भाकृअनुप
ICAR

Vision 2030

ICAR Research Complex for Goa

(Indian Council of Agricultural Research)

Old Goa - 403402, Goa, India

www.icargoa.res.in

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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 research 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 ICAR Research Complex, Goa established in 1989 is a multidisciplinary Institute mandated to address different issues such as resource conservation, watershed approach for water conservation, conservation of biodiversity, integrated farming system approach incorporating horticulture, animal husbandry and fishery for maximum utilization of available resources, climate change impact

and mitigation strategies for agriculture, employment generation and livelihood improvement, value addition and post harvest processing, agro tourism for the coastal ecosystem.

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.

(S. Ayyappan)

Dated the 17th June, 2011
New Delhi

डॉ. एन.पी. सिंह
निदेशक
Dr. N.P. Singh
Director

गोवा के लिए भा.कृ.अनु.प. का अनुसंधान परिसर
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Preface

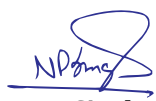
The ICAR Research Complex for Goa was established in April, 1976 by the Indian Council of Agricultural Research, New Delhi. This center was the humble beginning under the administrative and technical control of ICAR Research Complex for NEH Region, Shillong, Meghalaya for a short spell and then with the Central Plantation Crops Research Institute, Kasaragod, Kerala. After functioning at different Government farms in Goa, it was finally shifted to its present location at Ela, Old Goa in 1982. To intensify further the transfer of farm technology and to impart grass root level vocational training, a Krishi Vigyan Kendra was also established at the Research Complex in 1983. The ICAR, New Delhi, upgraded the Research Complex to a full fledged Institute in April, 1989 keeping in mind the ever growing needs of agricultural research, education and extension of the state of Goa.

The Research Complex is mandated with the applied and strategic research with some amount of basic research specific to this region, in field crops, horticulture, livestock and fisheries. Initially to orient the research programme to the requirements of next 25 years a perspective plan was prepared for a period upto 2025. However, with changing agricultural scenario

of this state and of this Konkan region necessary up gradation of programme was felt necessary. Therefore the present documentation of Vision 2030 is formulated in the context of climate change scenario, globalization and liberalization, simultaneously keeping in minds the needs of farming community of this region.

The document will serve as a ready reference to guide researchers, planners, and above all farming community for all round development of agriculture and allied sector of this region. The contribution made by all scientists to prepare this document, contribution of Dr S.B. Barbuddhe to compile and edit the document and effort made by Mr S Marathe for timely printing is appreciated.

I would like to place on records the critical review and suggestions made by Dr S. Ayyappan, Secretary, DARE and Director-General, ICAR and Dr A K Singh, DDG (NRM) in making the document relevant and useful one.



Dated: 15.6.2011
Old Goa.

N P Singh
Director

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Preamble

The coastal state of Goa is situated along the Konkan tract bound by Arabian sea on the West and the states of Karnataka and Maharashtra on the other three sides. Agriculture represents the third important economic activity in Goa providing livelihood to 16 % of the population after tourism and mining. While agriculture contributes just over 10 percent of the State's SDP, over 35 percent of Goa's population is partly or fully dependent on it. Through a clear vision, coupled with innovation, resourcefulness and hard work, Goa will have to stimulate economic growth by leveraging its core competencies such as ideal agro climatic conditions, 300 days of sunshine, average 3000 mm of annual rainfall, tropical temperature zone, fertile soil ideal for rice cultivation and horticulture crops like coconut, cashew mango, pineapple and banana, human resources, natural resources, scope for livestock enterprises, a coastline of over 120 kms, network of natural rivers and waterways of which over 250 kms are navigable and forest cover of nearly 34 per cent with rich bio-diversity. The problem in respect of field crops is getting further aggravated due to increasing scarcity and cost of labour especially in field crops like rice and sugarcane, which are labour intensive an consequently there is gradual shift to horticultural crops. There is high genetic variability among horticultural crops.

There is increasing emphasis on mixed farming wherein farming system research including watershed management is gaining importance. More than 80% of holdings less than 1 ha. About 18000 ha of Khajan land and 2000 ha of mangroves need to be preserved for ecological reasons as well as for food production. Goa does not have an agricultural university or other Institute to look after specific agricultural research needs of the state.

ICAR Research Complex for Goa was upgraded to the status of an independent Institute in 1989 to cater to the agricultural research needs of the Goa region. In order to undertake transfer of technology and training programmes for farmers as well as field functionaries, Krishi Vigyan Kendra (KVK) was established in 1983. It is a multi-disciplinary and multi-commodity research Institution.

The Research Complex carries out applied and strategic research with some amount of basic research specific to this region, in field crops, horticulture, livestock and fisheries. The research activities are carried out through 30 ongoing research projects distributed in crop improvement and protection, resource management and intergrated production, horticulture, animal sciences and fisheries and transfer of technology programmes of KVK. In the new role, Institute should be called upon to coordinate

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 forward path for stimulating horticulture as a growth engine is to focus on developing both a food processing sector as well as a fresh produce sector. The Institute also have mandate to study effect of climate change in west coast, mitigation strategies and coping natural disasters. The critical areas that need to be addressed include 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 brackishwater aquaculture and strengthening of secondary agriculture.

Scenario

Goa State has a total geographical area of 3, 61,113 ha covering both North and South Goa districts out of which an area of 1.25 lakh ha is under forests Goa, in the West coast region has coastal plains, interior hinterlands and elevated undulated terrain towards the Western Ghats. An area of about 613.27 sq. km is considered as total waste land available in Goa. These include water logged and marshy areas (41 sq.km), mining industrial wastelands (110.73 sq.km) and upland with or without scrub (292.83 sq.km), under utilized degraded notified forest land (72 sq.km) and barren stony areas (58.6 sq.km). The total net sown area in Goa state is 1.41 lakh ha.

Land, water and biodiversity are the most vital natural resources. Management of these natural resources assumes greater importance as they provide life supporting systems. These resources serve as a means and regulate the eco-system development. Over-exploitation and mismanagement of these resources is causing a serious threat to production system and degradation of natural resource base.

Resource Management

The natural resource management specially with respect to soil, water and crop management are being researched through the Institute and sponsored programmes. The coastal ecosystem being fragile, sustainable management technologies are being evolved and it is further to be strengthened to meet the challenging needs of the future.

West Coast ecosystem is a unique entity with wide range of topography, soils and climate, crop bio-diversity from the agriculture point of view. Warm humid tropical climate of the region favours a variety of flora and fauna for their growth and development. It is one of the richest ecosystems from the economic point of view. West coast region has coastal plains, interior hinterlands and elevated undulated terrain towards the Western Ghats.

Major Crops and Demand

The current crop husbandry in the region includes rice and rice based cropping system dominating the lowlands of the region while cashew and coconut based systems in the uplands. Rice-rice system although is practiced to a limited extent, rice-pulse, rice-groundnut and rice-vegetable dominates the scenario. Cashew is grown less intensively mostly as mono crop. Coconut

gardens are often inter/mix cropped with banana, spices like pepper, vanilla etc, in the region.

General information about Goa

Total geographical area	3,61,113 ha
Gross Cropped area	1,68,634 ha
Forest Area	1,42,446 ha
Number of Districts	2
Number of Talukas	12
Population	14,57,723
Literacy	87 %
Per capita income	₹ 1,32,719
Languages	Konkani, Marathi, Hindi and English

Horticulture is a major component in agriculture of Goa with two major plantation crops on large scale (cashew in 55672 ha and coconut in 25608 ha). At present about 45 units process cashew in Goa with a total capacity of 50,000 MT. Goa state being an internationally renowned tourist destination with huge influx of tourists from both domestic and international throughout the year, the requirement of fresh fruits and vegetables is always high. Assuming the recommended dietary requirements and predicted consumption patterns, Goa will require about 1 to 1.2 lakh t/yr. fruits and vegetables each by the year 2030. Kokum *(Garcinia indica)* is native to Goa and exhibits great variability owing to its cross-pollinating nature and seedling origin. This makes kokum deserve a thorough study on genetic diversity. Though there is rich diversity, there are no commercial orchards of kokum.

In Goa, the area under vegetable crops during 2006-07 was 8,213 ha with the annual production of about 84,290 tonnes. But the production and productivity of vegetable crops over the year is stagnant in comparison to growing demand. The area under cultivable fallow land is also increasing year by year thus posing serious threat to availability of vegetable and other agricultural produces from Goa in the coming days. It is high time to devise a sustainable policy to improve the vegetable area and production to meet the requirement of local population and tourists.

The priority area of improvement would be to introduce large scale cultivation of hybrid vegetables in major crops. The local vegetable types cultivated fetch premium price apart from its demand among the local population. But the productivity levels of these types of vegetables are low compared to national varieties and the yield gap from hybrid vegetables is wide. Hence introduction of improved varieties/hybrids in major vegetable

crops followed by large scale cultivation of vegetable crops with improved production technologies may increase the production and productivity of these high value crops. Thus, the immediate goal would be to raise the present productivity level of 10 tonnes / hectare to national average of 15 tonnes / hectare, which will add almost 50 per cent more production of vegetables per year.

The climate in Goa is highly suitable for many cut flowers, loose flowers and cut foliage. Jasmine, marigold and crossandra are traditional flowers grown sporadically in the state for a long time. Floriculture is highly neglected field and its proportion towards other horticulture crops is less than one percent. The area under floriculture is hardly 25 ha with the production of 40 tonnes per year. And the production of cut flowers like Orchids, anthurium and gerbera under protection and gladiolus in open conditions is of recent origin in the state. Though Goa is lagging behind in production but leading in consumption of flowers when compared to other states. The value of the business works out to be about ₹ 15 crores in Goa. The total flower business is totally depended on supply from other states like Karnataka, Maharashtra, Tamil Nadu, Kerala etc. Post harvest technology is gaining momentum at Goa using locally available materials and recipes. Goa has potential to serve as a hub for value added horticultural products being near to Mumbai and well connected by air, road and rail.

Livestock Scenario

Livestock especially cattle are a traditional component of sub-mountainous production systems. There is no recognized breed of cattle from the state of Goa. Majority of the cattle population of this state is non-descript. Major cattle breeds reared in the Goa are Sahiwal, Red Sindhi and Gir. Major crossbreds reared in Goa are Jersey cross and Holstein cross. At present crossbreeding and grading up policy for non-descript cattle and buffaloes is being followed. Cattle are maintained under stall-fed and semi intensive system. There is acute scarcity of green fodder. Dairy cows in the village are kept in semi open housing with concrete / brick floor and GI sheet / asbestos roof. Farmers are purchasing feed ingredients for preparing concentrate ration either from Goa Dairy or nearby market. Cow dung and urine are being used for biogas production.

Pork is the common diet for about 40% population of Goa. Besides, it has got great demand because of heavy tourism. In coastal plains besides cattle, pig farming is common. The local non descriptive animals reared under the scavenging condition are the main source of pig meat. The production potential of the local animal is very poor. There is one Government piggery which supplies Yorkshire pure breed animals. However, maintenance of pure bred animals under field condition is costly and is not very successful. In view of this, cross breeding of locals with exotic were conducted. Buffalo

has three fold importance viz., milk production, meat production and draft purpose. Having potential for better milk yield with higher fat content, buffalo production fetches better return for the farmers. Further, the state has a meat complex, which serves the local beef traders as well as beef exporters. Lack of well defined programme for buffalo in the state is a major constraint.

There is no religious taboo for goat meat and chevon is the costliest meat. The tourist population as well as the opportunity for export of meat offers immense scope for rearing goat in this territory. In some areas goats are reared as herds. Goa has well established poultry farms with adequate infrastructure facilities to produce layers and broilers in large scale. However, to help small farmers, this Complex carried out research work and identified suitable layers for backyard poultry farming. Management practices for broilers, layers, ducks and Japanese quails were also evolved for the local condition. Organized poultry farms are confined to few pockets only. However, backyard poultry is common throughout the state.

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 rampant diseases are also introduced in new areas. The productivity level of the animals in the state is very low. Being hot and humid climate, it favors the growth of microbes. Among the most prevalent diseases mastitis and reproductive disorders were the major health problems. Abortion due to brucellosis and other infections are common. A major constraint on the provision and effective delivery of animal health services is lack of infrastructure for diagnosis. The existing facilities for animal disease investigation need to be strengthened in terms of manpower and facilties. This factor contributes to impaired capacity to recognize and monitor disease owing to poor diagnosis services.

Fisheries Scenario

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 90 per cent of the population of Goa are fish eaters. 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. Similarly, the quantity of fisheries exported from Goa is more than 2.0 per cent of the total fisheries exported by India, contributing about 35 crore to country's foreign exchange. However, there is large scope to increase the production and export through scientific and planned strategy.

Table . Scenario of agriculture in Goa

Field and Horticultural Crops

Crop	Area (ha)	Production (t)	Industrial use	Future expansion
Rice	47104	251524	-	Scope exists for export of scented rice varieties
Sugarcane	893	52343	Scope exists molasses bagasse and other by-products	
Groundnut	2828	8055	-	Possibility for area expansion
Pulses	7890	8535	-	-do-
Cashew	55732	17556	Feni making	Varieties with large apple size
Coconut	25686	128.72 (m. nuts)	Coir industry Oil industry	
Mango	4716	8334	Canning purpose	Popularization of Mankurad
Banana	2219	24662	-	Evolution of uniform yielding and bunchy top resistant cultivars
Pineapple	273	4520	Jam making	

Livestock

Livestock	Population	Milk/Meat/egg production /year	Export potential
Cattle			
Total number	70547		
Milk producing cattle	33418	1.77 lakh lit.	
Buffaloes	36116		Buffalo meat
Pig	58719		
Goat	10711		Chevon
Poultry	531326		
Meat production	606906	400 lakhs eggs	

Fisheries

Zone	Production /year	Market potential
Inland	1,500 t	Carps, freshwater prawn and shrimps for internal and export markets
Marine	1,00,000 t	Value added products and frozen products for export

Fishing is one of the important economic activities of the state. Goa has continental shelf of about ten million ha and an actively fished area of 20,000 sq. km. EEZ of Goa has estimated annual potential pelagic yield of 77,660 ton and demersal yield of 1,12,600 ton, where as the sustainable yield which could be safely harvested without upsetting the natural balance are 46,560 and 67,560 ton /year, respectively, for the two zones.

On the inland front, Goa has nine river and 550 km network of water bodies between them. It has 18,500 ha of Khazan land, 13,157 ha of estuary with Mandovi and Zuari estuaries being the main ones, 100 ha of freshwater ponds, 200 ha of old mine reject pits and 3,250 ha of reservoir submersion, in addition to 9,600 ha of double cropped rice fields where fish culture can be incorporated. In all the irrigation structures and homestead ponds fish can be incorporated and remunerative integrated farming systems with other components of crops and live stocks can be taken up.

Fig. Goa at a glance

Mission and Mandate

MISSION

The Institute was started with a mission to achieve, "the introduction and improvement of all potential crops and various species / breeds of livestock and scientific exploitation of various aquatic resources for improving fish production".

MANDATE

1. To conduct strategic and applied research on potential agricultural and horticultural crops, livestock and fisheries relevant to natural resource base of Goa and adjoining areas for sustainable productivity
2. To collaborate with national and international Institutes/agencies in developing and transferring new technologies
3. To act as a repository of information on Western Ghat agricultural system
4. To disseminate improved technology developed
5. To act as a center for training in updated technologies
6. To generate nucleus planting material and
7. To provide consultancy services.

Growth

The ICAR Research Complex for Goa became an independent Institute in 1989. The Director heads the technical and administrative units of the institute. The research and extension activities of the Institute were carried out through a network of five discipline based sections and a Krishi Vigyan Kendra (KVK). On the advice of the Quinquennial Review Team (QRT), the functional groups were reclassified into five sections viz. crop improvement and protection, resource management and integrated production, horticulture, animal science and fisheries. Different committees viz. Institute Management Committee (IMC), Quinquennial Review Team (QRT), Research Advisory Committee (RAC), Institute Research Council (IRC), and Scientific Advisory Committee (SAC) help the management to monitor and smooth functioning of the institute.

Infrastructure

The Institute which was started with the limited infrastructure facility made available by the State Government at the time of handing over, was further strengthened by addition of a main research cum administrative block, field structures, experimental units and plots, farm ponds, service structures, KVK buildings, guest house and residential quarters.

Laboratory

The main building houses state of the art laboratories with advanced basic equipments for conduct of research under soil science, agronomy, entomology, plant pathology, horticulture (including fruits, vegetables, flowers and post harvest), animal reproduction, animal nutrition, poultry science, veterinary public health, PCR lab, fish nutrition, fisheries analytical studies and live feed culture. The field laboratories include post harvest unit, orchid unit, poly houses for plant propagation, pathology and fruit and vegetable studies, animal units on cattle, pig, buffalo, rabbit, poultry and goat, fisheries units for integrated systems, ornamental fish and wet laboratory.

Library

The Institute library caters to the needs of researchers, extension workers, students and academicians all over Goa. The library presently subscribes to

14 foreign journals, 34 Indian journals, 27 magazines, 18 newspapers. There are 2474 books and 2015 bound volumes of periodicals/ journals, Databases viz., AGRIS, Hort CD, Vet CD in the library besides annual reports, bulletin and newsletters of different organization all over India and are made available for the staff of the Institute as well as outsiders.

ATDC

ATDC was established to provide a 'single window' delivery system for the products available from the institute to the farmers and other interested groups as a process of innovation, to facilitate direct access to the farmers to the institutional resources available in terms of technology, advice, technology products etc and to provide mechanism for feedback from the users to the institute.

ARIS

ARIS Cell has been established and equipped with computers under ARIS Programme during 1996-97. The VSAT was installed in July 2000 at Computer Centre. In 2009-2010 a Leased line Connectivity by BSNL under the National Knowledge Network was provided. The e-mail / Internet facilities have been created for scientists and other staff of the Institute. Currently about 50 computers are connected with LAN and are being provided with internet and Web mail services. This section is also maintaining the website of the institute (www.icargoa.res.in). We have also developed WASP which is the first Web Based Agricultural Statistics Software Package. The ARIS Cell provides the following facilities/ services to the institute such as Networking , Network services, Internet access, Database service, Hardware and software trouble shooting , Virus alerts, Institute e-mail handling etc.

KVK

Krishi Vignan Kendra (KVK) was established in 1983, as the grass root level vocational training Centre in the State of Goa. KVK is a project of ICAR for testing and transfer of agricultural technologies to bridge the gap between production and productivity and to increase self employment opportunities

among the farming communities. The trainings offered here follow the principles of "learning by doing" and "seeing is believing". It offers skill and knowledge oriented trainings in multidisciplinary areas like crop production and plant protection, horticulture, animal sciences, fishery sciences, home science and agricultural extension. The KVK is the light house of knowledge to the farming community of the State.

Field

The Institute initially started with 19.73 ha to which 33.64 ha was provided as an additional campus for KVK and field activities of the Institute. Presently the Institute is functioning in 50.83 ha of land. Field trials on seasonal and perennial crops are being periodically laid out. Germplasm banks on cashew and mango, varietals collections of important crops, watershed, soil and water conservation and bio- engineering models, livestock units, fish culture units have been established for the research studies. An automatic meteorological observatory was established for recording meteorological data.

Buildings

The Institute was functioning in a temporary office passed on from Directorate of Agriculture, Government of Goa in 1982, which had structures for piggery, rabbitry, cattle and farm office. Additional structural facilities were added, the important ones include main research cum administrative building, KVK administrative building, farmers hostel, agriculture technology dissemination centre, training building, animal units, fisheries field laboratory and horticulture and crop science field laboratories beside others. The old office building was modified into a guest house. Another guest house in KVK is under construction. One auditorium, canteen and main store buildings are constructed. A total of 37 residential quarters are added.

Budget

Table Budget of the Institute

(₹ in lakhs)

S. No.	Plan Period	Plan	Non Plan	Total
1.	Eight Plan	350.00	190.00	540.00
2.	Ninth Plan	552.00	504.00	1056.00
3	Tenth Plan	980.00	975.00	1955.00
4	Eleventh Plan	1351.00	1997.00	3348.00

ICAR RC Goa 2030

Goa has immense potential in the field of agriculture mainly due to its location, weather conditions, local market for high value crops, and its advanced human capital. It needs to think creatively to break away from traditional agriculture and focus on niche advantage and to move from commodity farming to creative diversification to secondary and tertiary high value added agriculture and adopt the latest technology to make quantum leaps. The main source of agricultural growth will be possible by the growing demand for high value products with attractive prices. Emergence of innovative institutions such as contract farming in small holdings as well as private initiative also offers many opportunities for growth of Goan agriculture. Most important, is the development of the agricultural sector to support tourism and the local population. Growth of local vegetables and fruits could grow to an extent that they could be exported. The dairy industry is growing and needs support for Goa to become self-sufficient. Diversification into kokum and other similar agricultural products appears to hold much promise. Horticulture can be developed not only to support tourism but also for export.

Some basic demographic facts are that in 2030 Goa's population would be around 2.0 million and the tourist population would hover around 3.50 million if all goes well. This will create a demand for the forward path for stimulating horticulture as a growth engine is to focus on developing both a food processing sector as well as a fresh produce sector.

Despite present alienation, this primary sector can be the employment and occupation generator of the state's economy and provide gainful livelihood in rural sector. Goa will have to follow a comprehensive strategy to achieve agricultural growth. This will include identifying an agricultural growth engine or focus area, harnessing and managing agricultural produce through food processing and branding.

Tourism and the growing affluence of the local population are going to stimulate a growing demand for eggs and white meat. The demand is large and likely to grow at an average rate of about 20 percent over the next 10 years. This growth in demand can create a large number of jobs and income in rural areas of Goa.

The khazan lands could also be used for non-intensive aquaculture, after taking the necessary safeguards to minimize any environmental impact. The development of this sector will create considerable impact, both in terms of revenue and employment generation.

Disease and low productivity, due to poor planting material, leads to farmers abandoning agriculture altogether for more lucrative professions. This trend needs to be reversed and Goan farmers need to be educated regarding the use of quality planting material and the use of modern bio-control methods to increase productivity. Goa can leverage its scientific talent to build a strong presence in genetics and biotechnology.

Focus

To accomplish the mission of the institute, the highest priority will be given to farmers and farmer friendly technology development. Research has been marching ahead to face complex challenges and to harness the opportunities for the welfare of the farmers and other stakeholders in the food-supply chain. The focus of the research will be oriented towards

- Improving resource use efficiency and reclaiming degraded resources (conservation and management)
- Increasing income and productivity/unit of input through integrated farming system models
- Developing successful models of agro- eco-tourism
- Developing models for protected cultivation of vegetables and flowers
- Improving livestock productivity through breeding, health and feed/ fodder management
- Diversification of brackishwater aquaculture and ornamental fish culture
- Processing and value addition of horticulture, livestock and fish products
- HRD in new and emerging areas involving all stakeholders in the food-supply chain.
- Climate change, its mitigation and coping with disasters
- Foster repositories of genetic resources related to crop, livestock, fish, insects and micro-organisms for their sustainable utilization.
- Foster linkages and collaborations with public and private, national and international organizations.

Harnessing Science

The ICAR Research Complex for Goa has developed into one of the excellent centres of multi-disciplinary primary research for Goa but the technologies and research carried out are relevant to much larger areas of West Coast. 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 through breeding, health care and feed/ fodder management and diversification of brackishwater aquaculture and ornamental fish culture as well as new science and tools.

Genetic resource enhancement

Western ghats region is regarded as biodiversity hotspot. The region possesses a vast variety of genetic resources of field and horticultural crops, animals, fishes and microbes. To address future needs, research will facilitate sustainable use of available genetic resources through characterization, genetic enhancement and prebreeding and molecular breeding through tools like marker-aided selection.

Collection, conservation and improvement of local genotypes of rice for improved production as well as salinity tolerance need to be done. Cashew being a major plantation crop of the region, the variability existing in the local germplasm was collected, evaluated and conserved. Improved varieties of mango were introduced and local variabilities were collected and evaluated. Improved selections in popular mango variety of the

regions including Mankurad were identified and maintained in the germplasm bank. Collections were made in major vegetable and flower crops of the region and are being evaluated.

Agricultural diversification

Research focus need to be strengthened to augment production of high-value commodities more efficiently and competitively. Along with the development of improved genotypes (varieties and hybrids) and management practices for, consumer-preferred quality traits and food safety would be given high priority while raising the productivity of these commodities in this agro-eco-region. Diversification of agriculture through integrated farming systems and agro-eco-tourism need to be intensified.

Institute being a complex with multi-disciplines dealing with a wide research mandate thrusted on farming system approach will lead to a complete life supporting system ensuring soil fertility, ecosystem management with increased profitability and sustainability. Crop-livestock-fish models suitable for different situations evolved will be very much useful for the farmers to effectively utilized the available resources.

Of the total cropped area of 1,71,455 ha in Goa, 63.7 per cent is under horticultural crops, thus horticulture playing a vital role in the economy of the state. Among horticultural crops, cashew occupies maximum area of 53,292 ha with a total production of 21,335 tonnes, followed by coconut 24,975 ha

with 125 million nuts, mango, vegetables and banana. Still, there is an immense scope to plant horticultural crops especially cashew, mango, banana, coconut, arecanut and other fruit crops, in the cultivable lands.

Agro-eco tourism is the symbiotic association of farming sector and tourism industry. Horticultural gardens which are invariably located in valley areas of the region are ideal locations to take visitors to natural destination. Attempts are needed to be develop model sites of such situations.

Management of natural resources

As elsewhere, the natural resources are dwindling and its quality is deteriorating. The agriculture is highly dependent on the natural resources. In this region, mining rejects poses 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. Evaluation of soil and water conservation, land use systems and other management practices need to be evolved for sustainable crop production in the lower central Western coastal region. Potential of conservation agriculture, precision agriculture and micro-irrigation needs to be perfected for this agro-eco-region. 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.

Efficient farming systems, composite farming, integrated nutrient management, integrated pest management, and integrated water management would be perfected further for wider adaptability.

Harnessing microbial biotechnology

Biotechnology and genetics are going to be the boom industry for the next 20 years. Biotechnology could also emerge as a big sector with increasing pressure to create more food using lesser resources. Use of bio-control measures to control plant and animal diseases need to be researched in a big way. Use of microbial techniques to improve upon the quality of fermented products has a wide scope. Use of biotechnological techniques for diagnosis of plant and animal diseases would be perfected. Use of effective microorganisms in decomposition of agricultural residues, mineralisation of organic matter and availability of nutrients for crop, livestock and fish production need to be intensified.

Livestock and fisheries resources

Package of practices for cattle and pigs including economic feeding and disease control measures are to be developed. Research on various livestock diseases including zoonoses and health problems with particular reference to general disease, reproductive health would be conducted. Thrust should be given on these aspects particularly in the establishment of demonstration fodder farm to supply quality planting material and seeds of leguminous and cereal fodders and training of farmers in cultivation and preservation techniques. Emphasis need to be given on rural poultry production.

While identifying the thrust areas of importance in fisheries for Goa and the adjoining areas, the resource potential in terms of location covering brackishwater, freshwater and marine waters, technology suitability, scope for increasing fisheries production and productivity emphasizing more on culture should be taken into consideration.

Post harvest management and value addition

It is reported that as high as 18 to 25% losses occur in the entire food supply-chain from production to consumption. Low-cost improved technologies are required to unleash potential and improve market efficiency and to remain competitive simultaneously. Strategies are needed to reduce post-harvest losses such as compressing supply chain by linking producers and markets and promoting processing of food commodities in production catchments to add value before being marketed; Multi-disciplinary and multi-stakeholder research for agri-commodities, especially post-harvesting engineering, horticulture, dairy, livestock and fish is needed.

Programmes for Western Ghats and coastal agricultural systems

Collection of data base and to serve as a centre for repository of information on Western Ghat Agricultural system is one of the identified mandates of the Institute. At present the Institute is focussing only on the requirement of Goa and its adjoining area which are in fact located in this region. Nevertheless, the Institute is already attending to the agricultural research needs of the coastal region in relation to Goa. The coastal area between the Western Ghat and Arabian sea from Maharshatra to Kerala will include the hill region, undulating terrain, narrow strip of plain land and the shallow seas all along the West coast. The research work done in Goa and adjoining areas will have the applicability to similar situations prevailing in other coastal areas of West coast.

Linkages

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 linkage and collaboration are maintained by the Institute with various organizations, universities and NGOs related to agricultural research and development. This collaboration will also help in sharing of infrastructure and manpower available. The added challenge is the emergence of the intellectual property rights regime, which needs to be converted into an opportunity. All these issues require effective and need-based institutions to accelerate innovations and link farmers with different stakeholders to harness growing opportunities.

Transfer of Technology

Effective delivery mechanism for new and better technologies would greatly help in bridging wide gap between the potential and the realized productivity. Paddy, sugarcane, groundnut, pulses are important field crops and coconut, cashew, mango, arecanut, vegetables are important horticultural

crops. The average yield of the above crops in Goa is much low. There is a wide gap between the state average and the yield realized by the progressive farmers adopted under the demonstration programmes.

Strategy and Framework

Goa is richly endowed with biodiversity and the agricultural sector continues to play a major role in the Goan economy. Land fragmentation, traditional way of farming, low returns from the sector when compared to the tourism cause a great concern over the future of agriculture in the State.

Being a multidisciplinary and multi-commodity Institute in true sense 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, and therefore it can take up the challenge of agricultural research requirements of the coastal region and Western Ghat, in future. The strategy in this direction would be a multi-disciplinary approach aimed at problem specified solutions to meet farmers' needs and 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. The goals and strategy framework is given in Annexure - I.

- Characterization and improvement of local land races of rice and pulses for biotic, abiotic stresses and quality parameters through conventional and molecular methods.
- Development of insect pest and plant disease management strategies and studying the genetic diversity of insect pests and plant pathogens.
- Evolving labour saving technologies and low cost production technologies through mechanization.
- Evaluation of soil and water conservation, land use systems and other management practices for sustainable crop production in the lower central Western coastal region.
- Management of coastal saline and mine reject soils of West coast region.
- Evaluation of technologies for acid soil amelioration.
- Development of strategies for rainfed regions.
- Management of denuded Western Ghat areas.

- Exploration of genetic resources in plantation, fruit, vegetables and flower crops.
- Genetic improvement of important fruit, plantation, spices, local vegetabales and flower crops of Goa.
- Emphasis on post harvest technology for enhancement of shelf life of commodities.
- Design, development and popularisation of low cost protected cultivation structures for Goa
- Development of economic feeding strategies to produce milk, meat and poultry in coastal ecosystem.
- Development of strategies for improvement of fertility in livestock.
- Development of mitigation strategies to reduce adverse impact of climatic change on livestock production
- Emphasis on the rural poultry production for enhancement of livelihood security of rural poor.
- Improvement of animal health care and delivery systems for efficient production and studies on emerging food-borne pathogens.
- Development of freshwater fisheries
- Crop- Livestock- Fish integrated farming system to enhance productivity and profitability.
- Diversification of brackishwater aquaculture with potential species such as mud crab, oysters and mussels.
- Ornamental fish culture research with particular reference to breeding and feed formulation.
- Application of remote sensing technique to augment marine fish production.
- Agricultural diversification through integrated farming systems and agro-eco tourism models.
- Intensifying transfer of technology programme for effective farming and capacity building.

Additional Resource Generation

Being an establishing Institute achieving the target on the resource generation is rather low. But efforts would certainly be made to generate income around ten per cent of the budget proposed through

- Extension of consultancy to outside organizations and other services like pest management, soil testing, farming systems, training, disease diagnostics, testing of feed, milk, etc.
- Revolving fund from seed, planting materials, mushroom spawn and rabbit productions
- Formulation of suitable adhoc schemes for AICRP, INCOIS, APEDA, DST, DBT, NWDB, National Horticultural Board and other Private agencies

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Epilogue

Goa had immense potential in the field of agriculture mainly due to its location, weather conditions and local market for high value crops. Farmers first approach will be adopted to march ahead in developing location specific technologies, to augment demand for food, improving livelihood opportunities of farmers, and for ensuring sustainable farming and agricultural growth. Self sufficiency in food crops, vegetables would be the first target. The dairy industry is growing and needs support for Goa to become self-sufficient. Rice has been the staple food of the people of Goa and therefore its main agricultural crop. Unfortunately, most of the rice fields produce just one crop a year. Rice production has plateaued since the mid-1980s. Goa will have to follow a comprehensive strategy to achieve agricultural growth. This will include identifying an agricultural growth engine or focus area.

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. Emphasis will be given on diversification of fisheries activities for sustainable production. Concerted efforts would be made to work for the needs of the farming community, especially of the smallholders and of the poor living in the backward areas. This will also help to conserve the vast genetic diversity among crops grown by the farmers. The institute will work to develop ideal integrated farming system models for the region and diversity agriculture through activities like agro-eco-tourism in a participatory mode. The Institute is strategically positioned for playing a bigger role for addressing the problems of West Coast Agriculture in an integrated and holistic manner.

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Annexure 1. Strategic framework

Goal	Approach	Performance measure
Genetic resource enhancement	• Identifying saline tolerant high yield rice varieties suitable for saline affected areas through conventional and molecular breeding • Study on the diversity of rice in the west coast region and characterization of the germplasm by morphological and molecular methods • Genetic enhancement of cowpea and other pulses for yield and seed quality • Genetic improvement of important fruit, plantation, spices, local vegetables and flower crops of Goa • Exploration of genetic resources in plantation, fruit, vegetables and flower crops • 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 • Identification of QTLs and application of marker assisted selection in crop improvement programmes in mango, cashew and coconut to overcome new challenges of biotic and abiotic stress in the light of climate changes • Development of strategies for improvement of fertility in livestock	Improved livelihood opportunities Sharing of germplasm Bioinformatic databases
Management of insect pest and plant diseases	• Development of innovative, non-conventional methods of insect pest and disease management including biological control and integration into IPM • Production of quality bio-agents and awareness training to the farmers	Research and development contributing to integrated plant diseases management

	• 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 • Development of rapid, economic and reliable detection techniques of the plant pathogens • 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 • 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 • Soil fertility management and coastal land use planning • Bio-rejuvenation of mine reject soils to sustain the production and ecology of the region • Rehabilitation of mine reject soils • Evaluation of technologies for amelioration of acid soils in West coast region such as with the application of lime • Development of suitable water harvesting technology • Development of suitable cropping system • Management of Denuded Western Ghat areas • Reclamation of problematic soils (Khajan lands and mine rejects) through Agri-Horti interventions	Reclaimed degraded soils, land and water resources Higher water use efficiency
Farm mechanization	• Evolving labour saving technologies and low cost production technologies through mechanization	Increased crop area
Agriculture diversification	• Introduction and evaluation of improved varieties and hybrids in important vegetable crops of the state for large scale adoption	Research and development contributing to higher returns per unit area

	• Standardization of production technologies for hybrid vegetable cultivation • Introduction and evaluation of high value vegetables like capsicum, cherry tomato, seedless cucumber etc. under protected condition • Introduction and evaluation of exotic vegetables viz., cabbage, cauliflower, Chinese cabbage, Brussels sprout etc. under open field condition • Introduction and evaluation of cut flowers like gerbera, anthurium, orchids, Lillium, carnation etc under protected condition • Development of agribusiness modalities involving public and private partnership through establishing effective network for livelihood security and rural empowerment through horticulture industry • Development of varieties, production techniques and practices for organic farming of horticulture crops employing the bio-fertilisers and bio-pesticides and conventional energy sources • Design, development and popularisation of low cost protected cultivation structures for Goa • Agricultural diversification through integrated farming systems and agro eco tourism • Intensifying transfer of technology programme for effective farming and capacity building	Improved research efficiency
Post harvest management and value addition	• Diversification in floriculture through value addition especially to improve the shelf life and to standardizes technologies for dry flower production, pigment and essential oil extraction • Novel products of horticulture for fast food market • Nanotechnology aided packaging • Value addition, packaging of locally available minor fruits vegetables spices	Technology for processing foods.

	• Product diversification and packaging of ethnic foods and recipes • Storage and shelf life extension of flower bouquets and garlands • Value addition of poultry products for better keeping quality and higher market value • Human resource development in PHT and value addition	Public private partnership models
Enhancement of livestock and fisheries production	• Development of economic feeding strategies to produce milk, meat and poultry and evaluation of alternate feed resources • Establishment of fodder farms and introduction of new high yielding varieties under different climatic conditions • Improvement of fertility in cattle and buffaloes in dairy herd by improved breeding management • Improvement in pork production by introduction and evaluation of new pig breeds suitable for area • Improvement of reproduction performance of small meat animals like rabbits • Rearing of alternate poultry species like Japanese quails and ducks to meet the growing demand of local people. • Improvement of animal health care and delivery systems. • Monitoring and surveillance of economically important and emerging livestock diseases. • Studies on emerging food-borne pathogens • Use of genomics to elucidate genomic diversity among microbes. • Development of mitigation strategies to reduce adverse impact of climatic change on livestock production • Development of freshwater fisheries • Ornamental fish culture research with particular emphasis on breeding and feed formulation • Diversification of brackishwater aquaculture with potential species such as mud crab, oysters and mussels • Application of remote sensing technique to augment marine fish production	Contribution of research and development in livelihood security and higher income generation

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