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किसानों का हमसफर
भारतीय कृषि अनुसंधान परिषद

Agrisearch with a human touch

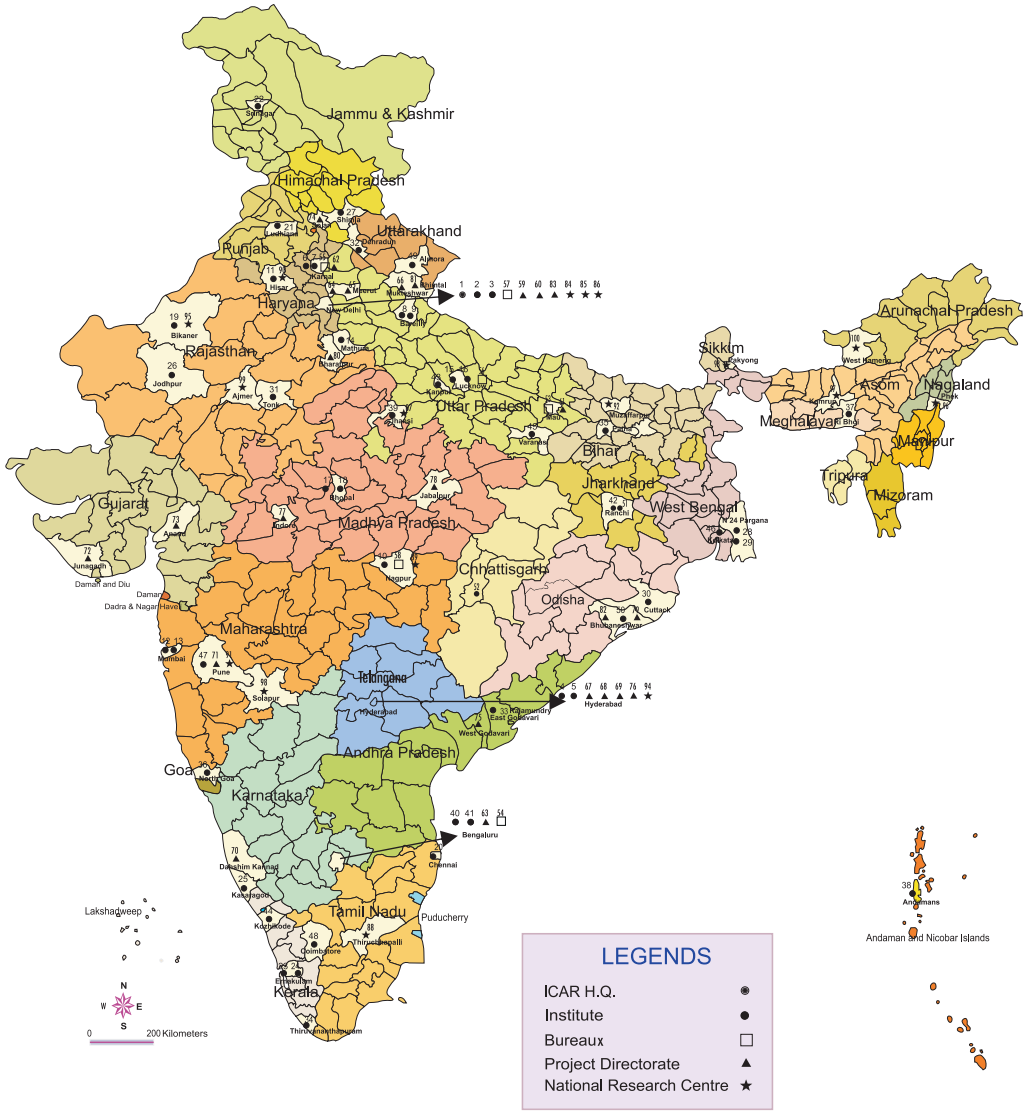
# Vision 2050

Central Island Agricultural Research Institute

Indian Council of Agricultural Research

# INDIAN COUNCIL OF AGRICULTURAL RESEARCH

## Institutes, Bureaux, Directorates and National Research Centres




### LEGENDS

- ICAR H.Q.
- Institute
- Bureaux
- Project Directorate
- National Research Centre

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

# INDIAN COUNCIL OF AGRICULTURAL RESEARCH

## Agricultural Universities


### LEGENDS

- State Agricultural Universities
- Central Universities with Agricultural faculties
- Central Agricultural Universities
- Deemed Universities

# Vision 2050

Central Island Agricultural Research Institute
(Indian Council of Agricultural Research)
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Andaman & Nicobar Islands

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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 Island Agricultural Research Institute (CIARI), Port Blair 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.

**(S. AYYAPPAN)**
Secretary, Department of Agricultural Research & Education (DARE)
and Director-General, Indian Council of Agricultural Research (ICAR)
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New Delhi 110 001

# Preface

The Central Agricultural Research Institute (CARI), Port Blair, has accumulated wealth of experience on island agriculture by conducting research and development related work for last 38 years. In recognition of its seminal contribution, the Council has placed its confidence on the Institute to provide authentic leadership in Island agriculture. Recognizing the pivotal role the Institute is poised to play on Island Agriculture, the Institute has been renamed as "Central Island Agricultural Research Institute, Port Blair".

Being in the centre of hotspot of biodiversity (i.e. in the confluence of Indo-Myanmar and Indo-Malaysian biodiversity) the Institute has been documenting the agro-biodiversity of Andaman & Nicobar Islands. The Institute has also been generating invaluable information on mangrove and coral ecosystem.

The objective of the Institute is to enhance productivity through characterization and conservation of island genetic resources, development of genetically superior varieties/breeds, systems approach in island farming, development of climate resilient agricultural technologies suitable for the agro-ecological conditions of these islands and effective management of post-harvest losses. With the accumulated experience and expertise in island agriculture, it is proposed to make a major stride towards the cherished goal of emerging as the "Institute of Excellence on Tropical Island Agriculture". The institute also aims to concentrate on selected crops, value added products etc, which could be exported under brand name from the island to the mainland and other countries. The institute strives to develop noble varieties/technologies unique to the Islands which will help major ramification on other Islands of the country.

The flagship programme of the institute "Integrated Agriculture system for tropical Islands" which is meant for development of model integrated farming system based on the topography of the Islands. This programme will enhance the adaptive capacity of the Island farmers and fishers in order to be better prepared for climate change and natural disaster utilizing the three KVKs present in Andaman & Nicobar Islands. Under this programme, the location specific farming system models will be developed including the wealth of the vast coastal and marine resources in the Island which could serve as unique models

for tropical Island eco-systems. Flagship programme on Integrated Agriculture System for Tropical Islands & Establishment of Quarantine and Bio-security facilities, are the two major planks on which future research programmes will be based. Special focus shall also be given on Tribal Sub Plan in order to elevate the socio-economic conditions of the tribals. It is proposed to carry out numerous technological interventions in agriculture, fisheries, horticulture, animal husbandry, post harvest and value addition technologies for the benefit of the tribal's in Nicobar District and Little Andaman.

The Institute is also aiming at carrying out research and development related work in Lakshadweep Islands and is also striving to give leadership in island agriculture to other islands under the domain of Indian Union.

S. Dam Roy
Director
ICAR-Central Island Agricultural Research Institute
Port Blair, A & N Islands

# Contents

# Context

Andaman and Nicobar Islands consists of 572 Islands, islets, rocks and reefs spread between 6°45′ N to 13°41′ N latitude and 92°12′ E to 93°57′ E in Bay of Bengal. However, only 36 Islands are reported to be inhabited out of which only 4 Islands, viz North, Middle, South Andaman and Great Nicobar have an area more than 1000 sq. km. The tropical ecosystem of the A&N Islands is very unique in terms of high rainfall, extremely humid climate, undulating terrain and backwater creeks with high diversity of flora and fauna. The topography of the Islands ranges from low range hills, narrow valleys at the foothills to coastal plains.

The agriculture in the A&N Islands is about 100 years old. Up to the end of IV Five Year Plan, the major stress was mounted under area expansion of agriculture to achieve self-sufficiency in food grains. From V Plan onwards, the thrust was diverted from area expansion to intensive agriculture practices and development of plantations on the hilly slopes. Presently, the emphasis is on increasing the area and production through crop diversification from traditional food crops and optimum exploitation of cultivable wastelands. The demand for produce from allied sectors like horticulture, animal husbandry and fisheries far exceeds the supply thus opening greater avenues for further development. Besides ensuring nutritional security, these products have the potential for exports in value added form. Diversification towards horticulture and livestock therefore has to be very major component to achieve expected growth rate under agriculture sector. The favourable climatic condition in Bay Islands offers great opportunity for cultivation of different types of vegetables including legumes. Approximately 46,000 ha land is under agricultural crops that include about 30,000 ha land under plantation and fruit crops, about 10,000 ha land under field crops and about 461 ha land as fallow land. The horticultural crops occupy 72% of total cropped area (50000 ha). The estimated area and production of various crops is provided in Table 1.

Global food demand is expected to be doubled by 2050, while production environment and natural resources are continuously shrinking and deteriorating. The preconditions for making agriculture sector more remunerative and sustainable would be to evolve effective mechanisms for technology delivery and to enhance capacity of all stakeholders in

**Table 1** Area, production and productivity of crops

| Crops | Area (ha) | Production (MT) |
|---|---|---|
| Coconut ( million nuts) | 21875.00 | 125.00 |
| Arecanut | 4225.00 | 5975.00 |
| Cashewnut | 1200.00 | 377.70 |
| Paddy | 7850.00 | 21500.00 |
| Maize | 115.50 | 215.20 |
| Pulses | 1317.40 | 646.50 |
| Oilseeds | 108.80 | 51.90 |
| Black Pepper | 600.00 | 130.00 |
| Clove | 156.00 | 5.25 |
| Cinnamon | 150.00 | 35.00 |
| Nutmug | 70.00 | 4.75 |
| Chillies | 397.00 | 605.00 |
| Ginger | 215.00 | 1910.00 |
| Turmeric | 78.00 | 470.00 |
| Banana | 1675.00 | 18350.00 |
| Pineapple | 230.00 | 685.00 |
| Sapota | 163.00 | 3120.00 |
| Mango | 295.00 | 2800.00 |
| Papaya | 325.00 | 2380.00 |
| Citrus fruits | 280.50 | 1305.00 |
| Other fruits | 435.00 | 5315.00 |
| Sugarcane | 274.48 | 5883.37 |
| Tapioca | 270.00 | 2120.00 |
| Sweet Potato | 145.00 | 850.00 |
| Miscellaneous | 287.50 | 2183.00 |
| Floriculture | 36.40 | 343.00 |
| Rubber | 918.99 | 198.635 |
| Red Oil Palm | 1593.00 | 959.187 |

*Source:* Department of Agriculture & Cooperation, New Delhi (2012-13)

the invention-innovation continuum. The production of food grains, vegetables and fruits has been far below the local demand. Consequently, the A & N Administration has been importing rice, wheat, pulses, vegetables and other agricultural commodities from the mainland. The gap between supply and demand would increase as population of the Island increases. This necessitate for intensive efforts to develop new agricultural technologies suited to the specific agro-ecological conditions

of these Islands.

Livestock farming is considered to be a profitable enterprise in agriculture and constitutes an important activity for accelerating the rural economy. As per livestock census of 2012, the cattle, buffalo, goat, pig and poultry population in the Island is 45,608, 7850, 64,602, 35,401 and 10,80,228 (nos) respectively. The major bottlenecks for low productivity are indiscriminate inbreeding and free mixing of the animals, dilution of genetic superiority, long inter-calving period, inadequate availability of feed and fodder and high parasitic load. The fisheries sector has a coastline of 1912 km, encompassing about 16,000 sq. km. of continental shelf area and about 6 lakhs sq.km. of 'Exclusive Economic Zone' (EEZ), which is about 30% of India's total EEZ. Besides, there are several protected bays, inlets, brackish water creeks and shallow inshore areas available in the Islands, which are suitable sites for the development of aquaculture farms. The present annual fish production is only 30,000 tonnes due to inadequacies in technical and physical capabilities. Out of total projected potential of 1.48 lakh tonnes the tuna constitutes 67,000 tonnes which about 45.27% of the project potential. There is a great scope of increasing the fish production and revenue generation by harnessing the tuna resources and their exports to the neighbouring countries. The island economy will transform to a great extent if such steps are taken. There is also great scope for mariculture particularly of cage culture of marine fishes in the Bays & creeks of Andaman & Nicobar Islands. The geographical isolation of the Islands has accounted for relatively a disease free environment in the Islands for both livestock and fisheries. With inflow of poultry, livestock and fishes into the Islands, and further due to the possible entry of pathogens through transboundary routes into these oceanic Islands – the Islands are, however, in the brink of animal health issues. Hence establishment of biosecurity & quarantine system in these islands is the need of the hour and therefore the Council has made a concerted effort for establishment of Biosecurity level +2, 3 facility in Andaman & Nicobar Islands, in order to deal with the invasive species which may have detrimental impact on the island environment as well to protect the flora and fauna of the island from the dreadful diseases. This will also facilitate trade with neighbouring countries where certification of disease free material are required.

### Improvement & Protection

Realizing the importance of Island agriculture to provide better livelihood to the people with integrated approach in these remote

Islands, ICAR established Central Agricultural Research Institute (ICAR-CIARI) on 23rd June 1978 by merging regional stations of IARI, IVRI, CPCRI and CMFRI. Since then ICAR-CIARI is conducting research work for the farming community of these Islands. Presently, the research work has been conducted under five division viz., Field Crops Improvement and Protection, Natural Resource Management, Animal Science, Horticulture and Forestry & Fish and Fisheries Science and Social Science section. However as the Institute has gathered most experience on Island agriculture for past 35 years.

There is very little scope for expansion of agricultural area to increase the production and hence, there is a need to move towards technology-driven, input-intensive sustainable farming systems in the future. To meet the food demand for the population nearly 120 lakh tonnes of food grains in addition to 43,000 tonnes of vegetables and 25,000 tonnes of fruits will be required. This can be achieved only if we can able to supply 0.8 – 1.0 BCM of water to produce the required food grains and other commodities, among other factors. As rainwater is the only source of the freshwater availability, its harvesting, storage and recycling forms the most important strategy for natural resource management in these Islands.

❑

# Challenges

Andaman and Nicobar Islands have great significance to the country both strategically as well as environmentally. Lately, it has also emerged as promising tourist destination. Further, the Islands have a fragile ecosystem with tropical rain forests which forbids any horizontal expansion of cultivated area. After Supreme Court ordered closure of all wood based industries in 2003, there is virtually no industry. Therefore, the Island economy has to be developed on two pillars of tourism and agriculture. Thus the real challenge to the future Island agriculture is to meet the requirement of local population and tourists at a reasonable cost. The cause of this challenge is rooted in high transport cost of perishable items viz. vegetables, fruits, flowers meat, milk and milk products etc. from mainland, which if not produced by local production will be detrimental to the growth of the tourism.

The productivity of existing crop and livestock (comprising both indigenous and introduced), that are adapted to the local climatic conditions of these Islands need to be improved through technological interventions suiting to the local tradition and practices of the farming community. The growing demand for food and livelihood security is more challenging in the changing climatic scenario, looming natural disasters and the limited bio-resources of the Island ecosystem. The vision envisaged for the next forty years is to develop climate resilient technologies for livelihood security of Islanders while sustaining the fragile Island ecosystem which is being threatened by climate change as well as abiotic and biotic stresses. This livelihood security can be achieved by providing water security, soil nutrient security, feed and fodder security and local level processing and value addition.

The institute has developed numerous technologies for the Island farmers for providing decent livelihood through technological intervention. The major goal of the institute is to provide a research base to improve the productivity of important agriculture, horticulture, livestock and fishery sector through basic, adaptive and strategic research. A major constraint towards enhancing profitability is the cost of inputs which have to be imported from mainland. In addition given the scattered location of production centers, local level processing and value additions technologies are required to reduce wastage and enhance shelf life.

The contribution of agriculture towards the Island GDP is 17.40%, whereas that of the industries and service sector is 6.4% and 76.2% respectively. The share of agriculture and allied activities has fallen sharply to 17.40% from 31.3% in 1999-2000. Although the contribution of agriculture sector is low over the period but the thrust has been given in horticulture and fisheries which has been identified as the potential sectors by the Island Development Authority. Despite being bestowed with abundant rainfall, agriculture in Andaman is waiting for a paradigm shift in its cropping pattern, genetic improvement, production techniques, market interventions, credit delivery etc. Perceptible shift in the farmers' mindset as well as timely delivery of appropriate technology at affordable cost are the trigger points for heralding the needed change in this sector which still employs more than 21% of Island's population directly and indirectly.

### Shrinking Agricultural Land Holding

The land distribution system was 2 ha each of paddy and hilly land and 0.4 ha of homestead land to each settler during the settlement, however with time, this holding has been fragmented. Island agriculture is rainfed, carried out on small holdings thereby putting limitations on large scale investments. Agriculture farm families in the Islands is approximately 12,000, wherein small and marginal farmers have 59.65% of the land holdings and own only 25% of the total area, while 40.34% of the land holdings owned by medium and big farmers have 75% of the area. The average size of the agriculture landholding in the Islands is only 1.85 ha which is declining rapidly; if this trend continues in the same pace the average size of holding will be reduced to threshold level by 2050.

The livelihood opportunities in the Island are limited to tourism and agricultural sectors. With tourism being Port Blair centric, agriculture & allied sectors are only options for livelihood for people located in far flung Islands. With the limited land availability only vertical expansion is possible to facilitate increase in yield per unit area to meet the food demand of the increasing population. Though the total rainfall received in the Island is predicted to be normal but variations may cause water shortage particularly during dry season. In addition, the Island will be confronted with the changing climatic pattern and extreme events. The cropping intensity should be increased to 300% through multistoried cropping system involving fruits, vegetables, tuber crops, flowers and medicinal plants as components in order to get maximum output per unit area.

### Deteriorating Production Environment

The availability of limited agricultural land and near-absence of water resources development for irrigation coupled with biotic and abiotic stresses are the major factors responsible for the present state of agriculture in the Islands. After the tsunami, a huge area of about 4000 ha has been permanently submerged which has resulted in reduction of total agriculture land. Soil erosion is the major problem in these Islands due to intense rainfall. Most of the nutrients are leached out of the system and siltation often damages the corals, the habitat and breeding ground of many shell and fin fishes. There is no sufficient underground water source in these Islands. Minor irrigation projects are also extremely limited. Though Island is receiving more than 3000mm of rain annually, still there is acute shortage of water for irrigation and drinking during the dry spell of the year. Presently only 3% of the total agricultural area is under the cover of irrigation. The nutrient content of the soils is also depleting. The degradation of soil, water quality can be easily overcome by systematic and efficient utilization of the natural resources and recharging of the soil with the macro and micro nutrients sources for long term effective use of the soil.

### Growing Food Demand

The local human population in these Islands is about 3.86 lakhs (Census 2011) with a growth rate of about 26.9% in the last decade. Assuming the population growth rate as in the last decade, it is projected that the population in these Islands will increase to nearly 8.50 lakhs in 2050. The requirements of growing population in terms of drinking water, various agricultural commodities including animal products and green fodder need to be met through Island-specific technological innovations. The demand of cereal, tuber crops and milk needs to be increased to more than 200%. The present area under paddy is about 8390 ha with production of 23916 tonnes against the requirement of 33210 tonnes. The demand of the meat, milk and other byproducts of livestock and poultry need to be doubled to meet the requirement of the fast growing population and tourism. The commodity-wise projected requirement of food articles in A&N Islands is given in Table 2. Therefore, to meet the challenge of growing food demand crop intensification/diversification with vegetable, spice and fruit crops are considered to be the better options of farm income.

However, considering the growing importance of agriculture in the Islands, macro-management of agriculture is necessary for proper planning and evaluating technological options for possible interventions

**Table 2** Production requirement of different food items for projected population

| Item | 2011 | 2050 |
|---|---|---|
| Population | 386000 | 834815 |
| Cereals (t) | 66240(D-51.4%) | 143254 |
| Pulses (t) | 4035(D -284%) | 8766 |
| Vegetables ## (t) | 23798 (Seasonal excess & deficit) | 51466 |
| Roots and tubers* (t) | 20488(D- 105%) | 44310 |
| Milk (t) | 23940(D- 44%) | 51759 |
| Fruits (t) | 14052 (E) | 30387 |
| Meat and fish** (t) | 11883 (E) | 25629 |

D: Deficit; E: Excess

# Assuming 50% of cereal requirement from rice and rest from imported wheat

* Deficit is mainly on account of potato which can be transported easily

** The excess is due to production of marine fish. However the production of chevon and freshwater fishes has to be increased to cater the taste of local population, tourists as well as armed forces

## However actual availability is less than demand due to high post harvest losses

for improvements.

### Geological Changes

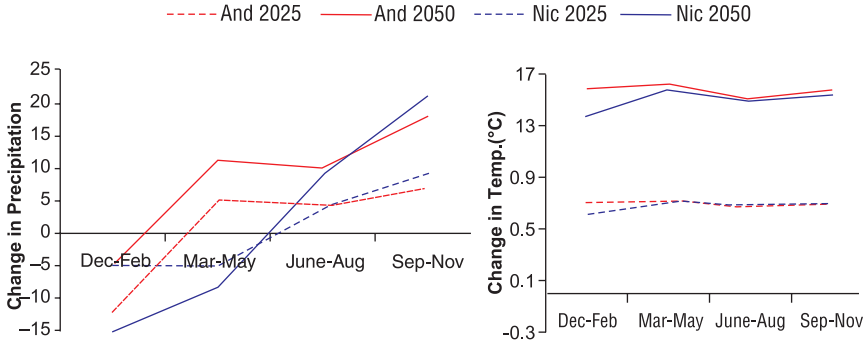
A&N Islands lie in the most severe seismic zone (zone V), where the expected intensity of seismic shaking is IX or greater on MSK intensity scale, adaptation strategies need to be evolved not only for the gradual sea level rise but also for storm surges and tsunamis. The Andaman and Nicobar Islands have smaller shelf widths and steeper slopes unlike the mainland coasts and hence the impact of tsunami and storm surges for these Islands would be low compared to that for east coast of India under similar conditions. However, these Islands are more vulnerable due to their flat topography, limited space for retreat and dense coastal settlements. The height of surge increases when the coastal crossing of storm is associated with high tide. The maximum storm surge disaster for the Islands under the worst hypothetical scenario involving the super cyclone with maximum wind speed of 80 ms-1 has been determined as 3.7 m under neap tide conditions. Further, massive earthquakes also result in alteration of Island topography leading to subduction of the Islands. A case in point is that following 2004 earth quake, South Andaman got subducted to an extent of 1 m.

### Climate Change and Agriculture

The most important change in the climate is the increase in the

global mean surface temperature, which has risen by approximately 0.74°C since the beginning of the 20th century. The major consequences of the global warming will be increased frequency and intensity of heat waves, heavy precipitation, tropical cyclone and increase in sea level between 0.18 and 1.90 m by 2100 according to varying estimates. This will have direct effect on the productivity of the agriculture, livestock and fisheries, the coastal areas are likely to get inundated, disease and malnutrition may increase and freshwater availability may get reduced.

The projected changes in mean temperature and precipitation for Andaman and Nicobar region assessed based on the recent GCMs using the MAGICC/SCENGEN software indicate that the rainfall pattern is all set to change significantly ($P<0.05$) during different seasons and the pattern of change in Nicobar would be different from that in Andaman. The mean temperature is also expected to increase by 1.5oC. As the SST has direct correlation with the intensity of cyclones, there is greater likelihood of frequent and more intense cyclones in the region in the near future.




Change in temperature (°C) and precipitation (%) in Andaman and Nicobar districts during 2025 and 2050 as projected by MAGICC/SCENGEN software

There is evidence of a 5-10% increase in intensity (wind speed) contributing to enhanced storm surges and coastal flooding. Moderate increase in temperature would also impact the health of livestock due to prevalence of more conducive environment for the pathogens thus resulting in outbreak of diseases and loss of germplasm. The sea level rise and associated sea surges which would affect the marine lives in general and giant leather back turtle in particular. The predicted negative impact of climate change on agriculture would also adversely affect livestock production by aggravating the feed and fodder shortages. Two major coastal bio resources- corals and mangroves are also vulnerable

to climate change which would indirectly affect the Island fisheries and thus the livelihood of the coastal fishers.

### High Vulnerability and Poor Adaptive Capacity

Small Islands are among the most vulnerable to future sea level rise and climate change. Sea level rise associated with global climate change produces greater wave attack and flooding leading to greater erosion and amplified impact of storm. Developing countries are likely to be more vulnerable to climate change not only because of projected magnitude but poor adaptive capacity due to institutional and resource constraints. Though the contribution of small Islands to global climate change is negligible they bear the maximum brunt of climate associated disasters.

### Loss of Biodiversity

The most significant impact of the changing climate on the Island ecosystem would be loss of critical habitats and thus the associated biodiversity. Documentation, characterization and sustainable utilization of Island biodiversity for the betterment of mankind thus assume great significance.

### Need for Ecologically Sustainable Intensification

With little new agricultural land to develop, meeting the food needs of future populations will require a doubling of crop yields. Further, there will be demand for diversified produces with enhanced productivity. However, under current food production practices this will greatly increase inputs into agricultural production systems, thereby vastly increasing opportunity for environmental pollution and degradation and depletion of natural and non-renewable resources. Hence, technologies and strategies have to be developed to meet these challenges of producing from limited available resources without compromising on the ecological balance of the fragile Island agro-ecosystem.

### Inadequate Research Infrastructure

The current research capacity for Island-specific research is grossly inadequate to meet the current and future challenges. There has to be a paradigm shift in research focus which demands corresponding financial thrust for strengthening human resource and physical infrastructure. Establishment of agri-incubation centers, large scale demonstration units and hi-tech laboratories in the area of post harvest technology, disease diagnostics, climate modeling, etc are critical to face the R&D challenges emanating from rising demands, imbalances in production-consumption

systems and growing globalization.

### Poor Horticultural productivity

As about 50% of the agricultural area is under coconut and arecanut, the cropping intensity needs to be increased to 300%. Multistoried cropping system involving fruits, vegetables, tuber crops, flowers and medicinal plants as components has to be popularized in order to get maximum output per unit area. There is a need for developing stable varieties in plantation crops, vegetables, fruits, flowers, medicinal plants and tuber crops through conventional breeding for sustainable production under challenging situations.

### Underutilization of Island Fisheries potential

The major challenge for the entire mainland coastal fisheries is to sustain production as the current exploitation has almost reached a plateau. However, the current level of exploitation in capture fisheries in the Islands is around 20% of which the contribution of oceanic fisheries resources accounting for 60% of the Island potential is almost nil. Specific intervention in terms of capacity building of Island fishers including the tribal's are building research base for choosing Island-specific craft and gear and developing technology for guided fishing in the Islands. The Islands have vast scope for popularization of cage farming and the primary challenge is in ensuring sustained seed supply followed by establishing a mechanism for marketing the farm produce.

### Absence of Regulated Market

Presently there is no regulated market or Marketing Board to systematically organize the market for agricultural produce. Most of the seasonal agricultural produce is sold to middlemen who collect the same at the local sub market centers at a very low rate depending on the supply and demand situation for the respective produce irrespective of MSP declared by the State. Sufficient marketing facilities are also lacking, which is responsible for low remunerative prices for the agricultural products of the farmers. Excess produce, be it in vegetables or spices or coconut instantly slash the price since the demand is extremely limited and outside market is almost inaccessible.

The institute is at a critical juncture in its progress curve, from where it has to curve a new path to develop agricultural production technologies which can feed the burgeoning population and tourism economy and can fit in agri-business modules with a production to consumption chain to provide a livelihood option compatible to the

aspiration of youth of farm families. There are plenty of opportunities for promoting agribusiness by establishing terminal market with hub and spoke model on PPP basis. The clusters have to be organized at spoke level. Workshops to be organized on price discovery through Forward Market Commission since three major commodities viz. copra, arecanut and spices are actively traded in the market. The production to supply chain of the essential commodity shows that there are more than 50% losses in the entire supply chain. Efforts should be made to link between the production centre to the consumer chain through the agribusiness model that would lead to assured market benefit to the producer and reduction in the post harvest and production loss of the agriculture produces. Industrial promotion strategy should be based on encouraging private investment not through subsidies but by improvements in infrastructural facilities and easing the process of various approvals. In promoting the growth of exports of fresh horticulture, agro products, processed food and sea food; the first step would be identification of a few items, keeping in mind their commercial value and the comparative advantage of the Island. The second step would be to focus on commercialization of identified products. This would imply establishing effective forward and backward linkages so as to sustain a symbiosis between industry and agriculture, encouragement to the use of modern technology and scientific techniques, investment in irrigation, development of fast means of intra-Island transportation, and strengthening of farmers' training and extension services. The third step would be to ensure availability of storage, processing, marketing, and transport facilities.

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# Operating Environment

Andaman and Nicobar Islands experience hot and humid tropical climate. The average maximum temperature is 30.10C and the minimum temperature is 230C. Relative humidity is in the range of 82 to 94% and it is highest in the month of August and lowest in February. The climatic conditions of Andaman and Nicobar Islands are warm, rainy and humid that favours the cultivation of paddy from May to December. Hence, paddy during kharif season is the main food crop. Among post rice crops, pulses and oilseeds are grown during December to April under rainfed conditions. Hence, pulses namely, mungbean, urdbean and cowpea are important crops to exploit rice fallows during dry season to boost up the agricultural production.

Agriculture in the Island is carried out under rainfed conditions. Though Islands receive an annual rainfall of more than 3100 mm spread over more than 7 months in a year, there are no fresh water perennial rivers, which can be used as a source of irrigation during dry spell. The dry spell prohibits growing second crop after paddy as well as it affects the productivity of the plantation crops. There is no unconsolidated ground water aquifer, which can be utilized. However, the shallow aquifers are present in valleys which can be used for limited irrigation. According to 2012 census, the total livestock population in the Island was about 1.54 lakh whereas the total number of poultry birds including ducks is about 10.8 lakhs. In spite of inadequate health cover and scarcity of proper nutrition, productivity of livestock and poultry is comparatively fair. There is no pasture lands earmarked for cattle to graze. They usually graze on the fallow lands after crop harvest. The nutritional problems become more acute during the dry season, where there is very less grass to feed upon. Among the different types of livestock, cattle & buffalo constitutes about 35 percent while goats constitute 42 percent and pig constitute about 23 percent of the total population. Fisheries contribute to the economy of the Andaman and Nicobar group of Islands to an appreciable extent. There has been a marked increase in the quantity of fish harvest. The catch is almost entirely from the marine sector while the production from Inland sector is quite negligible. The territory has a coastal line of nearly 2,000 kms with several protected and semi-unprotected bays and inlets, which have a vast potential for capture fisheries and mariculture operations.

The profile and characteristics of the soils of Andaman and Nicobar Islands show considerable spatial variation from heavy clayey to clayey loams and loams to sandy loams. Some soils are deficient in micro-nutrients. Though, annual rainfall is 3100 mm, it is intense during rainy season, there is virtual drought in the dry period from January to April. This calls for investments in the water conservation infrastructure. Climate change is a global challenge that needs both local and global response. IPCC has projected 1-30C increase in temperature which may reduce the yield up to 10% in different ways by 2020 in Asia. The Islands may not remain unaffected by these challenges, thus requiring appropriate responses. Besides the constant threat from the existing pests and diseases, Islands are also vulnerable to the ingress of many exotic pests and diseases as well as the emergence of new pests and pathogens. The global trade in agricultural commodities and trans-boundary movement of plants and animals has led to inadvertent introduction of pests (including insects, nematodes, pathogenic fungi, bacteria, viruses, weeds, etc.) harmful to the agriculture of a region.

In Islands, farmers mostly grow traditional photosensitive, low input requirement, lodging prone and low yielding (2-3 t/ha) cultivars of rice or with plantation crops having long gestation period. Though livestock and fish culture are being practiced by the farmers, they are not properly integrated on scientific basis. The availability of family labour has been dwindling over years. The rain-dependent farming leads to unstable production and financial risks. Post harvest processing and value addition will go a long way to meet the growing demand and may create market for value added products. As the majority of the farmers are in small and marginal category farming system approach should be the central point of research in order to meet the challenges of sustained food security and inclusive economic growth.

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# Opportunities

Dramatic change has recently occurred in our thinking about agricultural development, our use of natural resources, and stability of the global environment. The production-centric approach will slowly pave the way for location-specific holistic approach. Consumption and aspiration based practices will be replaced by opportunity and technology driven. New developments in non-conventional energy use, water harvesting technologies, high resolution remote sensing images and GIS tools for resource status assessment etc., will help to understand the problem better than ever and may pay the way for finding a solution based on research outcome.

In the Island ecosystem farming system is intended to give a wider choice to cultivars in the production of crops along with complimentary enterprises such as livestock and fish culture in unit area so as to expand production related activities and also to lesson risk. Although farmers practice farming system involving crop, animal and fish in the Islands, the proper linkage of one component with others are either missing or not established scientifically for enhancing overall production and productivity of the farm.

### Bio-diversity Conservation and Bio-prospecting

Andaman and Nicobar Islands are very rich in bio-diversity of crops, insects and microbes. Nevertheless, these Islands are very prone to genetic pilferage and natural disasters. Therefore, there is need of ex situ conservation of biodiversity by establishment of mini -gene banks of these resources. The diversity will be documented and characterized using frontier biotechnological methods followed by identification of useful traits, patenting and submission in national repositories. The useful genetic resources will be exploited for agricultural benefits.

### Broadening of the Genetic Base and Crop Improvement

Conventional breeding will continue to deliver the expected gains in productivity enhancement. However, collection of large number of germplasm and evaluation for the target conditions is expected to hasten the progress. Unlike rice, the pulses have narrow genetic base thus restricting the creation of new traits desired for developing varieties with high yield and tolerance to biotic and abiotic stresses. Since, pulses

have sufficient genetic variability among landraces in the form of wild relatives with distinct phenotypes which provides an ample scope for further improvement in their plant type for higher yield, resistance to biotic and abiotic stresses and quality traits. Induction of mutations can also help achieving these objectives. Thus pre-breeding programme need to be initiated using exotic, landraces and wild species to create wide variability. Conventional breeding would focus on development of high yielding varieties possessing adaptive advantage to biotic and abiotic stresses and climatic aberrations. Farmers' participatory plant breeding is becoming popular to incorporate and ensure farmers/consumers' preferences in varietal uptake and up scaling in future.

### Crop Improvement for Premium Quality

Genetic elimination of anti-nutritional factors and enhancing nutritive values of the pulses and bio-fortification of rice are achievable with modern technological options. Identification and development of high yielding super fine grain/aromatic rice varieties of premium quality fetch more income per unit area. The tapping of commercial potential of Makapuno coconut (Dahi Nariyal), packed tender nut water, virgin coconut oil, orchids, organic spices and medicinal plants. The hybrid maize, sweet corn and baby corn have recently shown good potential in the Islands. Similarly, in the context of mandated organic agriculture in the Islands, identification of high yielding crop genotypes grown organically can be "blessings in disguise" for product branding and higher incomes. The current agriculture practices in the Islands, particularly in the Nicobar group, are predominantly organic in nature. This provides an opportunity to systematically expand crops and areas under organic cultivation through research support and developmental initiatives. The quality of spices from Andaman & Nicobar are very high as compared to mainland, hence, the branding spices as Andaman Organic Spices because most of the Islands are organic by default.

### Field Laboratory for Climate Change

Globally sea level rise due to climate change has been considered as a major challenge and it is particularly true in case of Islands. The 2004 earthquake led to varying degrees of subduction of different parts of the Islands up to an extent of 1.5 m. These areas provide an opportunity to use such areas as Field Laboratories for studying the changes in biodiversity, impact of sea water intrusion and experimenting various developmental interventions for expanding livelihood options for the coastal inhabitants.

### Model for Island Agriculture

The uniqueness of agriculture in Andaman is that the entire area is under integrated farming. This type of farming system is traditionally practiced and is accepted to be ideal for Island conditions. The variations in topography and cropping pattern across the Islands provides scope for developing models for specific crop or animal based farming systems, which can serve as field demonstration units for not only the Islands in the region but also the tropical Island nations across the country.

### Proximity to South East Asian (SEA) Countries

The geographical proximity of the Islands to many SEA countries is a great opportunity to strengthen the Island economy through building on areas of competitive advantage. Establishment of sea and air connectivity between the Islands and the SEA countries would significantly alter the production basket of the Islands with offering significant boost for fresh/processed tuna, marine ornamental fishes, orchids, ornamental plants, organic spices, plantation crops, etc. It will positively alter the investment scenario, enhance the employment avenues and boost the Island economy.

### Vast Coastal Oceanic Resources

The Islands are blessed with one fourth of the country's coastline and a third of India's Exclusive Economic Zone. The resources are grossly underexploited and through appropriate mix of policy, research and development interventions, these resources can be exploited for social and economic benefit of the Islanders.

### Potential for Specific Pathogen Free Genetic Stocks

The Islands are geographically isolated and the existing mechanism of plant and animal quarantine can be strengthened so as to develop these Islands as a hub for production of disease free plant and animal genetic stock. The indigenous germplasm have many economically important traits which can be characterized and used for developing genetically superior breeds/varieties using modern biotechnological tools. The high yielding indigenous varieties of coconut, underutilized fruits and vegetables, tuber crops, flowers and medicinal plants have been recognized for their commercial importance and can be exploited to their full potential.

# Goals/Targets

Central Island Agricultural Research Institute has been pursuing research and development to enhance the agricultural productivity and to provide decent livelihood to the farmers, farm youth and women through the technological backup and innovative approach. The growing demand of food security and livelihood security is more challenging in the changing climatic scenario and the limited bioresources of the Island ecosystem. However, the efforts would be to exploit the maximum productivity with the available limited inputs. The new challenges in the future will be to continue to develop technologies for livelihood security of Islanders while sustaining the fragile Island ecosystem which is being threatened by climate change as well as abiotic and biotic stresses. This livelihood security can be achieved by providing water security, soil nutrient security, feed and fodder security and local level processing and value addition.

### Characterization, Management and Utilization of Natural Bio-resources

The Island is bestowed with wide variety of crop, animal, fish insects, microbes and horticultural diversity. The utilization of the genetic richness of the Island diversity for the sustainable production of the agri-horticulture, fishery and livestock components has been done in the past and will be continued to exploit the fullest potential. The augmentation of the productivity will be achieved through collection, conservation, characterization and utilization of horticultural crops, conservation, characterization and utilization of lesser known indigenous livestock and herbal bio-resources, development of biopesticides from indigenous bio-resources and propagation of rare and elite Macapuno type coconuts in Andaman and Nicobar Islands through embryo culture. There is need to upscale studies on bioactive properties of natural bioresources for developing bio-pesticides. A standard decision support system will be developed for assessment of the vulnerability of coastal bio-resources to climate change.

### Improving Productivity of Agriculture, Livestock and Fisheries

Demand of the agriculture, livestock and fishery produce is being increasing steadily with the growth of the population. To cater the need of the growing population and the burgeoning tourist population the production level and the productivity of the major crops, livestock and

fishery needs to be augmented. The thrust will be given on the major crops which are congenial for the Island ecosystem like plantation crops, spices, livestock and the fisheries. Island specific technological packages will be available to improve the productivity of the perishable vegetable crop, horticultural and forestry crops, genetic improvement of rice for tolerance to salinity and resistance to biotic stresses. Large scale protected cultivation will be in vogue owing to systematic research on structural design and package of practices compatible to different farmers' socio-economic conditions. Technological options for fish harvest and post harvest would be made available through systematic research which would accommodate the concerns of the tropical Islands in the region/ world. Given the geographic spread of the Islands and the distributed production points, Island-specific regional integrated processing facilities will be developed to enhance the shelf life, reduce losses and value addition for crop, horticultural, animal and fish products.

### Frontier Research for Knowledge and Increased Productivity

To improve the research efficiency the frontier research areas have been identified as research on biotechnology, nanotechnology, climate change, assessing carbon dynamics, bioprospecting of the important resources and use of candidate genes for better health and production. The modern biotechnological tool will be used for the augmentation of the production. The conventional approaches will be integrated with the advanced biotechnological tools and approaches for improving the productivity of livestock, fishes, agri-horticulture crops.

### Water Resource Development and Utilization

Islands receives an annual rainfall of more than 3100 mm however, there is acute shortage of water during the dry spell of the year. Agriculture is fully dependant on the rain fed. There is need for development of technologies for various tropical Island situations and their efficient utilization for enhancing water productivity through efficient irrigation scheduling, compatible nutrient management, resource efficient cropping system, and energy efficient water application methods. Research focus will be on water resource management for sustainable crop production and evaluation of land shaping techniques for in-situ rainwater harvesting, crop diversification and livelihood security in degraded areas.

### Management of Energy and Agricultural Waste

Island ecosystem is a closed system. In view of agriculture intensification, agriculture waste management will be a major issue.

Energy is considered to be one of the serious concerns in the growing agriculture sector. The research on the use of unconventional energy resources would to be explored to minimize the dependency on the fossil fuel-based farming system. Island agriculture terrain is undulating which limits the use of farm machinery. Therefore, efforts would be made to evolve the location specific agriculture machinery which suits to the terrain and landscape of the tropical Islands to minimize drudgery and efficient utilization of energy.

The waste management is another issue which needs priority as the Island is very fragile and any change may affect the agriculture productivity and livelihood. Suitable technologies will be developed for optimal utilization of agricultural and animal wastes mainly the crop residues.

### Building Capacity on Island Agriculture

Human resource development is vital for implementing and upgrading research programmes and the vast experience of the institute in Island agriculture would be utilized to forge alliances with the agricultural universities and research centers in mainland India and the Island nations. However with a view to upscale our research on Tropical Island Agriculture System the institute will make effort to develop state-of-the art facilities, strengthening collaboration with SAU's, Research and Extension Organizations and to enhance faculty competence for improving higher education and research in agriculture and allied disciplines. The institute would strive to become a deemed university with linkages with small Island developing states (SIDS) so as to build necessary competent manpower for managing these unique resources.

### Database on Impact of Farm Technologies in Tropical Islands

A database on the technologies developed with quantifiable socio-economic impact on the target clientele in the entire region would be developed which would drive the regional agricultural policies. Further, an updated repository would be built on the tribal livelihood systems and their indigenous traditional knowledge.

### IT-enabled Technology Transfer

Considering the remoteness and inter Island connectivity, the focus is to reorient techno-delivery system through participatory and tele-agricultural communication system with the involvement of local Administration and NGO. This would serve as a model for the other tropical Island nations in the region and elsewhere.

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# Specific Targets

- Emerge as the Centre of Excellence on Tropical Island Agriculture.
- Develop policy framework for climate-resilient integrated Island agriculture for the tropical Islands including small Island developing states (SIDS) and serve as the hub for developing the trained human capital for managing these unique ecosystems.
- Make A & N Islands self-sufficient in production of selected agri-horti commodities based on the principle of competitive advantage.
- Characterize and develop genetically superior lines of crops and breeds of animals which are suitable for Island-specific environs.
- Characterization of agriculturally important Island biodiversity and creation of geo-reference GIS-based interactive database
- Creation of embryo and stem cell banks of all indigenous livestock and poultry
- Develop climate-resilient crop varieties and models of farming systems suitable for various Island landscapes.
- Establish integrated post harvest research facility and systematically reduce post-harvest losses in agricultural, livestock, poultry and fisheries sectors in the Islands.
- Build technological capacity through research and innovative interventions in fishing technology and mariculture for optimal exploitation of capture and culture fisheries in the Islands.
- Establish bio-security and quarantine facility to protect the precious germplasm of this island and to make the Island disease free zone. ❑

# Way Forward

In Andaman & Nicobar Islands the agricultural land area is limited and hence production system has to be strengthened through ecologically sustainable research and technological interventions so as to meet the needs of the growing population. Management of natural resources is vital for long term sustainable agricultural development in the Islands. Specific issues that confront agricultural sector are land degradation, ground water imbalances, impaired soil health and low productivity of the farming system. Events associated to changing climate compound these factors and endanger the safety and security of the Islanders.

It is essential that our agricultural research programmes are geared up and oriented to develop technologies compatible with the needs of stakeholders and farmers. It is envisioned that the institute would acquire the necessary infrastructure and human intellectual capital for becoming as the International Centre of Excellence on Tropical Island Agriculture through systematic research on various aspects of Island agriculture.

The mandate, vision and mission of the institute are as follows:

### Mandate

- To provide a research base to improve the productivity of important agri-horticulture, livestock and fisheries of A & N Islands through adaptive and basic research for attaining economic self sufficiency
- To develop appropriate plans for conservation of natural resources and their sustainable use
- To standardize technologies for animal health coverage and livestock production
- To standardize techniques for capture and culture fisheries including coastal aquaculture
- First line transfer of technology and training to the relevant state departments

### Vision

Sustainable development in agri-horticulture, livestock and fisheries sector in the changing climatic scenario to ensure decent livelihood in the fragile Island ecosystem

**Mission**

Providing decent livelihood to farm youth from agriculture in a fragile Island ecosystem on sustainable basis.

The institute will undertake systematic consolidation of research output by (a) infrastructure development (b) building internal human resource (c) forging research partnership with mainland and overseas research agencies in the coming plan periods in a phased manner so as to realize the targets set for the 2050.

The broad research programmes under which the research would be carried out are:

(a) Characterization and Bio-prospecting of Natural Island Bio-resources
(b) Climate Proofing Island Agriculture for Improving Productivity
(c) Development of Harvest & Post-harvest Management Practices and Value Addition
(d) Policy Support Research for Integrated Island Agriculture

Our primary focuses is to improve the productivity of the Island agriculture through characterization of Island genetic resources, development of genetically superior varieties/breeds, systems approach in Island farming and effective management of post-harvest losses. The effective transfer of technologies would help to achieve self sufficiency in major food items, particularly the perishable commodities and to ensure nutritional and livelihood security to the island farmers/fishers/farm women especially the tribal farmers of the Nicobar group of islands. For socioeconomic amelioration of the tribal communities and the farm women it is envisioned to provide livelihood opportunity through sustainable technological intervention and capacity building under "Tribal Sub Plan". It is envisaged that this strategy will help to improve the adaptive capacity of Island farmers/fishers to changing climate. "Integrated Agriculture System for Tropical Island" is being taken up as the flagship programme of this Institute to enhance the adaptive capacity of the island farmers and fishers in order to build disaster and climate resilient islands through frontier research. The integrated approach will be promoted by developing location-specific farming system models, including the wealth of the vast coastal and marine resources in the islands, which can serve as unique models for tropical island ecosystems. The geographical location of island confer freedom from various diseases, insect, pest, however, the unrestricted entry of unwanted bio-organisms pose a continual threat to the crop-animal-fish component of the islands. In order to protect the precious flora and faunal diversity of the islands, it is envisioned to develop facilities for "Composite Bio-security and Quarantine Facility".

With the accumulated experience and expertise in island agriculture, it is envisioned to make a major stride in coming years towards our cherished goal of "emerging as the Institute of Excellence on Tropical Island Agriculture in the Asian countries". It is high time we capitalize on our own research foundation and the cumulative strength as a member of National Agriculture Research System (NARS) to be a model for tropical island agriculture research to the South East Asian countries in short term and entire world, in long term.

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## NOTES

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