 t/ha, respectively have been achieved in the project areas. The Complex released 3 improved varieties of fruits and 41 of vegetable crops and the area under improved varieties has increased considerably in Jharkhand and parts of Odisha, West Bengal, Chhattisgarh and Bihar. The Complex has made a modest beginning in development of location-specific, multi-commodity, integrated farming system models for rainfed, irrigated and water stagnated and flooded prone areas. The complex has also developed linkages for research complimentarity with line departments in the eastern region.

ICAR-RCER 2030

The vision is to pre-position the institute with desired competitiveness for developing the kind of technologies needed to address the multiple vulnerabilities confronting agriculture and allied fields today and likely to confront tomorrow and thereby contribute towards production, profitability and sustainability in agriculture, particularly in view of Look East Policy of Govt. of India, for ensuring food security in the country.

Mission

- Transforming "Low productivity-High potential" eastern region into high productivity region for food, nutritional and livelihood security in a manner that is environmentally sustainable, socially acceptable and monetarily profitable.
- Utilization of vast seasonally waterlogged and perennial water bodies for multiple uses of water and aquatic crops besides, poverty alleviation and women empowerment through employment generating activities.
- Promote network and consortia research in the eastern region**.**

Focus

The institute is dedicated to innovate and develop low cost, efficient and sustainable technologies to suit the specific requirements of agriculture development in eastern region. The jurisdiction of the various research programmes of institute will spread over all the 7 states of eastern India. Hence, appropriate and affordable technologies will be developed to make this vast high potential and low productive area, comprising of six distinct Agri-ecological Economic Zones (AEZ), into high productive zone. In the nutshell, the complex would concentrate on the following keys areas :

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

Harnessing Science

ICAR Research Complex for Eastern Region is committed to address the issues of natural resource conservation and to increase the agricultural production. Changing life style and dietary consumption patterns, however, call for added emphasis on diversified production system. Hence, emphasis will be given for cultivation of fruits, vegetables and value added agricultural products. The region also holds promise for livestock and fishery development by utilizing the potential of untapped natural resources.

Potential of Genetic Resource Management

The region is endowed with rich resources of plant and animal biodiversity. Harnessing this valuable natural resource for improving the genetic makeup of different crops will play a major role in increasing agricultural production. Integration of traditional breeding programmes with frontier technologies on genetic resource management like gene pyramiding, marker assisted selection; allele mining will go a long way in addressing the issues of food production. Likewise, in case of livestock, genetic improvement is need of the hour. Quality seed production in case of crop and livestock shall be carried out in a participatory mode.

Management of Natural Resources

Soil and water are the basic resources of agriculture. Scientific and efficient management of these resources is the core of sustainability of agriculture production system. The region is largely dependent on rainfed agriculture. Despite the annual rainfall being adequate across all agro-eco systems, agriculture production suffers from water stress on the one hand and excess runoff and water congestion causing floods on the other. For the sustainable management of natural resources, the techniques like integrated watershed management, conjunctive use of surface & ground water, improving water productivity, managing flooded, flood prone and waterlogged areas and acid soils management needs to be perfected. Restoration of degraded lands through agroforestry interventions is another major issue in non-classified wastelands.

Harnessing Solar Energy

In eastern region, annual average Direct Normal Irradiance (DNI) varies between 4.0-5.5 KWh/m^2/day, which need to be harnessed through photovoltaic cells. The efficiency of photovoltaic technology is reported to be 10-16%. Taking into account the total geographical area of eastern region, net annual average DNI per day would be 3.4 X 10^{12} KWh/day. Assuming 10% efficiency of photovoltaic cells and converting 1% of total geographical area, i.e., 0.718 m ha into photovoltaic panels, approximately 940 MW of electricity could be generated per day. Technology need to be perfected to harness the solar power in eastern region so as to make its use in various agricultural production systems.

Agriculture Diversification

The present economic regime offers opportunity for diversified dietary behaviour of both urban and rural population. Traditionally, rice and wheat dominates the food habits in the region. To combat nutritional deficiency, horticultural crops by virtue of their

palatability and rich nutritional value can be a better option for fulfilling the diversified dietary needs of the people of eastern region. Crop diversification through horticulture crops can also play a vital role in increasing the income of rural household. Organic farming in rainfed areas including Tal, Diara, Chaur and Maun areas of Bihar also needs to be taken up.

Multiple Uses of Water

Integrated farming system

Fish cum duck farming has beneficial effect as both are complementary to each other. Composite fish culture along with duck farming could result 5.0 – 6.0 t/ha of fishes, besides 43000 nos. of eggs and 24.0 tonnes of droppings per hectare.

Fish culture in waterlogged areas

Waterlogged areas, having water stagnation 0.3-1.0 m, could be utilized for effective fish culture by further digging of the area in the form of trenches and raising a portion above highest flood level using excavated soil to cultivate vegetable or horticultural crops. Two types of fish trenches, (a) Tr-R - meandering type trenches simulating river condition and (b) Tr-P - continuous trenches surrounding island of raised bed simulating pond conditions may be used. The fish yield to the tune of 1.97 t/ha could be obtained by stocking fries @ 15000/ha.

Rice-fish culture

Rice-fish culture is useful in productive utilization of seasonally waterlogged lands. Transplantation of thirty five days old rice seedlings (cv. IR 6444) in July-August could result into 5-6 t/ha of rice grains, and 1.6 t/ha of fishes.

Breaking the seasonal barrier in scampi farming

In northern India, the freshwater prawn, scampi (*Macrobrachium rosenbergii)* is normally cultured during June to December, depending on the water temperature (18-34^{0}C with an optimum range of 27 to 31^{0}C). Therefore, the fresh prawn-crop is invariably not available to consumers after December. In Bihar, *Macrobrachium rosenbergii* has been, however, successfully cultured during post- monsoon, winter season for the first time by providing suitable shelters in ponds and trenches, from August to February. This adaptive research work has paved way for scampi farming beyond December in the seasonally waterlogged areas of Bihar.

Post Harvest and Value Addition

Post harvest losses of fruits and vegetables account for about 25% of total loss. Litchi, mango, guava, banana, anola, jackfruit, bael, tamarind are promising fruit crops of this region. Among vegetables crops, tomato, brinjal, cauliflower, cabbage, peas are predominantly grown. The poor shelf life of these crops, however, is a major constraint in the production system. Value addition of fruits like jackfruit, bael and tamarind and vegetables like tomato, peas, cauliflower will enhance its marketability. Similarly, flowers like rose, chrysanthemum and gladiolus perform well under eastern Indian conditions. However, sustained efforts need to be made to standardize the packages to improve the shelf life. Research on developing suitable and economical post-harvest technologies for

processing, preservation and value addition of important horticultural products is the priority of the complex.

Bio-Risk Management

Horticultural crops are highly sensitive to climatological changes. Their production and productivity are severely influenced by the anomalies of climatic parameters. Incidence of pests and diseases are highly influenced by changes in weather parameters. Development of weather based forecasting tools for the prediction of pest incidence in horticultural crops will be a major component in integrated pest management strategies. Use of conceptual as well as black box models like artificial neural networks in pest and disease forecasting can be used to develop forewarning systems. Advance tools like GIS and remote sensing for mapping of pest and disease incidence will be helpful in assessing the risks involved and their management.

Improve Access to Information and Knowledge

Access to information and knowledge is vital for increasing food production. To equip personnel with state-of-the-art technology skill, expertise and knowledge, capacity building programmes in cutting-edge technologies and frontier areas viz. climate change impact modelling, risk analysis and management, integrated faming system research, water productivity assessment, multiple use, bio-informatics, information and communication technology, behavioural science and research management skills, IPR issues, integrated water management, integrated aquaculture management and socio-economic and policy research are envisaged. Brainstorming meetings, effective co-ordination of multi-commodity, multi-disciplinary research and co-ordination with line departments of state/central government will be done to advocate policy issues for the benefit of stakeholders.

Institutions and Policies

Policy research will be an integral part of the mission of the complex. In order to disseminate agriculture technologies, socio-economic constraints in adoption of biophysical solution will be identified. 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 and nutritional security, and alleviate pressure on fragile natural resources. Taken together these activities will create a formidable matrix for advancing sustainable agricultural development in the region.

Transfer of Technology

Technologies developed at research stations have to be assessed at micro level with greater involvement of farmers and accordingly modified to suit the needs of the clientele. To bridge the gap between the technologies developed at research stations and its adoption by major stakeholders especially by farmers, technology assessment, refinement and dissemination will be taken up.

Strategy and Framework

The necessity to grow enough food, feed, fuel and fibres to meet requirements of the ever-increasing population has put the tremendous pressure on natural resources. There is degradation of resource-base in the form of large scale soil and water erosion in the hilly and sloppy areas, appearance of wide-scale secondary salinization and waterlogging in the irrigated and flood-affected area, deterioration in water quality, chemical degradation, diminishing forest cover and inaccessibility to the costly inputs in agriculture.

Soil is a vital natural resource. This resource is under competitive demand for industrial growth and urban expansion. Since pressure on available soil resources will increase with time, its effective and rational use will be the core strategy to increase the productivity on sustainable basis. Soil health and fertility must also draw immediate attention of all concerned, especially when organic matter content has gone down (0.3-0.5%), and several micronutrient deficiencies are now surfacing prominently. Thus, there is a strong need for conserving soil and land resources and preserving natural ecosystem in proper equilibrium so that short-term exploitative measures on soil resources do not jeopardize long-term sustenance of soil productivity and health.

Water is also a scarce resource. It is estimated that even after achieving the full irrigation potential, nearly 50% of the total cultivated area will remain rainfed. Such low level of water availability is considered a severe constraint to socio-economic development and maintenance of environmental quality. The water productivity is 0.37 kg/m^3 in the region compared to 1.01 kg/m^3 in Punjab. Likewise, groundwater utilization is hardly 33.0% in eastern region compared to 58.0% at national level. The institute, therefore, envisages increasing the water productivity by 3-folds so as to achieve the target of food production by 2030.

Following strategies will be adopted to accomplish the vision and goals of ICAR-RCER:

1. Natural Resource Management through Development and Applications of State of Art Technologies

- Development of agricultural, horticultural and aquatic crops based location specific farming system models.
- Improvement in soil biological properties in agricultural, horticultural and makhana based cropping system.
- Amelioration of acidic soils.
- Evaluation of alternate strategies for climate adaptive water resource management, and feasibility studies on multipurpose water harvesting projects.
- Optimum use of water resources through improved water application and water conservation technologies.
- 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.

- Restoration of degraded lands through agroforestry interventions.
- Harnessing of solar power to enhance agricultural production.
- Evaluation of ITKs and plant biomolecules in livestock and fisheries health and growth promoters.

2. Harnessing the Potential of Genetic Resources

- Collection, conservation and utilization of available genetic resources of agricultural, horticultural, livestock, fishery and other aquatic crops.
- Development of improved cultivars of agricultural, horticultural and aquatic crops suitable for cultivation in eastern India.
- Development of crop varieties having tolerance to biotic and abiotic stress under climate change regime.
- Ensuring intellectual protection of genetic resource through IPR strategies.
- Conservation and genetic evaluation of indigenous breeds of livestock and fishes using conventional and modern techniques.

3. Development of Efficient and Effective Production Technology with Emphasis on Quality

- Development of location-specific integrated pest and disease management technologies.
- Research on development of multiple stresses- tolerant and climate resilient field crop varieties like rice, wheat and maize. Special attention could be given to introduce crops like barley and millets which are hardy and can be grown under harsh environmental conditions, particularly in plateau and hilly region.
- Introducing legumes in rice fallows on a large scale.
- Introduction of short duration pulses which are tolerant to heat and diseases, and kharif pulses in marginal lands to ensure nutritional security.
- Crop diversification in rainfed upland plateau from low productive rice to alternate cereal, pulses and oilseeds.
- Introduction of rabi/summer sunflower in West Bengal, Odisha and Bihar through research and development of hybrids / varieties alongwith appropriate crop production and protection technologies.
- Introduction of high yielding mustard varieties and package of practices for late sown varieties.
- Balanced fertilization including research on restoration of organic carbon pools.
- Technological interventions for improving livestock and fishery health and production.
- Improving feed utilization employing scientific techniques.

- Post harvest management focused on value addition and shelf life.
- Crop-livestock and environment interactions including development of area specific mineral mixture.

4. Accelerated Dissemination of Technologies and Capacity Building

- Capacity building of stakeholders including farmers and extension workers.
- Large scale outreach programmes in partnership with stakeholders in the region.
- Commercialization of technologies through organized intellectual property rights and benefit-sharing system.

- Promotion of effective, efficient and decentralized governance by introducing best management practices in the Indian Council of Agricultural Research.

Epilogue

ICAR Research Complex for Eastern Region, Patna is committed to bring a demand-driven and technology-led Second Green Revolution in the eastern region of India so as to meet a challenge of the ever increasing demand for food, improving livelihood opportunities of farmers and for ensuring sustainable farming and agricultural growth. The much awaited Second Green Revolution is the way forward to prosperity, progress, peace and pride of the nation. This will be based on inclusive growth. The key factors of Second Green Revolution will consist of enhancing soil health, water management, quality seed and planting material, seed replacement, minimizing post harvest losses, value addition, enlarging credit and its access to the stakeholders, improving infrastructure for marketing and dissemination of new technologies besides addressing the issues of climate change, gender and socio-economic aspects. It could be achieved in a participatory mode by becoming more vigilant and introducing institutional processes that develop a culture of responsibility, accountability and integrity in science.

Besides crops, sustainable livestock production and development of location specific integrated farming system models is need of the hour. There is also tremendous potential for fishery and horticulture development in eastern region. Livelihood improvement of landless and marginal farmers is also a great challenge ahead, which needs to be addressed through animal husbandry, fishery and agroforestry interventions.

Annexure 1: Strategic framework

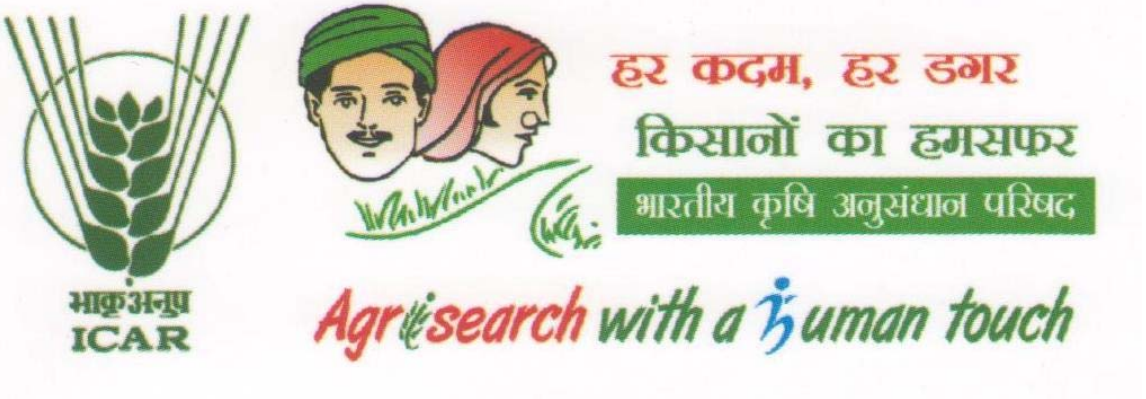
Goal	Approach	Performance measure
Improve food security	• Sustained agricultural intensification for higher productivity and quality output from shrinking land and water resources. • Appropriate crop sequences for efficient utilization of natural resources. • Enhancing potential of different irrigation systems in eastern India. • Developing technologies for affordable high - tech and precision agriculture. • Development of crop-livestock-fish based IFS models. • Development of technologies and value addition for improving keeping quality of livestock-fish products. • Improvement of livestock, fish and poultry breed through selection and/or crossbreeding. • Improving feed utilization of livestock and fishery employing scientific techniques. • Sustained agricultural intensification for higher productivity and quality output from shrinking pond and water resources. • Enhancing potential of different water bodies through makhana based farming systems. • Increasing productivity of makhana for value added products, ensuring marketability and profitability.	• Contribution of research and development in resource conservation and productive utilization of resources. • Income and employment generation. • Improved growth and yield. • Increase in digestibility and feed conversion ratio.
Maintain and improve the status and quality of natural resources	• Management options to improve soil health and land quality. • Technological options to enhance water-use efficiencies, water quality, and increase water availability. • Quality assessment of soils and land characterization of different agro-ecosystems. • Ground water quality assessment and mitigation measures. • Location based integrated watershed management. • Ensuring environmental security using appropriate technology • Exploring options for conjunctive use of rain, surface and ground water in canal command.	• Improved water and input-use efficiencies • Reclaimed degraded soil, land and water resources. • Maintain and improve the status and quality of natural resources.

	• Development of high producing low water consuming fodder varieties. • Restoration of degraded lands through agroforestry interventions.	
Improve risk management	• Approaches for climate change adaptation and mitigation. • Development of strategies and technologies for productive utilization of Tal, Diara, Chaur and Maun areas. • Resource mapping using GIS technique & remote sensing for better and efficient utilization of land and water resources. • Strengthening and assessing Decision Support System for optimizing use of critical inputs and enhancing productivity/ profitability. • Design, fabrication & commercialization of makhana popping machine. • Disaster management and mitigation strategies.	• Technologies and management strategies developed for flood and drought management. • Assess vulnerabilities of water management and selection of best strategy to compensate for climate change.
Crop improvement	• Germplasm conservation: Collection and conservation of genetic resources of agri-horti crops including leafy, minor and underutilized vegetables. • Sustainable use of germplasm: Characterization genetic enhancement, pre-breeding, distant hybridization using tissue culture, functional genomics and proteomics. • Development of new cultivars specific to climate change induced biotic and abiotic stresses. • Development of cultivars with high nutritional and medicinal value including leafy vegetables. • Development of cultivars specific to agro industries and protected horticultural cultivation • DNA barcoding of public and private sector cultivars. • Maintenance breeding of parental lines and varieties- purity maintenance during seed production and DUS characteristics under PPV & FRA reguatories. • Seed quality enhancement and production of quality seed and planting material.	• Shared germplasm, new genes/cultivars. • Climate resilient horticulture. • Promote trade, avoid gene piracy and reduce malnutrition. • Quality seed production.
Crop production	• Development of improved package of practices for agri-horti crops with respect to climate change by resource conservation technologies, INM etc of eco-friendly approaches.	• Improved livelihood of farmers by enhancing income. • Improved input use efficiency.

	• Development of sustainable cropping, intercropping, multitier cropping systems for enhancing productivity. • Development of integrated farming system models by diversified cropping enterprise system.	• Food and nutritional security
Development of quality cultivars of agri-horti crops	• Exploration, collection, conservation, evaluation and utilization of genetic resources of agri-horti crops. • Widening genetic base through sexual reproduction in horticultural crops. • Ensuring supply of quality seed and planting material in case of fruit and vegetable crops.	• Identification of superior genotypes of different agri-horti crops so as to increase the production.
Increased productivity of fruit based production system in eastern plateau and hill region with improved quality of produce	• Standardization of technologies for high density orcharding of different fruit crops. • Participatory action research for ameliorating biotic and abiotic constraints in fruit based production system. • Development of fruit based multicommodity production system. • Development of protocol for organic cultivation of fruit crops.	• Nutritional security and livelihood improvement in rainfed agro-ecosystems.
Integrated location-specific, multi-commodity farming system involving field crops, horticulture, aquatic, livestock, fisheries and other enterprises	• Participatory development of integrated farming system models for food and nutritional security.	• Increased livelihood security of small holders, employment generation and natural resource management.
Nutrient management for horticultural crops	• Develop and evaluate site specific nutrient management for horticultural crops. • Development of nutrient deficiency soil map of the eastern plateau region with the support of state of the art tools like GIS and Remote Sensing. • Identification of limits of nutrient element for horticultural crops.	• Use of right source of nutrient at right time. • Balanced fertilization.
Microbial consortia based project	• Identification of native soil microorganisms promoting plant growth in the acid soil of eastern plateau region. • Exploring the possibilities of use of native microbial consortia for increasing the productivity of horticultural crops.	• Enhancement of the productivity and fertility status of the native acid soils.
Carbon sequestration to increase soil	• Enhancement of carbon stock of the native soil.	• Increasing the C-stock in the soil leading to increasing soil fertility.

organic carbon pool	• Development of suitable cropping system for enhanced C-stock in the soil.	
Acid soil management with special reference to climate change	• Identification of types of soil acidity in the surface and sub-surface horizon. • Identifying the agri-horti crops resistant to soil acidity. • Identification of toxic elements present in the soil and its effect on crops. • Integrated use of organic and inorganic material for management of soil acidity.	• Increasing the productivity of agri-horti crops in the acid soils of eastern plateau region.
Establishment of resource centre on post harvest management of horticultural crops	• Developing data base on traditional foods of eastern region especially of tribal societies. • Information generation on post harvest processing, preservation and value addition of food crops and to create/disseminate information to the related industries.	Increase in number of processing units in eastern region
	• Development of improved post harvest technology to minimize the post harvest losses in field, during storage and transportation. • Enhancing shelf life of horticultural commodity. • Development of diversified horticultural commodities.	Value addition
Enhance opportunities for inclusive growth	• Characterization of disease resistance and drought tolerance indigenous livestock and poultry breeds of eastern region. • Improving product quality of livestock and fishes employing molecular biology and biotechnology. • Development of efficient input use efficiency system for maximizing profit and improving product quality. • Marketing and supply chain improvement of livestock and fish products. • Characterization of potential genetic stock of fishery resources. • Harnessing solar energy for irrigation and post harvest technology.	Disease incidence and minimizing the post harvest losses. Food safety and maintaining international standard.
Improve access to genetic material, information, knowledge and resources	• Collection & evaluation of Gorgon nut germplam. • Development of new genetic variability and improvement of makhana through induced mutagenesis. • Germplasm exploration and maintenance in gene bank. • Horizontal expansion of promising cultivars of makhana.	Improve access to genetic material, information, knowledge and resources. Crop diversification.
Improve access to information and knowledge	• Improve access to technologies through effective use of Information and Communication Technology (ICT) and	Access to information and knowledge on agricultural technologies.

	knowledge management. • Strengthening service delivery system through ICTs tools and farmers' service centre. • Access to location specific data and knowledge resources.	
Transfer of technology	• Popularisation of cost-effective technology among farmers. • Participatory action research in farming system, watershed management, water management and aquaculture. • Analysis of different information delivery systems developed and strengthening service delivery system through ICT.	• Adoption of modern agricultural technology by farmers
Technology assessment, refinement and dissemination	• Participatory process for technology assessment, refinement and dissemination. • Study on empowerment of women with special reference to development and dissemination of farming system technology.	Perfection in technology and its adoption by the stakeholders.
Strengthening linkages	• Evolve institutional mechanisms for market linkages, market access; and supply-chain issues. • Develop approaches that link production, value-addition and marketing.	Horizontal expansion of the technologies generated.
Human resources development to address emerging challenges	• Formulating network of Research Organizations for meeting R & D needs of prioritized researchable issues. • Capacity strengthening of scientists and technical personnel through training at the national and international level. • Organizing training programmes for various stakeholders. • Capacity strengthening through trainings on scaling up productivity of soil and water in different production system. • Organizing brainstorming meetings, effective co-ordination of multi-commodity, multi-disciplinary research and liaisoning with line departments of state /central government.	• Improved research efficiency. • Qualified manpower in agriculture, agri-research and agri-business.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