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किसानों का हमसफर
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Agrisearch with a human touch

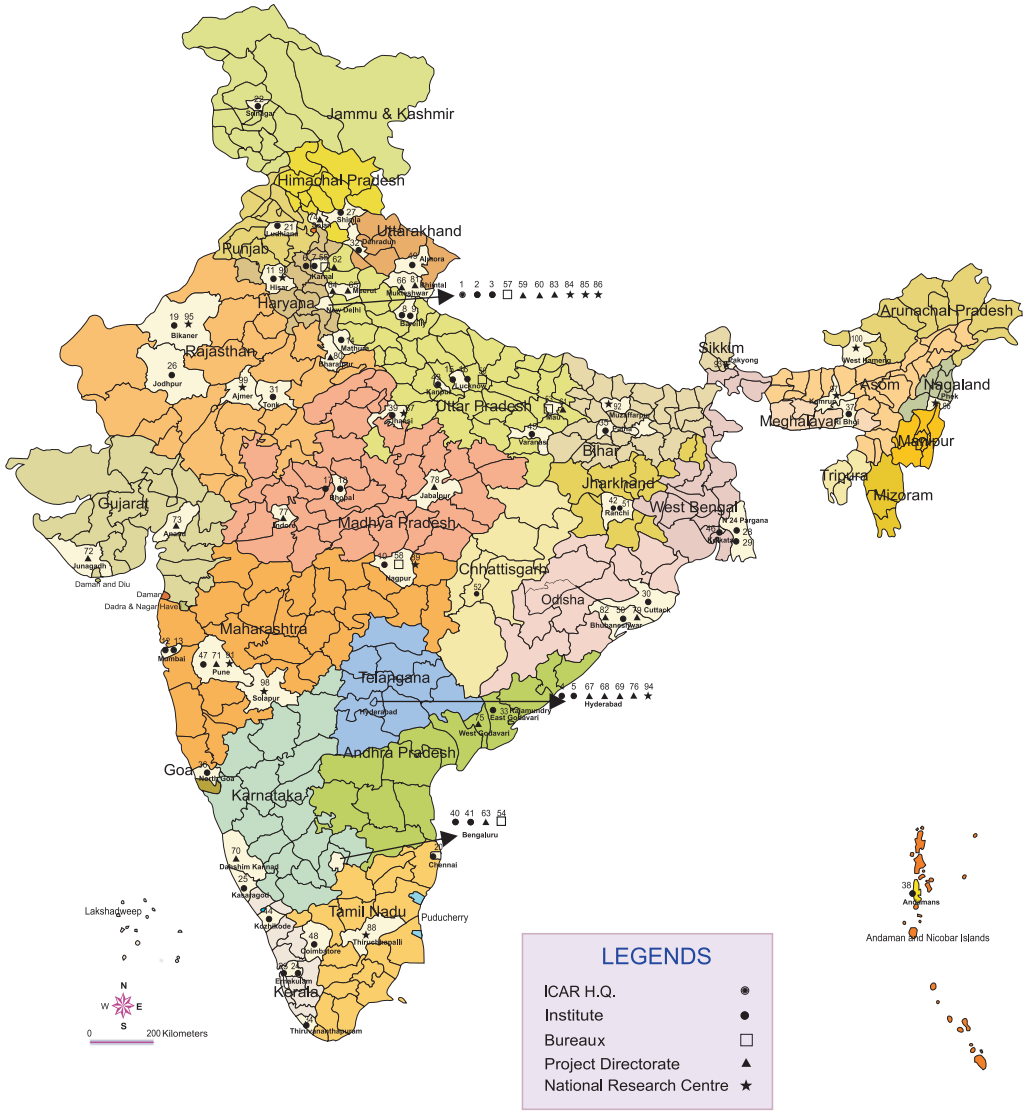
# Vision 2050

Central Coastal Agricultural Research Institute

Indian Council of Agricultural Research

# INDIAN COUNCIL OF AGRICULTURAL RESEARCH

## Institutes, Bureaux, Directorates and National Research Centres




● 64 Research Institutes ● 6 Bureaux ● 15 National Research Centres ● 15 Project Directorates

# INDIAN COUNCIL OF AGRICULTURAL RESEARCH

## Agricultural Universities

# Vision 2050

Central Coastal Agricultural Research Institute
(Indian Council of Agricultural Research)
Goa

www.ccari.res.in

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# संदेश

भारतीय सभ्यता कृषि विकास की एक आधार रही है और आज भी हमारे देश में एक सुदृढ़ कृषि व्यवस्था मौजूद है जिसका राष्ट्रीय सकल घरेलू उत्पाद और रोजगार में प्रमुख योगदान है। ग्रामीण युवाओं का बड़े पैमाने पर, विशेष रूप से शहरी क्षेत्रों में प्रवास होने के बावजूद, देश की लगभग दो-तिहाई आबादी के लिए आजीविका के साधन के रूप में, प्रत्यक्ष या अप्रत्यक्ष, कृषि की भूमिका में कोई बदलाव होने की उम्मीद नहीं की जाती है। अतः खाद्य, पोषण, पर्यावरण, आजीविका सुरक्षा के लिए तथा समावेशी विकास हासिल करने के लिए कृषि क्षेत्र में स्थायी विकास बहुत जरूरी है।

पिछले 50 वर्षों के दौरान हमारे कृषि अनुसंधान द्वारा सृजित की गई प्रौद्योगिकियों से भारतीय कृषि में बदलाव आया है। तथापि, भौतिक रूप से (मृदा, जल, जलवायु), बायोलोजिकल रूप से (जैव विविधता, हॉस्ट-परजीवी संबंध), अनुसंधान एवं शिक्षा में बदलाव के चलते तथा सूचना, ज्ञान और नीति एवं निवेश (जो कृषि उत्पादन को प्रभावित करने वाले कारक हैं) आज भी एक चुनौती बने हुए हैं। उत्पादन के परिवेश में बदलाव हमेशा ही होते आए हैं, परन्तु जिस गति से यह हो रहे हैं, वह एक चिंता का विषय है जो उपयुक्त प्रौद्योगिकी विकल्पों के आधार पर कृषि प्रणाली को और अधिक मजबूत करने की मांग करते हैं।

पिछली प्रवृत्तियों से सबक लेते हुए हम निश्चित रूप से भावी बेहतर कृषि परिदृश्य की कल्पना कर सकते हैं, जिसके लिए हमें विभिन्न तकनीकों और आकलनों के मॉडलों का उपयोग करना होगा तथा भविष्य के लिए एक ब्लूप्रिंट तैयार करना होगा। इसमें कोई संदेह नहीं है कि विज्ञान, प्रौद्योगिकी, सूचना, ज्ञान-जानकारी, सक्षम मानव संसाधन और निवेशों का बढ़ता प्रयोग भावी वृद्धि और विकास के प्रमुख निर्धारक होंगे।

इस संदर्भ में, भारतीय कृषि अनुसंधान परिषद के संस्थानों के लिए विजन-2050 की रूपरेखा तैयार की गई है। यह आशा की जाती है कि वर्तमान और उभरते परिदृश्य का बेहतर रूप से किया गया मूल्यांकन, मौजूदा नए अवसर और कृषि क्षेत्र की स्थायी वृद्धि और विकास के लिए आगामी दशकों हेतु प्रासंगिक अनुसंधान संबंधी मुद्दे तथा कार्यनीतिक फ्रेमवर्क काफी उपयोगी साबित होंगे।

**(राधा मोहन सिंह)**

केन्द्रीय कृषि मंत्री, भारत सरकार

# Foreword

Indian Council of Agricultural Research, since inception in the year 1929, is spearheading national programmes on agricultural research, higher education and frontline extension through a network of Research Institutes, Agricultural Universities, All India Coordinated Research Projects and Krishi Vigyan Kendras to develop and demonstrate new technologies, as also to develop competent human resource for strengthening agriculture in all its dimensions, in the country. The science and technology-led development in agriculture has resulted in manifold enhancement in productivity and production of different crops and commodities to match the pace of growth in food demand.

Agricultural production environment, being a dynamic entity, has kept evolving continuously. The present phase of changes being encountered by the agricultural sector, such as reducing availability of quality water, nutrient deficiency in soils, climate change, farm energy availability, loss of biodiversity, emergence of new pest and diseases, fragmentation of farms, rural-urban migration, coupled with new IPRs and trade regulations, are some of the new challenges.

These changes impacting agriculture call for a paradigm shift in our research approach. We have to harness the potential of modern science, encourage innovations in technology generation, and provide for an enabling policy and investment support. Some of the critical areas as genomics, molecular breeding, diagnostics and vaccines, nanotechnology, secondary agriculture, farm mechanization, energy, and technology dissemination need to be given priority. Multi-disciplinary and multi-institutional research will be of paramount importance, given the fact that technology generation is increasingly getting knowledge and capital intensive. Our institutions of agricultural research and education must attain highest levels of excellence in development of technologies and competent human resource to effectively deal with the changing scenario.

Vision-2050 document of ICAR-Central Coastal Agricultural Research Institute (CCARI), Goa has been prepared, based on a comprehensive assessment of past and present trends in factors that impact agriculture, to visualise scenario 35 years hence, towards science-led sustainable development of agriculture.

We are hopeful that in the years ahead, Vision-2050 would prove to be valuable in guiding our efforts in agricultural R&D and also for the young scientists who would shoulder the responsibility to generate farm technologies in future for food, nutrition, livelihood and environmental security of the billion plus population of the country, for all times to come.

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# Preface

Agriculture continues to be the mainstay of the Indian economy. Despite a fall in its share from 55.1 per cent in 1950-51 to 14.0 per cent in 2011-12, the importance of agriculture has not diminished. The country achieved self-sufficiency in food production at the macro level, but still is a food deficit country facing massive challenges of high prevalence of malnourished children and high incidence of rural poverty. However, India is marching towards a global outsourcing hub in the production and supply of inputs needed for sustainable agriculture products and processes developed through biotechnology and Information and Communication Technology (ICT).

The Indian Council of Agricultural Research upgraded the ICAR Research Complex for Goa to a full-fledged Institute in April, 1989, which is further upgraded to ICAR-Central Coastal Agricultural Research Institute (ICAR-CCARI) in Jan. 2015 keeping in mind the sustainable agricultural and allied activities in fragile coastal ecosystem of the country and the ever-growing needs of agricultural research, education and extension of the coastal region. The Research institute is poised to carry out applied and strategic research in field crops, horticulture, livestock and fisheries. However, economic viability of farming has to be improved by substantially increasing the net income of farmers. Protection and improvement of land, water, bio-diversity and genetic resources are essential for sustained increase in productivity, profitability and stability of major farming systems.

High rainfall to the tune of 2800 to 3000 mm and fertile soils and valleys in the undulating terrains of the west coast would be favorable factors for increasing production of many agriculture commodities particularly horticulture and plantation crops. As the natural resource base is strong, potential cash crops like cashew, spices as intercrops in coconut and arecanut gardens, fruit and flower crops can be produced in this region which can take advantage of programmes such as Agriculture Export Zone (AEZ). However, marginal and small holding farmers with less than 1 ha in this region have many limitations in large scale adoption of technologies for increasing output.

The Institute would have to endeavour for developing modern technologies in the changed scenario of economic liberalisation for export oriented agriculture. The strategy in this direction would be

a multi-disciplinary approach aimed at problem specified solutions to meet farmers' needs.

This vision document outlines a roadmap for self-sufficiency in agricultural production through a multipronged approach. Farmer-to-farmer learning by establishing farm school in each block, adopting location-specific Integrated Farming Systems (IFS), ensuring timely availability of quality seeds, integrated and balanced nutrient application and management, efficient water management, water harvesting and water use efficiency deserve the highest priority.

Higher growth in agriculture assumes great importance and is a matter of concern for policy planners and research scholars in recent times. There is potential for enhancing yield of major crops through better soil and water management, profitable crop rotation, innovative marketing and genetic engineering. We need to strengthen the existing infrastructure through seamless integration at policy level so as to avoid functional bottlenecks in operation across stakeholders mainly collaborating institutions, state agricultural departments, SAUs, ICAR institutes, etc. for taking the major objectives forward. The Vision-2050 document is an effort to address the problems and challenges in relevant areas, for chartering a path of holistic development, monitoring, surveillance, decision making and policy formulation.

I take this opportunity to thank Indian Council of Agricultural Research (ICAR), especially our esteemed Director General and Secretary, DARE, Dr. S. Ayyappan for ushering a wide vision of Indian Agriculture through his visionary wisdom. I express my gratitude to Dr. A.K. Sikka, Deputy Director General (NRM) for his sincere advice and consistent encouragement for developing this vision document. I am also thankful to Dr. B. Mohan Kumar, ADG (Agronomy & Agroforestry) and Dr.Rajbir Singh, Principal Scientist (Agronomy) for their encouragement, guidance and critical comments to develop this document. I also thank all my colleagues from the Institute for their contribution to bring out this document.

Narendra Pratap Singh
Director

# Contents

# Context

In the new millennium, the challenges in Indian agricultural sector are quite different from those met in the previous decades. The enormous pressure to produce more food from less land with threatened and shrinking natural resources is a tough task for the farmers.

The Indian Council of Agricultural Research, New Delhi, established the ICAR Research Complex for Goa in April, 1976. After a short spell under the ICAR Research Complex for North East Hill Region, the complex was brought under the administrative and technical control of the Central Plantation Crops Research Institute, Kasaragod, Kerala. After functioning at different Government agricultural farm sites in Goa, the location was finally shifted to Ela, Old Goa in 1982. In order to intensify the transfer of technology and to impart grass-root level vocational training, a KrishiVigyan Kendra was also established at the Research Complex in 1983.

The centre was upgraded to a full-fledged Institute in April, 1989 to cater to the growing needs of agricultural research, education and extension in the state of Goa. Later, the institute has been further upgraded to ICAR- Central Coastal Agricultural Research Institute to address the sustainable agricultural and allied activities in fragile coastal ecosystem of the country. The Institute is poised to carry out basic, applied and strategic research specific to the coastal region, in field and horticultural crops, livestock and fisheries keeping in view the sustainable management of natural resources in the region.

Broadly the entire agro-climatic zones of the coastal region of India comes under four agro ecological regions. The Indian costal region is spread across nine states and three union territories with five states namely Gujrat (13 districts), Maharashtra (5 districts), Goa (2 districts), Karnataka (3 districts), Kerala (14 districts) and Union territories (Pondicherry, Daman and Diu and Dadar and Nagar Haveli) on west coast, and four states namely Tamil Nadu (13 districts), Andhra Pradesh (9 districts), Odisha (11 districts) and West Bengal (3 districts) on the East Coast.

It is noted that in India, the coastal ecosystem covers an area of 10.78 million ha along 8129 /9000 km long coastline. All the above districts together cover about 3.99 lakh square km of the area to form the coastal ecosystem of the Country with an estimated population of

about 20.13 crores accounting for about 17% of the total population of the country. The major activities in the coastal region include agriculture and allied sectors, tourism, mining, industries, shipping transport,etc.

Of the total of 6.73 million ha of salt effected area, 2.56 million ha is reported to exist in coastal areas, accounting for about 30 percent of the total salt affected soils of India. The salinity affected area due to brackish water area is about 1.4 Million ha., reported to exist in the States of Gujarat, Maharashtra, Goa, Karnataka, Kerala, Tamilnadu, Andhra Pradesh, Odisha and West Bengal.

By and large, rice is the staple food in the coastal region besides other food resources like fish, meat, milk and milk products and regional vegetable and fruits. A number of improved rice varieties including salt tolerant types are originated from coastal rice genetic resources of the country. The rice area in the coastal districts accounts for 15 per cent of the total area as well as production of the country. The total rice production from the coastal states is about 15.36 metric tonnes of which contribution of Andhra Pradesh is the highest followed by Tamil Nadu, Odisha and West Bengal. The average productivity of rice in this region is about 2.20 t/ha which is on par with the national average.

Coconut, cashew, arecanut, major spices (black pepper, turmeric, ginger, cinnamon, clove, nut meg), fruit crops like banana, mango, pineapple, jackfruit, an array of lesser known/ minor but economically important fruit crops, etc.; regional vegetables of genetic importance, tuber crops, and various medicinal plants form important horticultural resources contributing significantly not only to the economy of the coastal states but also to the foreign exchange of the country through exports.

In coastal region of India livestock resources are diverse and plenty in number. While constituting 14.2% of total Indian landmass of the country, the coastal region possesses 19.5% of the livestock population of total Indian livestock. The East Coast of the country is more affluent in both population and the genetic diversity in livestock resources than the west coast.

The Indian coastal eco-system has vibrant fishery sector with continental shelf of 5.3 lakh $km^2$, mangrove belt of 6740 $km^2$, Brackish water resource of 11.9 lakh ha, 50,000 traditional boats, 73,500 motorised boats, 72,000 mechanized boats, 1537 fish landing centres, 300 fish processing units, 3432 fishing villages, 8.7 lakh fishermen families and 4.1 million fisher-folk.

At present, the Institute has 50.83 ha land of which 33.67 ha was acquired during 1987. The staff strength of 93 comprises of 21 scientists

from different disciplines on research side and another 18 technical, 21 administrative and 32 skilled support staff.

The research activities of the institute are grouped under five functional groups namely, Crop Improvement and Protection, Resource Management and Integrated production, Horticulture, Animal Sciences and Fisheries. Transfer of technology programmes are organized for farmers comprising both on campus and off campus training and field demonstrations through active participation of KVK. The Institute is also a centre for AICRPs on cashew, integrated farming system (IFS) and pig and a voluntary centre for AICRP on rice, arid legumes and vegetable crops.

Salient research achievements of the institute are identification of suitable varieties of different crops. For example, a short duration rice variety 'Annada' was developed for cultivation in the rainfed uplands. Similarly, new high-yielding varieties of rice were identified for cultivation in Goa (Pusa-44 and Karjat-3, found suitable for rainfed shallow lowland situation, Naveen for *Rabi* season and CSR-27 and CSR-36 for coastal saline soils). About 16 landraces of rice were collected and their characterization is in progress. Suitable technologies for rice based cropping/farming systems were identified, improved varieties in groundnut and cowpea for cultivation in rice fallows under residual soil moisture situations were introduced and tested, sugarcane varieties suitable for local situations along with fertilizer schedules were standardized and suitable species for rehabilitation of mine reject soils were identified. Different bio-engineering measures for soil and water conservation involving cashew and mango were initiated. Eco-friendly management of major insect pests and diseases in plantation, fruit crops, field crops and vegetable crops was developed and validated. Integrated pest management practices for management of red palm weevil in coconut through pheromone traps were popularized. Endophytes and rhizobacteria from different crops were screened for their antagonism against *Ralstoniasolanacearum*. PCR based sensitive detection of *R. solanacearum* from soil and other sources was standardized. Sensitivity of detection is as low as 100 bacteria/g of soil.

On-going research includes identification and development of suitable high yielding salt tolerant rice varieties for coastal saline soils, identifying high yielding pulses including groundnut in rice fallows for increased production and productivity, standardization of spawn production technology for local mushroom production, standardization of technologies for production of bio-control agents for disease management and increasing production in field and horticultural crops.

Goa along with Daman, Diu and other small locations has a unique political history of being ruled by Portugal for 450 years. Portuguese introduced many plant species and varieties from their colonies such as Brazil. Cashew is one such introduction done first at Goa for soil and water conservation measures. Cashew being a major plantation crop of the state currently occupies 55,732 ha with estimated productivity and annual production of 415 kg per ha and 23,138 tonnes, respectively. However, under the existing edaphic and agro-climatic conditions, there is vast scope for enhancing productivity and production by which the demand for the raw material for the processing sector can be easily met with. Cashew germplasm collection of 80 local accessions is being maintained. This collection is comprising of 14 jumbo nut types, 26 bold nut types, 12 medium nut high yielders, three dwarf types and the remaining 25 either high yielders/cluster bearers, irrespective of nut size. Improved and popular varieties of cashew developed elsewhere have used Goangermplasm of cashew.

The state has much variability in cashew and its utilization can go a long way in producing varieties which have both nut quality of international standards and big apple sizes for juice extraction. Goa is the only state where cashew apples are utilized for making alcoholic beverage, "Feni'. It has a great potential for revenue earning. Now Goan cashew feni enjoys the status of a GI product. Microflora of naturally fermented cashew apple juice was studied. The predominant yeasts isolated and identified from fermented cashew apple juice were *Saccharomyces cerevisiae, Pichia species* and *Issatchenkiaorientalis*.

Coconut is the second most important crop of the state. There are two local popular tall varieties, Benaulim and Calangute. Inter/mixed cropping of new intercrops such as coriander (cv. PusaSugandha) were found highly productive and profitable.

The state also has varieties of mangoes like Mankurad, Hilario etc. with outstanding qualities those need to be conserved and economically exploited. A total of 114 varieties of mango germplasm are conserved at the Institute farm. Cardozo Mankurad is registered by the Institute as fibreless selection in Mankurad mango.

Kokum being a speciality of the region with high value products like juice, butter etc, its cultivation has to be planned either as a mixed crop in coconut/arecanut gardens or as border crop or as block plantations. Low cost polyhouses have vast scope for vegetable cultivation, like capsicum and flowers e.g. Gerbera. Diversification of cropping systems with vegetables, flowers and high value crops alone or as intercropping of crops like ginger, turmeric, vanilla etc in coconut/arecanut has proved

to be profitable. The technology on commercial production of turmeric and ginger has been successfully transferred to the progressive farmers.

Noni is a potential medicinal and dye crop of the future and occurs wild along the Konkan coast. Due to tourism activities the plant is being overexploited. A program to collect and conserve the germplasm of noni native to Goa and Maharashtra has been initiated. Six accessions of Goa were sent to NBPGR, New Delhi for conservation.

The institute has done research on computational genomics and developed softwares. Marker Express 1.0 software was developed to locate RAPD/ISSR primers and design iSCAR primers. It was validated using expressed sequences and published polymorphic RAPD primers on oil palm. DG-MAP software was developed for locating RAPD and SSR priming sites and to work out the distance between the priming sites. It was validated using genome sequence of cucumber. The software successfully mapped the known and predicted markers closely linked to F locus.

Small scale farm mechanization in agriculture is required. Introduction of tree climbers in coconut and harvesters in mango would reduce dependence on skilled labour. In rice, use of transplanters, cono-weeder, drum seeder, rotary weeder and harvester can reduce dependence on farm labours. As the land holdings are small, use of power tillers need to be promoted. Post-harvest management including preservation, processing, and value addition needs greater attention.

In the livestock sector, focal areas of attention include breeding of cattle and other meat animals, improvement of local breeds of cattle, scientific rearing of rabbits and goats, backyard poultry rearing, nutrition and health care. Pig being the preferred local species, some of its value added products like sausages need to be promoted to meet the needs of the tourism industry. Similarly, partial stallfed rearing of goats will be a high revenue earning proposition. Backyard rearing of poultry like Vanaraja, Giriraja and dual purpose poultry would be boon to rural areas.

Crosses of Yorkshire and local pigs were identified as suitable breed for coastal tropical humid climate and popularized. The complete package of meat rabbit production including suitable breed, housing, feeding etc. has been standardized. Similarly, package of practices were standardized for improving fertility and fecundity in pigs and rabbits. The major issue with livestock farming in Goa is non-availability of feeds and fodders. The annual requirement of concentrate, green fodder and dry roughages is about 1.23, 10.08 and 1.67 lakhs tonnes, respectively. In terms of supply, the deficiency percentage is highest for concentrate at 93%, followed by 49% for green fodder and 50% for dry roughages.

Feeding of green fodder as replacement of costly concentrate mixture was standardized and economic ration formulations for various types of livestock were popularized. Hydroponics technology for fodder production and feeding to dairy animals was standardized. Technology for preparation of silage without feed additives was developed to preserve the surplus green fodder. An indigenous technology for the preparation of bypass fat was developed and introduced for supplementation to the dairy animals. Economical feeding strategies were developed for dairy animals and pigs by utilizing the locally available unconventional feed ingredients like brewers' grain, cashew apple waste, etc. For the proper use of the locally available crop residues, feed block feeding technology is being popularized in Goa, which in due course will be disseminated in the other coastal areas.

Disease investigation laboratory was established for taking up disease diagnosis work. State-of-the-art facilities to diagnose listeriosis and other foodborne infections in humans and animals and to subtype strains have been established. The Institute has been recognized as a Centre of Excellence for molecular epidemiology of *Listeria monocytogenes* and has excellent facilities for molecular subtyping of bacterial pathogens. PCR based diagnostic kit for detection of *Listeria monocytogenes* from food and clinical samples (human and animal) has been developed. A well characterized repository of the strains of *Listeria*, Indian *Listeria* Culture Collection (ILCC) has been established.

The water bodies in the coastal line present opportunities for exploiting both inland and marine fisheries. For fisheries, the areas needing consideration include Khazan (saline) land aquaculture production with identification of suitable cultural technology for species diversification, identification of suitable seed production technology and setting up of seed production units for the commercially important brackish water finfish and shellfish species for promotion of aquaculture production. In the marine sector, conversion of unproductive trawlers into long line Tuna fishing vessels, cage culture/mariculture of seabass and mussel and facilities/yards for drying fish to utilize the bumper marine catches need attention. Emphasis should also be on ornamental fishes for revenue earning.

The region also attracts tourists because of natural beauty and the pristine environment. Therefore, there is tremendous scope for intermixing agricultural technology with eco- tourism, for getting higher income and profitability to the farmers of the region.

However, increasing labour costs, land fragmentation, traditional way of farming and low returns from the sectors (both agriculture and

livestock) compared to tourism causes great concern over the future of agriculture in the state. There is challenge of increasing production of crop, flowers, milk, meat, poultry and fish to reach a level of at least self sufficiency. The region also suffers from extensive land degradation and erosion.

Horticultural crop productivity of the western region is high and there is a need to have research programmes addressing the specific problems in the region. Western Ghats is a major biodiversity hotspot and there is tremendous genetic diversity among the horticultural plant species. Hence, specific programmes to cover the conservation and utilisation of the horticultural genetic diversity in the region need to be formulated.

Being a multi-disciplinary and multi-commodity Institute and covering detailed aspects of field and horticultural crops, livestock, fisheries and related aspects, besides its location in a typical coastal ecosystem representing the West coast zone of the country, it can take up the challenges of agricultural research requirements of the coastal region and parts of the Western Ghats, in future.

❑

# Challenges

The coastal ecosystem of the country, especially the east coast, is more prone for the natural disasters like cyclones, tsunamis, sea rise etc. Besides this, increased urbanization and industrialization, burgeoning population density / pressure on coastal eco-system, enhanced importance of other new sectors like information technology, alternative commercial livelihood activities such as tourism and mining in some coastal states like Goa, have relegated the agricultural activities in the coastal region to feel as a sector of lesser economic importance, nevertheless the latter is vital for basic food, fodder and feed. As a consequence, the number of people involved in agriculture is declining steadily and so is the investment and interest of the people in agriculture. Again, for the same reason, the cost of scarce labour is increasing which may cause the profits from agricultural enterprises to decline. Concurrently, reduction in the availability of labour for agriculture has made the timely execution of agriculture operations difficult. This is also leading to fertile agricultural lands becoming not only fallow but are getting converted into nonagricultural activities like commercial building infrastructures. This puts a question mark over the future of agriculture in the coastal region, especially in small states like Goa, unless immediate corrective measures are taken to reorient our priorities towards modern sustainable agriculture for enhanced production and productivity, high value agricultural products, increased mechanization and value addition to the produces.

The east coast faces threats from frequent cyclones, heavy winds and floods, whereas the west coast faces heavy rainfall events and in some parts and sea-water intrusion. All these cause severe damage to agricultural production. Apart from these, climate change in terms of increased temperature, change in rainfall and elevated CO2 is also likely to influence the performance of agriculture in the region. Climate change in the 2030 scenario is projected to affect the yields of irrigated rice up to 10% in majority of the coastal districts. However, in some coastal districts of Maharashtra, northern Andhra Pradesh and Orissa irrigated rice yields are projected to marginally increase (< 5%). On the other hand, rainfed rice yields are projected to increase up to 15% in many of districts in the east coast, but reduce by up to 20% in the west coast. Impacts of climate change on irrigated maize in the coastal districts are

projected to be much higher with likely yield loss between 15% and 50%, whereas rainfed maize is projected to lose up to 35%. But, in some districts of coastal Andhra Pradesh, rainfed maize yield is likely to increase by 10%. Projected increase in seasonal maximum temperature during kharif in these areas is less than 1°C in the 2030 scenario.

Livestock in this region are more susceptible for stress due to the climate change and leads to the outbreak of the diseases. Most of the local coastal germplasm is on extinction (eg: Ongole breed of Coastal Andhra and Vechur cattle breed of Kerala) due to non-scientific conservation practices and need immediate scientific intervention. .Due to high human population density and influx of floating, there is more threat from the outbreaks of zoonotic diseases, recurrence of infectious disease.

In coastal states like Goa, mine rejects pose a threat to the ongoing agricultural lands on the low lying areas and silting and pollution of rivers, which have to be properly looked into and corrective measures incorporated. The state has about 18000 ha of khazan land which is problematic and not suitable for many agricultural crops excepting rice cultivation and fisheries. Unless a planned development is envisaged this natural resource cannot be properly utilized. Goa has 2000 ha of mangroves which are very important for sustaining the coastal eco-system and marine fish production. There is a need to protect these mangroves and proper study of its ecology. These challenges are going to be manifested in a long way.

The requirements for milk and meat for Goa are approximately 4 lakhs litres and 63 tonnes per day. However, Goa produces only 1/3rd of its daily milk and meat requirements and for the rest, it depends on the neighbouring states.

The requirement for eggs and broilers for Goa is approximately 3.5 lakhs and 25000 per day respectively. However, Goa produces approximately 1/3rd of its daily requirement and for the rest totally dependent upon the neighbouring states. The per capita availability of eggs and meat is 80 and 3 kg, respectively, which is less than the recommended levels. The major issue with the poultry farming in Goa is non-availability of feeds and high cost of production. Increase in tourism sector has itself increased demands for fruits, vegetables, flowers, dairy products, poultry, eggs and fish. In this direction, prioritization has to be made for promotion of cash value crops, horticultural crops, appropriate livestock and fish species, integrated to suit the local agro-climatic situations. Crop improvement programmes have renewed orientation to address the new challenges posed by the climate change.

There are many issues related to coastal agriculture that need to be addressed including development of integrated farming system models for effective utilization of available homestead resources and holistic watershed development, diversification through development of agro-eco tourism, effective utilization of fallow lands for profitable production of field and horticultural crops, rehabilitation of mine reject soils, livestock rearing, diversification in brackish water aquaculture and secondary agriculture.

Some of the challenges which need attention are:

- Reclamation of coastal saline soils (*khazan land*) for paddy and fish cultivation.
- Remediation and rehabilitation of mine reject soils to tap their potential by cultivating suitable crops. In this context, development of eco-friendly and cost-effective techniques is of paramount importance.
- Development of multiple stress tolerant (salinity, submergence and mineral toxicity) rice varieties for coastal saline areas
- Collection, conservation, characterization and utilization of plant genetic resources for future breeding programme.
- Screening of genetic resources considering the trends in current climate changes and utilization of potential genetic resources in development of new varieties
- Eco-friendly Management of insect pests and diseases in the major field and horticultural crops
- Climate change poses serious threat to biodiversity and agricultural production. Emergence of new pest and diseases, and emergence of minor pest and pathogens to major ones due to climate change.
- Insufficient availability of elite planting material and seeds of horticultural crops
- Non availability of reliable, rapid and low cost disease diagnostic methods
- Management of stem and root borer and tea mosquito bug in cashew
- Shortage of feeds and fodder, evaluation of fodder crops suitable for coastal conditions and development of feeding strategies for high producing animals
- Increasing productivity of the livestock to achieve the self sufficiency for the coastal region through breeding, improving feed and fodder sources, improved health care, rural poultry and piggery development.
- Increasing productivity of eggs and meat through rearing of

alternative poultry species like Japanese quails and ducks and use of alternate locally available feed ingredients to reduce the feed cost.

Non-availability of suitable machineries with timely servicing and availability of ample spare parts for the same at the user's door step

Heavy loss of paddy crop due to coincidence of harvesting of kharif paddy crop in East coast with North-East monsoon and cyclonic storms is a big challenge for threshing , drying and storage and processing

Effective strategic research programmes to withstand the onslaught of natural disasters/ calamities and mitigate their impact on farming sector.

Migration/ shifting of farmers to other occupations and enterprises for better income alternatives/opportunities.

Youth not evincing keen interest in animal husbandry activities.

# Operating Environment

With upgraded status of the institute, ICAR-CCARI, Goa is poised to have operating environment on both West and East coast for accomplishing the sustainable food security in the coastal region.

Seventy one coastal districts coming under nine coastal states and three union territories fall under four agro ecological regions namely, a) Agro-ecological region - 19.Western Ghats and Coastal Plain, hot humid-perhumid eco-region (E2BA5), b) Agro-ecological region - 18. Eastern Coastal Plain, hot sub-humid to semiarid ecoregion (S7Cd2-5), c) Agro-ecological region - 5. Central (Malwa) Highlands, Gujarat plains and Kathiawar Peninsula Ecoregion (I5 D2) and d) Agro-ecological region - 2 Western Plain, Kachchh and part of Kathiawar Peninsula, hot arid eco-region (M9E1). The Indian costal region, on west coast, covers five states namely Gujrat (13 districts), Maharashtra (5 districts), Goa (2 districts), Karnataka (3 districts), Kerala (14 districts) and Union territories (Pondicherry, Daman and Diu and Dadar and Nagar Haveli), while four states namely Tamil Nadu (13 districts), Andhra Pradesh (9 districts), Odisha (11 districts) and West Bengal (3 districts) are covered on the east coast.

It is noted that in all, the coastal ecosystem covers an area of 10.78 million ha along 8129 km long coastline. All the above districts together cover about 3.99 lakh square km of the area to form the coastal ecosystem of the Country with an estimated population of about 20.13 crores accounting for about 17% of the total population of the country.

The climatic zone on the west coast is dominated by tropical wet and tropical wet and dry, whereas part of Gujarat has semi-arid and arid zones. The east coast has tropical wet and dry climate covering major states and semi-arid in parts of Tamil Nadu coastal areas. The average temperature on the west coast ranges from 25.0-27.5 °C. Similar temperature range is observed for coastal region of Odisha and West Bengal. But, Tamil Nadu and Andhra Pradesh on the east coast, experience average temperature of more than 27.5°C. Almost all states on west coast except Gujarat and Northern part of coastal Maharashtra receive rainfall above 2500 mm, whereas Gujarat and Northern part of Coastal Maharashtra receive 1000-2500 mm. East coast of India receive about 1000-2500 mm rainfall. More specifically, Coastal Odisha and West Bengal receives 1500-2500 mm.

### Input management

Farm input management in the coastal states plays vital role in agriculture and allied sectors. One of the major inputs to agriculture i.e. seeds, are produced and supplied by different states is variable. The seed material produced by State of Maharashtra, Kerala and Odisha are 161789, 9282 and 68112 Metric tonnes, respectively. The fertilizer consumption patterns is also variable. The total NPK consumption per ha by Maharashtra, Karnataka, Kerala, Odisha is 128, 179, 94 and 77, respectively. The plant protection chemicals used by Maharashtra and Kerala are 10696 and 693 Metric tonnes. The area under irrigation in coastal districts of Karnataka is about 1.62 ha. Thus, there is variable use of the important input in agriculture by different coastal states.

### Market access to coastal regions of India

Coastal region of India is very well connected to other parts of India and world through road, airports, shipping ports and rail infrastructures. Several National highways are passing through the coastal region. There are nearly more than 50 major railway stations, 8 international (Goa, Mumbai, Chennai, Kochi Kozhikode, Mangalore, Thiruvananthapuram, Visakhapatnam) and 10 domestic (Rajkot, Bhavnagar, Belgaum, Mangalore, Cochin, Tuticorin, Pondicherry, Rajmundry, Behala) airports, 12 major ports (Mumbai, Jawaharlal Nehru Port, Kandla, Murmugao, New Magalore, Kochi, Kolkata-Haldia, Paradweep, Vishkhapattanam, Chennai, Ennore, Tuticorn), 162 minor Portss (Gujarat (40), Maharashtra (53), Goa (5), Daman and Diu, (2) Karnataka (9), Kerala (13), Lakshadweep (10), Tamil Nadu (14), Pondicherry (1), Andhra Pradesh (12), Orissa (2), West Bengal (1)), etc.

Coastal region also has to withstand the onslaught of various natural calamities which greatly influence the activities of agriculture and allied sectors. Planning and execution of the appropriate research and transfer of technology programmes have to be take up keeping in view the vulnerability and the operating environment subjected to the natural calamities and their impact on the above sectors.

The impact of Super cyclone disaster on livestock during October, 1999 was visualized in the loss of lives of Buffaloes - 13,464, Bullocks - 52,973; Cows - 1,56,424; Calves - 90,232; Sheep - 1,03,127; Goats - 1,96,212; Pigs - 8,945 and Poultry - 11,51,245 in Qdhisha . The disposal of the decomposed carcasses was the major problem. Similarly, coastal regions of Odhisha and Andhra Pradesh also faced impact of severe tropical cyclone “Phailin” in October, 2013 leading to loss of lifes, flooding the agricultural lands and fishing industry. Of late during

October, 2014, Andhra Pradesh and Odhisa again had severe impact of cyclone "Hudhud" which not only flooded the agricultural lands even the crops like banana, coconut, cashew, etc. were devastated severely.

The state of Goa forms the part of Western Ghats. Agriculture represents the third important economic activity in Goa providing livelihood to 16 % of the population after tourism and mining. The topography of Goa can be divided into coastal plains, sub-mountainous region and hilly region. In coastal plains mainly rice is grown in kharif and, rice and groundnut in rabi extended summer seasons. Sub-mountainous region is covered mainly by horticultural crops namely cashew, coconut, arecanut, mango etc. Thick forest areas cover hill region. The coastal plains and sub-mountainous regions are suitable for livestock rearing. There is a gradual shift from labour intensive field crop production to perennial horticultural plantations due to the better returns and lower risk. There is emphasis on mixed farming wherein farming system research including watershed management is gaining importance. Cashew is cultivated in nearly 55000 ha with paddy covering about 31000 ha. Problematic soils, khazan lands covering an area of 18000 ha are not suitable for cultivation of many crops except rice and fish farming. The region has substantial area under mine rejects which is problematic and not suitable for agriculture purposes.

The coastal region of the country is rich in rice diversity particularly land races tolerant to soil salinity and variable nutritional qualities and tolerance to deep water conditions. These landraces are potential source of genes for future use in variety development programmes.

The farming system forms the part of Agri-silvi-horti-pastoral coastal ecosystem. The important farming systems, blessed with strong natural resource base and enchanting scenic beauty in the hinterlands of coastal regions of the country are as follows:

1. Rice based farming systems
2. Coconut based cropping/farming system
3. Arecanut based cropping/farming system
4. Cashew based cropping/farming system
5. Animal based farming system
6. Fish based integrated farming system

Agricultural Mechanization in most of the coastal region is low to moderate, inspite of abundant subsidy opportunities through central and stateschemes, which is mainly due to unsuited/inundated land terrains, small land holdings and lack of serving facility and non-availability of spare parts of machines.Thereby, it is real challenge for popularization of mechanization in farming sector.

Development of integrated farming system and agro-eco tourism models has tremendous scope owing to the prevailing agro-climatic conditions for intermixing agricultural technology with eco- tourism. Farmers having agriculture as base with spice/horticulture plantations, floriculture and natural resource like rivers, ponds, jungles with various flora and fauna, healthy and peaceful environment are venturing into this business along with agriculture. The coastal region, even though it occupies 20 per cent of the total geographical area of the country, it has been ecologically the most sensitive, economically very important region supporting allied sectors like tourism industry, shipping transportation and the like.

The Coastal region of India is also enormously rich in animal genetical diversity. A total of 35 well recognized livestock (registered with National Bureau of Animal Genetic Resources, Karnal) and poultry breeds are available from this region.

Animal husbandry in coastal region has a major role in agricultural community and agricultural activities and provides considerable income for these families. Enhancement of income for farmers through livestock–crop integration makes system sustainable.

The vast population and diversity of livestock in the coastal India could prove to be a vital asset for the country and unlike many other natural resources which will deplete over the years, a sustainable livestock production system will continue to propel coastal agriculture through sound integration.

Indian coastal region has brackish water resource of 11.9 lakh ha, 50,000 traditional boats, 73,500 motorised boats, 72,000 mechanised boats, 1537 fish landing centres, 300 fish processing units, 3432 fishing villages, 8.7 lakh fisherman families and 4.1 million fisher-folk. The fishery sector contributes to 0.8 per cent of the national GDP and 5 per cent of the agricultural GDP. The Indian fish production is growing at an average rate of six per cent.

Besides the above , the region generates agro-industrial by-products viz. cashew apple waste, brewery waste, prawn head waste, coir dust are available in abundance.

As regards Goa state, livestock especially cattle are a traditional component of sub-mountainous production systems. In some areas goats are reared as herds. In coastal plains besides cattle, pig farming is common. Organized poultry farms are confined to few pockets only.

However, backyard poultry is common throughout the state. Immigrant livestock remains low.

There is no recognized livestock market in the state of Goa.

Therefore, dairy animals, goats, poultry are brought from neighboring states. Along with the animals, diseases are also introduced in new areas.

The state of Goa is deficient in production of cereals, pulses and vegetables, so also in livestock feed ingredients. These feed ingredients are brought from neighboring states, therefore, the cost of production of livestock increases. Agro-industrial by-products namely cashew apple waste, brewery waste, prawn head waste, coir dust are available in abundance. However, their digestibility is low. These products can be incorporated to some extent in animal feed to reduce the feed cost, thereby reducing the cost of production. Rural poultry production with use of suitable breeds like Gramapriya and Vanaraja has to be popularized to improve the rural economy and job opportunity with self employment. Further backyard poultry can be reared in the integrated farming system approach for better productivity and sustainability of the system.

For free flow of improved technologies, access to latest developments in the field of agricultural research taking place elsewhere and constant upgradation of agricultural research at the Institute, viable linkages and collaborations are maintained by the Institute with various other organizations, universities and NGOs related to agricultural research and development.

Comparison of coastal areas / agriculture with other eco systems

| Parameters | Coastal | Hills and mountains | Arid zone | Plain land |
|---|---|---|---|---|
| Soil and Topography | Sandy coast and plains in East coast<br>Sandy plains, Plain, lateritic plateaus and Undulating topography in West coast | Sloppy and undulating, valleys | sandy plains, plains | Plain land |
| Climate | Hot humid, Dry and hot | Cold and dry, Wet and cold, | Arid, hot | hot tropical, sub tropical |
| Rainfall Distribution | High rainfall<br>Unimodal/bimodal | Heavy rains with high soil erosion and run-off losses | Scanty rainfall | Moderate rains, unimodal and bimodal distribution |
| Wind | High wind velocity in East coast | | Hot dry winds | |
| Agricultural crops | Mostly rice and tuber crops are the staple food | | Course and fine cereals. oil seeds | Course and fine cereals. oil seeds |
| Plantation crops | Coconut, Cashew, Arecanut, rubber, oilpalm, cocoa | Tea, coffee, Chincona | Date palm | Coconut, arecanut, Oil palm, Cashew, cocoa |

| | | | | |
|---|---|---|---|---|
| Fruits | Mango, banana, pineapple, jack fruit, papaya, pummelo, acid lime, rough lemon, minor fruits | Stone fruits and nuts, Mandarins, Strawberries, Avacado, hill banana, persimmon, kiwi fruit, pineapples | Dates, Ber, Pomegranate, Aonla, Manila tamarind | Citrus fruits, banana, mango, papaya, litchi sapota, guava |
| Vegetables | Important vegetables are brinjal, bhendi, chilli, vegetable cowpea, amaranthus, sweet potato, cucurbits, radish, tubercrops, drumstick, tapioca, curry leaf, legume vegetables, | Cole crops, chow chow potato, root crops, garlic, | Cucurbits, okra, cluster bean, drumstick, mesquites | Solanaceous, cucubitaceous, leguminous, tubers and root crops, okra, tree leafy vegetables, |
| Spices | Nutmeg, pepper, cinnamon, turmeric, ginger, chilli | Clove, saffron, fennel, asafoetida | Seed spices like cumin, fenugreek, fennel, coriander, poppy, | Fenugreek, mustard |
| Animals | Contributes significantly to the livestock breeds of the Country | Yak, mithunand sheep are important livestock | Camel | Regional livestock breeds |
| Fisheries | Marine and brackish water fisheries activities are conspicuous | | Inland /sweet water fisheries | Inland /sweet water fisheries |
| Economic activities | Plantation and spice based in west coast; rice based in east coast, beach tourism fisheries industry and shipping transportation | Agro based industries for agricultural and horticultural crops of economic importance, hill station tourism | Seed spices and guar gum based industries, desert safari tourism | Agro based industries |

# Opportunities

Indian coastal agriculture has rich agro-biodiversity comprising of plant,livestock and fisheries genetic resources. Abundant and assured rainfall (1500 – 3000mm) is the unique opportunity ushering fostering support for agriculture. In the coastal areas, bulk of the agricultural output is not only from crop production, but also from livestock production, fisheries and aquaculture, supporting the livelihood of millions. Rice is the major staple crop in the coastal region. In addition, horticultural crops and plantations, especially coconut predominate coastal agriculture.

Coastal districts have, in general, warm and humid climate favourable for commercial cultivation of an array of commercially important field and horticulture crops. The prevailing weather conditions are a boon for commercial plant propagation activities of horticulture crops.

Some of the opportunities are described below:

**Biodiversity:** Coastal region all along the Western Ghats is one of the mega centres of diversity having many endemic species. The area is one of the world's ten "Hottest biodiversity hotspots" and has over about 4500 species out of which 35 percent are endemic. Nearly 2000 species of higher plants, 84 species of fishes, 87 species of amphibians, 89 species of reptiles, 15 species of birds and 12 species of mammals are endemic to the Western Ghats. At least 325 globally threatened species occur in the Western Ghats. It has been reported that approximately 17% of a set of 2500 microbial species are likely to be present in this region. Western Ghats scores over Eastern Himalayas in harbouring a larger number of species restricted to India alone.

**Water resources: Besides abundant and assured annual precipitation (91500-3000mm), m**any of the coastal districts are fed by the river streams, river deltas and back-water streams.Sabarmati, Mathi, Narmada, and Tapti in Gujarat, Mandovi and Zuari in Goa are the rivers flowing through states and joining Arabian Sea. Coastal rivers viz. Netravati, Sharavathi, aghanashini,etc., of Karnataka flow through three coastal districts and unite Arabian Sea; Hoogly delta (West Bengal), Mahanadi (Odisha), Godavari delta and Krishan (Andhra Pradesh); Kaveri (Tamil Nadu) are major rivers resources in East coast districts flowing to Bay of Bengal.

The State of Goa is located on the west coast of India and receives abundant rainfall from the South-West monsoonal winds. Rainfall in recent years has been below an annual average of 3000 mm. Though the State has a huge potential of assured water, a high percentage of the water resources get drained down owing to Goa's physiographical set up and ultimately joins the Arabian Sea. The state has nine rivers, of which six rivers originate and flow exclusively within the state boundaries. Goa has a reasonable scope for fisheries production mainly from marine capture and inland culture resources. It has an equally good potential for production of fisheries processed products for both internal and export markets. More than 80 per cent of the population of Goa is fish eater. Per capita fish consumption is 7.4 kg compared to the national average of 5 kg and recommended average of 11 kg. Though Goa's coastline of 105 km forms only 1.25 per cent of the country's total of 8192 km, its recorded marine fish landing contribution to the country's total ranges from 2.2 to 3.8 per cent.

**Meat and meat products:** In Goa, about 80% population is non-vegetarian. The demand for meat and meat products is very high both for domestic consumption as well as for tourists. There is an opportunity to enhance production of meat, eggs and fish.

**High Value Crops:** Increase in tourism sector has increased demands for exotic fruits, vegetables, and flowers. In this direction, there is an opportunity for promotion of high value crops, horticultural crops integrated to suit the local agro-climatic situations.

**Organic farming:** Organic horticulture has a tremendous potential in the state of Goa. The concept is already well accepted by consumers as well as producers. Agro-tourism centres in the state are actively involved in promoting the organic products produced either at their own centres or by collecting from the vicinity of their centres. Some products such as organic cashew, organic spice products like black pepper, turmeric, nutmeg, chillies, banana, etc. are already being promoted at agro-tourism centres and fetching premium price.

**Floriculture:** The western region of India has got high potential for cultivation of cut flowers and locally available flowers. Huge diversity exists in jasmine, crossandra and other flower species endemic to the region. Floriculture is highly neglected in Goa and accounts for less than one per cent of total horticultural crops. As per rough estimates, Goa has hardly 25 hectare of area under floriculture with the production of 40 tonnes per year. Considerable amount of flowers are brought to Goa region daily for its requirements from neighbouring states. There is an opportunity to develop floriculture industry in the region to make the

region self-sufficient in meeting the demands created by the tourism and seasonal festivals.

**Spices and Condiments:** Major spices like black pepper, clove, nutmeg, cinnamon, ginger and turmeric are economically important crops in both east and west coast regions which contribute significantly to the National economy for domestic and export purposes.Opportunities can be encashed for enhancing the production and productivity of these high value crops through novel varieties and production technologies in the light of climate change environment. Secondary agricultural activities will have abundant scope in the region. Nutmeg is one of the economically important tree spice crops suitable for commercial cultivation in Goa. Abundant seedling progeny exists in arecanut mixed cropping systems. Potential local germplasm stock of nutmeg needs to be identified, collected, evaluated and conserved for posterity. Scope for evaluating the promising nutmeg genotypes as intercrop in coconut gardens is enormous and needs to ensure it as a compatible tree spice crop component in coconut garden, besides introduction of other spice crops like cinnamon and black pepper. There is high degree of variability in chillies grown in Goa.

**Secondary Agriculture:** Reduction in the availability of labour for agriculture has made the timely execution of agriculture operations difficult. Therefore, there is an opportunity to reorient the priorities towards high value agricultural products and value addition to the produces. The potentialities for agro-based or bio- based industries have not been realized. Agro-industrial potentialities of crops such as ginger, turmeric, cinnamon, tuber crops such as tapioca, yams, sweet potato, groundnut, can be used as a source of carbohydrate, starch and protein. Agro-waste such as paddy husk, rice bran, rice straw, sugarcane bagasse, press mud, vermicompost can be good materials and require consideration and development.

**Medicinal plant resources:** The region is very rich in medicinal plants. Medicinal plant species of Western Ghats represent a variety of life forms ranging from lichen, algae, herbs, shrubs, climber and trees, which are annuals to perennials. The auto-ecology and syn-ecology of medicinal plant species is complex and their proper understanding requires a sound knowledge of the ecology, taxonomy and ethno-botany for these species. Western Ghats with its species diversity is a treasure house of different kinds of medicinal plants. The limited knowledge on the varied use of the medicinal plants, their availability and extent of distribution weakens the ways to utilize these resources efficiently.

Therefore, it is required to bring the information from various sources under one roof.

**Agro-eco tourism:** The booming tourism industry in the region may be taken as an advantage for promotion of agro-eco-tourism in the hinter lands in addition to coastal region.

**Livestock potential**: The Coastal region of India is also enormously rich in animal genetical diversity. A total of 35 well recognized (registered with National Bureau of Animal Genetic Resources, Karnal) livestock and poultry breeds are available from this region. Animal husbandry in coastal region has a major role in agricultural community and agricultural activities and provides considerable income for these families. Enhancement of income for farmers through livestock–crop integration makes system sustainable.The vast population and diversity of livestock in the coastal India could prove to be a vital asset for the country and unlike many other natural resources which will deplete over the years, a sustainable livestock production system will continue to propel coastal agriculture. Milk is available in abundance and the presence of vibrant dairy co-operatives in the coastal districts of the country boosts the dairy industry in this region.There is better availability of power and communication infrastructure due to presence of major and minor ports.

**Fisheries potential**: The fisheries sector contributes to 0.8% of the national GDP and 5% of the agricultural GDP. The total fish production of the country is estimated to be 9 million tonnes with an approximate value of 80,000 crores. The Indian fish production is growing at an average rate of 6% (7.3% in inland and 3.7% in marine sectors). Indian contributes approximately 5% of the global fish production (3.2% of marine and 10.2% of inland). The total marine fish production of the country is estimated as 3.7 million tonnes out of which approximately 60% comes from the coastal region (within the territorial water limit of 12 km). The brackishwater fish production of the country is estimated to be 2.7 lakh tonnes. Thus, the total fish production from the coastal regions of the country may be estimated as 2.5 million tonnes. Hence, the coastal fisheries contribute approximately 30% of the total fish production of our country.

The fisheries exports from the country significantly depends upon the coastal fisheries resources. The present fish export from our country is 9.8 lakh tonnes in volume and 30,000 crores in value. The fish assumes greater significance as nutritious protein food to coastal population of the country. The Per capita fish consumption of the country/annum is estimated to be 9.6 kg. On the other hand, the Percapita fish consumption of the coastal region of the country/annum is approximately

12 kg with minimum and maximum values for Gujarat (3 kg) and Goa (30 kg) respectively.

The Coastal region of Goa is having a favourable tropical climate conducive for the production and growth of many of the tropical crops and animal species. High rainfall to the tune of 2000 to 3000 mm and fertile soils and valleys in the undulating terrains of the west coast would be favourable factors for increasing production of many agriculture commodities particularly horticulture and plantation crops. As the natural resource base is strong, potential cash crops like cashew, spices as intercrops in coconut and arecanut gardens, fruit and flower crops can be produced in this region. The farmers are receptive towards advanced technologies. Although the pace of agricultural development was not as fast as other parts of India, the potential is very high because of its rich natural resource base.

# Goals and Targets

ABOUT 1/4th of India population live and depend on coastal environment and its resources for livelihood. Coastal ecosystem is potentially rich in natural resources with ecological, economical and social significance. Climate variability associated with increased incidences of extreme events and climate change in coastal areas is a matter of concern. Keeping the above issues in view there is need to envisage the appropriate goals/ targets to address various challenges ultimately to achieve sustainable food production, processing and supply. Our goals have to be in the direction of utilizing natural resources, crop and animal genetic resources of the coastal region in a sustainable way. Land fragmentation, traditional way of farming, low returns from the sector when compared to the aligned industries like tourism/ mining cause a great concern over the future of agriculture in the region. Owing to its location in west coast region and being a multidisciplinary and multi-commodity Institute covering different aspects of field and horticultural crops, livestock and fisheries related aspects, the Institute has to target and focus on the challenge of agricultural research requirements of the coastal region and Western Ghats. The strategy in this direction would be a multi-disciplinary approach aimed at problem specified solutions to meet farmers' needs and aligned industries. A multi-pronged strategy would be adopted to accomplish the vision and the goals of the institute to enhance efficiency and effectiveness of the research resources. Following emerging areas of research have been identified for the next decades.

**Emerging areas of Research**

- Farming system research
- Agro-eco tourism
- Organic farming
- Land use planning and management of problematic soil
- Breed improvement, nutrition, health care, management, product development and quality control in livestock and poultry
- Plant genetic resources and genetic improvement of field and horticultural crops by conventional and molecular approaches
- Climatic change impact, adaptation and mitigation
- Bioinformatics
- Protected cultivation for flowers and vegetables

- Diagnostic kits for plant and animal health
- Developing post harvest processing and value addition technology
- Integrated pest and diseases management (biological agent)

In view of the Institute's vision, the following strategic frame work has been formulated for addressing these issues by 2050.

| Goal | Approaches |
|---|---|
| Biodiversity Conservation and Genetic Enhancement | • Protection of plant varieties and farmers' rights and capacity building of farmers for on-farm conservation of plant genetic resource.<br>• Collection, conservation, characterization, documentation and utilization of various crop genetic resources having tolerance to biotic and abiotic stresses<br>• Integration of molecular breeding tools using QTLs for development of new generation varieties/genotypes suitable for nanotechnology-based production approaches such as ultra high density models, ultra precision farming, etc.<br>• Development of precision farming technology for cashew production considering higher productivity targets through efficient use of genetic resources, natural resources and post harvest handling of the product.<br>• Study on the diversity of rice in the west coast region and characterization of the germplasm by morphological and molecular methods<br>• Screening of genetic resources considering the trends in current climate changes and utilization of potential genetic resources in development of new varieties or hybrids in mango, cashew and coconut<br>• Development of strategies for improvement of fertility in livestock |
| Management of insect pest and plant diseases | • Development of sustainable and efficient insect pest and disease management strategies by incorporating bio- and nano-technology<br>• Development of innovative, nonconventional methods of insect pest and disease management including biological control and integration into IPM<br>• Production of quality bio-agents and awareness training to the farmers<br>• Population dynamics, virulence and diversity of the insect pests and plant pathogens in the coastal ecosystem in the emerging scenario of changing climate change to design appropriate management strategies<br>• Development of rapid, economic and reliable detection techniques of the plant pathogens<br>• Study on the host-pathogen interactions |
| Management of natural resources | • Long term studies on the effect of different resource management strategies on soil health care including the sustainability<br>• Evaluation and demonstration of soil and water conservation, land use systems and other management practices for sustainable crop production in the region on holistic watershed basis<br>• Soil fertility management and coastal land use planning<br>• Evaluation of technologies for amelioration of acid soils in West coast region such as with the application of lime<br>• Development of suitable water harvesting technology<br>• Reclamation of problematic soils (khajan lands and mine rejects) through Agri-Horti interventions |
| Farm mechanization | • Introduction of precision equipment and state of art technologies for irrigated agriculture in coastal region<br>Enhancing power availability in the entire region<br>On-Farm post harvest technology for minimizing transport cost and increasing employment and income in the rural areas (Coconut, cashew, mango processing, unexploited / under utilized fruits/ vegetables. |

| | |
|---|---|
| Agriculture diversification | • Introduction and evaluation of improved varieties and hybrids in important vegetable crops of the state for large scale adoption<br>• Introduction and evaluation of cut flowers like gerbera, anthurium, orchids, lillium, carnation etc under protected condition<br>• Development of agribusiness modalities involving public and private partnership through establishing effective network for livelihood security and rural empowerment through horticulture industry.<br>• Development of varieties, production techniques and practices for organic farming of horticulture crops employing the bio-fertilisers and biopesticides and unconventional energy sources<br>• Design, development and popularisation of low cost protected cultivation structures for Goa<br>• Agricultural diversification through integrated farming systems and agro-eco-tourism<br>• Intensifying transfer of technology programme for effective farming and capacity building |
| Secondary Agriculture | • Diversification in floriculture through value addition especially to improve the shelf life and to standardize technologies for dry flower production, pigment and essential oil extraction<br>• Novel products of horticulture for fast food market<br>• Nanotechnology aided packaging<br>• Value addition, packaging of locally available minor fruits, vegetables, spices<br>• Product diversification and packaging of ethnic foods and recipes<br>• Value addition of poultry products for better keeping quality and higher market value<br>• Human resource development in PHT and value addition |
| Enhancement of livestock and fisheries production | • Development of economic feeding strategies to produce milk, meat and poultry and evaluation of alternate feed resources<br>• Scientific exploitation of feed resources to fill the gap between demand and availability of livestock feedstuffs.<br>• Improvement in pork production by introduction and evaluation of new pig breeds suitable for area<br>• Rearing of alternate poultry species like Japanese quails and ducks to meet the growing demand of local people.<br>• Improvement of animal health care and delivery systems.<br>• Use of genomics to study the zoonotic and food-borne pathogens<br>• Development of mitigation strategies to reduce adverse impact of climatic change on livestock production<br>• Ornamental fish culture research with particular emphasis on breeding and feed formulation<br>• Diversification of brackish water aquaculture with potential species such as mud crab, oysters and mussels<br>• Application of remote sensing technique to augment marine fish production |
| Capacity Building | • HRD in new and emerging areas involving all stakeholders in the food supply chain.<br>• Organization of trainings on speciality topics at national and international levels<br>• Foster linkages and collaborations with public and private, national and international organizations |

# Way Forward

THE way forward to achieve the goals of Vision 2050 would be a holistic strategy encompassing various programmes making the region self-sufficient in food production. There is need for strengthening knowledge-led and technology-based alleviation of food insecurity. More food has to be produced with lesser resources. The efficiency of production has to be increased through modern management of improved technologies. The agricultural research and development in this region would augment farmers' income, livelihood security, generate employment opportunities, conserve natural resources, and increase value addition for higher and inclusive agricultural growth. The institute will work to develop ideal integrated farming system models for the region and diversify agriculture through activities like agro-eco-tourism in a participatory mode. Emphasis will be given on diversification of fisheries activities for sustainable production. The Institute is strategically positioned for playing a bigger role for addressing the problems of West coast agriculture in an integrated and holistic manner. Emphasis will be given on rearing of alternate poultry species like Japanese quails and ducks to meet the growing demand for egg and meat.

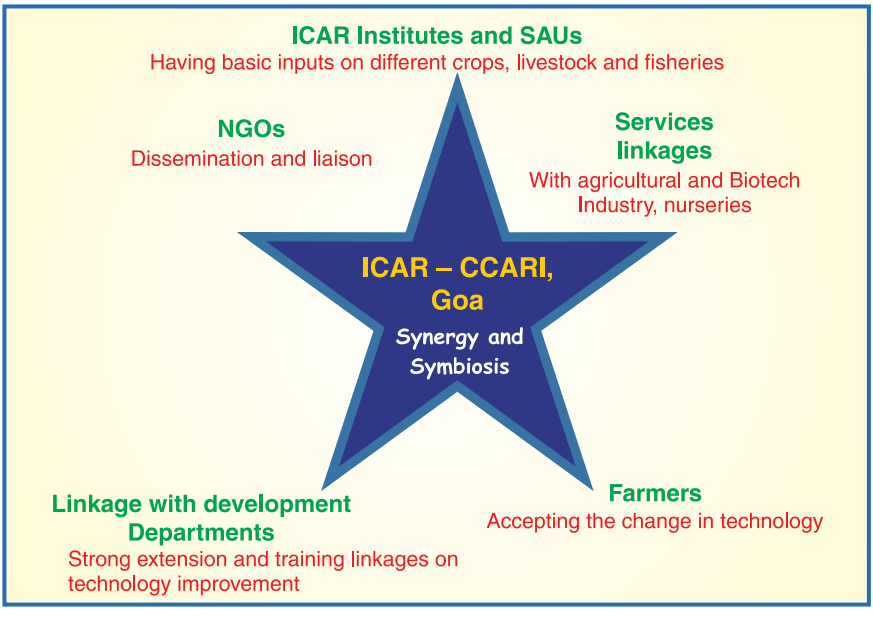
Emerging technologies like information technology (IT) and computer application, super efficient and more accurate electronic equipment, geographic information system (GIS), geographic positioning system (GPS), and hybrid seeds, biotechnology, gene revolution, next generation sequencing (NGS), laser technology, efficient micro-irrigation systems, zero or reduced tillage technology, site specific nutrient management system including balanced soil and plant nutrition and health management based on soil test for macro and micronutrient tests need to be used and synergized and monitored regularly.

Future road map of the institute would be to develop new centre of excellence in computational genomics, a repository for tropical orchids, a gene bank of plant genetic diversity of western region, a phenomics facility for screening germplasm for salinity, submergence, high temperature stress, a grand facility for seed and planting material production. The Institute will also strive hard to use genomics to elucidate newer paradigms in diagnostics for livestock diseases.

The institute will have the roadmap for conservation and utilization of core genetic resources of horticultural crops and livestock species for

the posterity, taking into account the changing environment and socio economic development of the region.

The ICAR-CCARI, Goa has been developed into one of the excellent centres of multi-disciplinary primary research for Goa but the technologies and research carried out are relevant to not only to much larger areas of Coastal region but also adjoining regions of western ghats and plains on eastern coast. The Institute will play a much bigger and important role of addressing concerns of Coastal agricultural research besides agriculture of Goa. The Institute will coordinate the development of technologies with various Institutions of ICAR as well as State Agricultural Universities in a network mode and also take the models of Integrated farming systems to other areas. This would lead to effective utilization of resources and much greater impact. The institute would strive to harness power of science in increasing productivity and profitability, enhancing resource use efficiency, developing suitable models of integrated farming systems, agro-eco-tourism, reducing cost and post-harvest losses, improving livestock productivity and diversification of brackish water aquaculture and ornamental fish culture.




## Annexure I. Abbreviations

| | |
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| AICRP | All India Coordinated Research Project |
| APEDA | Agriculture and Processed Food Export Development Authority |
| DBT | Department of Biotechnology |
| DST | Department of Science and Technology |
| GI | Geographical Indication |
| GIS | Geographic Information System |
| GPS | Geographic positioning system |
| ICAR | Indian Council of Agricultural Research |
| ICT | Information and Communications Technology |
| IFS | Integrated Farming Systems |
| INCOIS | Indian National Centre for Ocean Information Services |
| IPM | Integrated Pest Management |
| NGO | Non-Governmental Organization |
| NGS | Next generation sequencing |
| SAU | State Agricultural University |

## NOTES

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