

ISO 9001:2008



# ICAR-CCARI

वार्षिक प्रतिवेदन  
**Annual Report**  
**2014-2015**



## ICAR-Central Coastal Agricultural Research Institute

(Formerly ICAR Research Complex for Goa)

भा.कृ.अनु.प.-केंद्रीय तटीय कृषि अनुसंधान संस्थान

(भारतीय कृषि अनुसंधान परिषद)

ओल्ड गोवा ४०३ ४०२, गोवा, भारत

(INDIAN COUNCIL OF AGRICULTURAL RESEARCH)

Old Goa - 403 402, Goa, India





*Visit of Hon'ble Union Agricultural Minister*



*Visit of Secretary (DARE) & DG, ICAR*



वार्षिक प्रतिवेदन  
ANNUAL REPORT  
2014-2015



भाकृअनुप - केंद्रीय तटीय कृषि अनुसंधान संस्थान  
(भारतीय कृषि अनुसंधान परिषद)  
ओल्ड गोवा- ४०३ ४०२, गोवा, भारत

**ICAR-Central Coastal Agricultural Research Institute**  
(Indian Council of Agricultural Research)  
Old Goa - 403 402, Goa, India

# **ICAR-CCARI, Goa**

## *Annual Report*

### *2014-2015*

**Publisher** : **Dr. Narendra Pratap Singh**  
*Director*  
ICAR - Central Coastal Agricultural Research Institute  
Old Goa 403 402, Goa India  
Tel : 0832-2285381, 2284677/678/679  
Fax : 0832-2285649  
E-mail : director.ccari@icar.gov.in  
Website : www.ccari.res.in

**Correct Citation** : **Annual Report, 2014-15**  
ICAR - Central Coastal Agricultural Research Institute  
Old Goa, Goa - 403 402, India

**Chief Editor** : **Dr. Narendra Pratap Singh**

**Editors** : **Dr. R. Ramesh**  
**Dr. S. Priya Devi**  
**Dr. R. Solomon Rajkumar**  
**Dr. Maruthadurai R.**  
**Dr. Gopal R. Mahajan**  
**Mrs. Manju Lekshmi N.**

**Technical Assistance & Designing** : **Mr. S. K. Marathe**

© All rights reserved

## PREFACE

ICAR - Central Coastal Agricultural Research Institute (CCARI) is one of the research Institutes under Natural Resource Management (NRM) division of Indian Council of Agricultural Research (ICAR), New Delhi. The erstwhile ICAR Research Complex for Goa completed 25 years of existence and celebrated silver jubilee during 2014. Considering the impact created by the Institute in coastal agricultural research, ICAR, New Delhi upgraded the Institute and change the name of the Institute as ICAR-Central Coastal Agricultural Research Institute (ICAR-CCARI) to facilitate research along the coastal regions of India. This Institute plays a major role in promoting excellence in agriculture and is mainly involved in research activities which are aimed at improving the production and productivity of major crops of this region through various strategies including farming system approach. ICAR - CCARI is spread over 53 ha in which all the major infrastructure and experimental field for research work are established. In 1983, a Krishi Vigyan Kendra (KVK) was established in this Institute to provide transfer of technology to the farming community.

The Institute is mandated to carry out strategic and applied research specific to coastal region of the Country in the areas of field and horticultural crops, livestock and fisheries. The research activities of the Institute are grouped under five functional sections *viz.*, Natural Resource Management, Crop Science, Horticultural Science, Animal Sciences and Fishery Science. The Institute is a regular centre for AICRPs on cashew, integrated farming system (IFS) and pig, voluntary centre for AICRP on rice, arid legumes, vegetable crops and palms. In addition to Institute projects, research projects are also funded by ICAR through various network and collaborations, Department of Science and Technology and Department of Biotechnology. Extension and development projects are channelled through various development programmes like Tribal Sub Plan, National Horticultural Mission, Rashtriya Krishi Vikas Yojana and also through other developmental agencies.

Salient research achievements of the Institute during the last one year include, Identification of promising crop varieties/accessions of field and horticultural crops; Development of suitable soil and water conservation measures in cashew, coconut and mango; Development of integrated farming system models; Development of eco-friendly management practices of major insect pests and diseases in plantation field crops and vegetable crops; Development and standardization of production technologies for field and horticultural crops of Goa; Standardization of low cost protected structures for vegetable and flower crop production; Standardization of packages for rearing cattle, goat, buffalo, pig and poultry; Standardization of hydroponics green fodder production and bypass fat production; Disease diagnosis and animal health management; Standardization of ornamental fish culture, carp culture and brackish water fish farming; Standardization of mussel farming practices; Dissemination of PFZ advisories and validation of advisories; and Exploration of fish diversity of Goa. Scientists of the Institute published many research articles in peer reviewed journals.

I place on record my gratitude to Dr. S. Ayyappan, Honorable Secretary, DARE and DG, ICAR, New Delhi, Dr. A.K. Sikka, DDG (NRM), ICAR New Delhi, Dr. B. Mohan Kumar, ADG (A,AF&CC) and Dr. S. K. Choudhary, ADG (SWC) for the encouragement and guidance extended. I appreciate all the scientists and other staff members who contributed to the development of the Institute. I sincerely acknowledge the efforts made by the editors and the publication committee of the Annual Report for compilation and proper editing.

As the Director of the Institute it gives me immense pleasure to present the Annual Report 2014-15 and I hope the report will be useful to researchers, policy makers, planners and extension personnel.

Place: Old Goa  
Date: 10-05-2015

  
(Narendra Pratap Singh)  
DIRECTOR



## CONTENTS

Chapters	Page No.
Executive Summary	01
Introduction	07
Weather Report	11
<b>Research Achievements</b>	
Natural Resource Management	15
Crop Science	16
Horticultural Science	25
Animal Science	42
Fisheries Science	47
AICRP Main Centres	51
AICRP Voluntary Centres	56
Externally Funded Projects	60
<b>Institutional Activities</b>	
Transfer of Technology	81
Intellectual Property Rights	86
Education and Training	89
Awards and Recognition	93
Ongoing Research Projects	94
Human Resource Development	97
List of Publications	102
Workshops, Seminars and other Events	111
Committees and Meetings	122
Distinguished Visitors	126
Personnel	127



## Executive Summary

ICAR-Central Coastal Agricultural Research Institute conducts strategic and applied research under five functional sections viz. Natural Resource Management, Crop Science, Horticultural Science, Animal Science and Fishery Science. The highlights of the research achievements of this Institute for the year 2014-2015 are presented below.

### Natural Resource Management

Conserving the soil and thereby the soil organic carbon is one of the viable ways to combat climate change. After 13 years, the Continuous contour trench + *Stylosanthes scabra* + *Glyricidia maculate* in the 6×6 m spaced cashew could sequester the highest amount of carbon (5.78 Mg ha<sup>-1</sup>) in 0-0.90 m depth. In closely spaced (4×4 m) cashew experiment, the Continuous contour trench + *Stylosanthes scabra* + *Vetiveria zizanoides* sequestered 6.59 Mg ha<sup>-1</sup> carbon in 0-0.90 m depth. This indicates that a tremendous scope of using the soil and water conservation measures to capture the atmospheric carbon into soil. Similar soil and water conservation measures also caused highest soil microbial biomass carbon of 33.9 and 39.2 µg g<sup>-1</sup> soil. This explains the positive effect of the soil and water conservation measures on the microbial activity. In the mango crop, Continuous contour trench + vegetative barrier (*Vetiveria zizanoides*), Staggered contour trench vegetative barrier (*Vetiveria zizanoides*) and vegetative barrier (*Vetiveria zizanoides*) reduced the runoff loss by 44.8%, 32.7% and 16.1% and soil loss by 84.1%, 72.5% and 33.4% over control, respectively. Circular trenching was the best effective measure to arrest the soil and water erosion under coconut.

Analysis of the soils of four typical salinity groups (coastal saline soil tracts) namely non-saline, weakly saline, moderately saline and strongly saline during three seasons (monsoon, winter and summer) exhibited typical variations in the chemical and microbiological properties. The soils were most biologically active during the monsoon followed by winter and lowest in summer. Non-saline soils was the most biologically active soil during all the three seasons.

A rice based farming system model (crop-livestock-mushroom) has been developed on 0.7 ha area for typical lowland situations of Goa yielded a net return of ₹ 1.17 Lakhs during one year. Further, the value of the farm employment generated was ₹ 1.01 lakh and value of products recycled within farm was and ₹ 0.32 lakh.

The Institute has developed and launched an online web portal on Soil Test Based Fertilizer Application (<http://www.icargoa.res.in/soilgoa/index.php>) to important crops of Goa. The web portal can be used to decide the amount of fertilizers to be applied for given crop, area, number of trees/plants, age of tree/plant. The recommendations given are based on the soil fertility status of the Talukas and villages in the State of Goa.

### Crop Science

Korgut, a traditional rice landrace of Goa, has been registered as unique germplasm, for tolerance to salinity stress at seedling stage, with the National Bureau of Plant Genetic Resources (NBPGR), New Delhi and assigned the national identity number INGR14055. Six promising lines, resulted from five cycles of pure-line selection from local landrace Korgut, were evaluated under natural coastal salinity conditions in farmer's field at Chorao Island along with the original bulk Korgut. Among the six selections tested, KS-17 recorded highest grain yield (1837 kg/ha) followed with KS-4 (1820 kg/ha) and KS-16-1 (1577 kg/ha). Evaluation of 17 landraces of rice collected from Goa, under stress (coastal salinity condition) and normal condition revealed that, genotypes Saalsi and Walayo, recorded high yield in both the conditions indicating that these genotypes can perform better under salinity stress situation. All the 17 land races of rice were characterized for different agro-morphological and yield and its contributing characters. Observations were recorded at four phases viz., seedling phase, vegetative phase, reproductive phase and maturity phase.



In a project, development of high yielding salt tolerant rice varieties for coastal saline soils, 47 crosses were produced using different parental combinations. True  $F_1$ s were identified on the basis of morphological characters and their seeds were collected for advancing to next generations.

Under the STRASA project, 45 *Saltol* introgressed rice lines received from IRRI, Philippines were tested under natural coastal salinity conditions of Goa, for the second consecutive year. The result indicated that, the genotype IR87848-301-2-1-3-B recorded highest grain yield (4713 kg/ha) followed by IR 87831-3-1-1-2-2-BAY B (4525 kg/ha), IR87848-301-2-1-1-B (4234 kg/ha), IR 87938-1-1-3-1-2-B (4116 kg/ha) and IR 87952-1-1-1-2-3-B (4113 kg/ha).

Field screenings of the cashew varieties and hybrids against the incidence of TMB revealed that varieties such as DHV-1, Balli-1, RL-2, and Balli-2 showed least shoot and panicle damage. Among the hybrids, HB-26, HB 12/05 and HB 11/05 showed least shoot and panicle damage. Red ant or Weaver has been tested as a potential biological control agent for tea mosquito bug (TMB). Thirty per cent of the plants were colonized by red ants. The results revealed that the damage score of 0.8 to 1.2 was recorded in trees colonised by red ants whereas maximum damage score of 2.98 to 4 which was recorded in trees without red ants. Stem injection of Imidacloprid, Fipronil and Thiamethoxam on the infested cashew trees revealed that 58% of treated trees recovered.

Biology of invasive mealybug *Phenacoccus solenopsis* on cashew revealed that the pre oviposition, oviposition and post oviposition period were 4.02 days 10.84 days and 2.14 days, respectively. Parasitization (6.31% to 35.52%) of *P. solenopsis* by *Aenasius bambawalei* was recorded in cashew. Infestation and unusual occurrence of aphid *Toxoptera odinae* was observed on cashew plantations. Minimum population (84.44 aphids/ leaf) was recorded during third week of January and maximum population (203.06 aphids/ nut) was recorded during second week of February, 2015.

Effect border crops and food baits on the incidence of fruit fly on cucurbit indicated that the least percentage of fruit fly infestation (16.38) was recorded in castor + food baits spray followed by (19.14) in maize + food baits spray. Management of sweet potato weevil *Cylas formicarius* was undertaken with seven insecticidal treatments. The least percentage of infested tubers (2.25) was recorded in vine dipping followed by spraying of fipronil (0.002%) at 45 DAP as against control (16.3).

Experiment on integrated management of foot rot in black pepper in farmers field indicated that application of talc formulation of biocontrol agent *Trichoderma*, reduced the incidence of foot rot and improved the plant growth. Grafting of susceptible cultivated types of brinjal on wild root stock completely controlled the incidence of bacterial wilt and hence this technology could be used in bacterial wilt management. Application of lime @ 10 and 20 t/ha to the soil reduced the incidence of bacterial wilt. Change in the soil pH is attributed to the effect.

Selected *R. solanacearum* isolates were deposited in NBAIM, Mau and in MTCC, Chandigarh repositories. Sequence analysis of *egl* gene of 10 representative *R. solanacearum* isolates from Goa and adjoining Maharashtra resulted in the assignment of sequevars to 3 of the isolates. MLST analysis of these isolates revealed the presence of six haplotypes and the dominant one is haplotype 1 with five isolates.

LAMP PCR was standardized for the detection of *R. solanacearum* and the detection technology is validated using the soil samples from the field and found as the most reliable method. Antagonistic xylem residing bacteria (XRB) re-colonized brinjal plants upon treatment and few XRB degraded 3OH-PAME in the assays. Hence these bacteria could be potential biocontrol agents. 21 lines of  $F_4$  and 102  $F_5$  lines of brinjal cross (Agassaim X Surya) vary in fruit colour, fruit shape, colour pattern and bearing habit were forwarded to next generation. Antagonistic bacteria (EB69, XB177 and XB122) reduced the bacterial wilt incidence and increased the yield in brinjal field trial.

Growth media for mass multiplication of *B. amyloliquefaciens* (RCh6-2b) and *P. aeruginosa* (Rs-08-72) were standardized. Population of RCh6-2b in the talc formulation is maintained over 7.0 Log CFU g<sup>-1</sup> (A1) and over 8.0 Log CFU g<sup>-1</sup> (A1+A2) after 180 days. Liquid formulation of *B. amyloliquefaciens* (RCh6-2b) was standardized and evaluated for its viability. Population of RCh6-2b in different liquid formulation indicated that the population is above 7.0 Log CFU mL<sup>-1</sup> after 210 days in all the cases. Population of Rs-08-72 in the talc formulation is maintained over 7.0 Log CFU g<sup>-1</sup> till 60 days. Population of Rs-08-72 in different liquid formulation indicated that the population is above 7.0 Log CFU mL<sup>-1</sup> after 210 days.

### Horticultural Science

Goa Benuaim Pani a coconut selection with desirable tender coconut qualities was identified. Benuaim, the land race of coconut from Goa was submitted for registration with NBPGR, New Delhi as a genetic stock. Studies initiated to identify coconut palms with fruits developing resins and other defense reactions immediately upon attack by eriophyid mite. Segregation for height and foliar traits was analyzed in 196 open pollinated progenies of dwarf areca.

New putative SCAR marker for tagging salinity tolerance in banana was identified. Predicted SCAR markers were worked out for allele mining in banana. Allele mining of banana genome was attempted using RAPD derived SCAR primers for dwarf stature.

A rare chilli accession (IC 0611607) with small sulfury white immature fruits with a crop duration of 10 months was identified characterized and conserved. Three germplasm accessions of noni collected from Maharashtra were conserved in seed bank of NBPGR New Delhi and received national identity numbers. Grafting and air layering techniques were perfected for noni (*Morinda citrifolia* L.) Seven accessions of *Amaranthus tricolor*, two accessions of *Amaranthus dubius*, three accessions of chilli from Goa were conserved in National Gene Bank New Delhi along with assigned IC numbers.

Germplasm collection of 123 mango varieties/ accessions and two wild relatives of Mango (*Mangifera camptosperma* and *M. graphitthi*) was maintained. Out of eighteen Mankurad variants, 9 accessions came to first flowering and fruit set. Three more new accessions of Mankurad variants were collected clonally. Analysis of fruits of from the mother trees of new mango accessions was carried out for quality parameters. High density planting of two varieties viz. Shweta and Lalit was established.

Among the introduced mango hybrids, Amrapali hybrid variety recorded the best performance with respect fruit yield and quality under agro-climatic conditions of Konkan coast of Goa, followed by hybrid 87.

Germplasm collection of 24 nutmeg and 6 cinnamon local seedling accessions were maintained. Two varieties of Black pepper, Thevam and Shakti were introduced from IISR. The fruiting period of nutmeg genotypes varied from 4 to 5.5 months. Genotypes namely NMD-1, NMD-2, NMD-5, NMF-5 and NMF-6 recorded higher number of fruits per tree (162 - 427 fruits/tree). Highest shelling per cent (65.23%) was recorded in NME2 followed by NME2 (64.38%). Protocols for processing of nutmeg fruit pericarp for making candy, jam and Syrup were standardized. Suguna, Suvarna, Sudarshan, Alleppey Supreme of turmeric and Garo local of ginger varieties were introduced.

Coconut based multiple species farming system yielded 3913 nuts of coconut, 1377 kg of banana hands, 2.5 kg of nutmeg nuts and 0.45 kg of dry mace and recording of yield data of elephant foot yam, production of a number of banana suckers and biomass of coconut fronds, glyricidia, banana leaves and pseudo stem, etc is under progress.

In jack fruit, wide variation was recorded in traits like, stalk length (2.3 to 9.8 cm), stalk girth (6.9-10.3 cm), fruit weight (5.57 to 16.10 kg), fruit length (33.9 to 68.2 cm), fruit girth (59.80 to 90.80 cm) rachis length(15.8 to 38.2 cm), number of bulbs per fruit (83 to 271).



In papaya breeding programme, seeds have been extracted from three crosses like, 27/16 x 24/18, 8/4 x 12/4, 21/7 x 21/9 and one selfed fruit of hermaphrodite plant no.15/10.

After eight months of storage, overall acceptability of aonla muraba prepared without liming and stored at ambient condition was the highest (7.4 out of 9.0). Jam prepared from pink coloured wax jambo fruits recorded overall acceptability of 6.5/9.0 as against 5.8/9.0 for jam made with 75% Pink wax jambo and 25% roseapple after seven months of storage.

Standardization and validation of Precision Farming Technologies (PFT) for major vegetable crops is initiated in Chilli. Out of three varieties (Kashi Anmol, Nisha and Preeti (F1 hybrids) evaluated under drip and conventional system of cultivation, the earliest flowering was noticed under drip irrigation system in Nisha and Preeti followed by Kashi Anmol. Days to first harvest has also earliest under drip irrigation in Nisha (40 days) followed by Kashi Anmol and Preeti (41.75 days).

Under AICRP on vegetable crops, four trails in brinjal (IET, AVT-I, BBW AVT-I and II) and three trails in chilli (IET, AVT-I and II) are in progress. The earliest flowering was noticed in 2014/BRLVAR-1 (28 days) followed by 2014/BRLVAR-2 (33 days) in brinjal IET. In BBW AVT-I, no wilt incidence was recorded in resistant check SM-6-6 and the highest wilt (60%) incidence was noticed in susceptible check Pusa Purple Long at 30 days after transplanting.

Under RKVY project, nine varieties of gladiolus, 13 varieties of gerbera and two capsicum hybrids were evaluated for Goa condition. Eight varieties of anthurium and six varieties of orchids were planted for evaluation. Around 100 local accessions in traditional vegetable crops were collected during survey for seed production.

Among different cultivars of tuberose evaluated, Mexican Single, Suvasini, Pearl Double could be recommended for commercial cultivation under agroclimatic conditions of

Goa. Higher quality and longest vase life (10.75 days) of spikes of tuberose Cv. Pearl Double were obtained by using holding solution containing 8HQS-200ppm+GA<sub>3</sub> 25ppm+AgNO<sub>3</sub> 50 ppm+Citric acid 50ppm+Sucrose 3%. Storage of individual florets of 'Mexican single' for 6 days at 4°C in non-vented polyethylene (100gauge) wrapping was most effective to enhance vase life and maximum score for fragrance, turgidity and freshness. Value addition studies in tuberose spikes by tinting with edible dyes revealed that higher time of immersion (24 hours) and dye concentration (1.5%) allowed more dye to be translocated throughout the spike.

Nineteen types/ varieties of ornamental coleus were evaluated for its suitability to various uses in landscaping. Ornamental coleus cuttings planted in Sand+Saw dust+Vermicompost (1:1:1) had significantly higher survival percentage with maximum number of roots, leaves, root, shoot and petiole length. Among different rose varieties evaluated, Jubileums, Restless and Brisbane blush were judged as most ideal for using as loose flower under open field conditions of Goa. With respect to dehydration studies in different rose varieties, overall acceptability for most quality traits were exhibited by varieties which were dried by embedding in silica gel.

Microclimate of the single span and double span structures with various crops, varieties and geometry were analyzed. The effect of the microclimate on crop production, incidence of pests and diseases also were analyzed.

Studies on post harvest crop losses in paddy was concluded and the general recommendations are brought out.

### Animal Science

Efforts were taken to reduce heat stress on milk production in buffalo by managerial intervention ie manual cooling of buffalo by splashing of water twice daily and by nutritional intervention ie supplementation of bypass fat to the feed @ 20 g / lit of milk. In Murrah cross buffalo the highest daily milk yield upto 9.412 lit



was attained in February under by pass fat feeding. It was noted that heat stress was overcome by 24.71 % and milk yield was increased around 9.36 % by supplementation of bypass fat along with cooling arrangement.

Effort was made to reduce heat stress on cattle by supplementation of bypass fat @ 20 g / calf to the feed along with mechanical cooling. Heat stress was overcome by 25 % and growth was enhanced by 17 % due to fortification of feed with the bypass fat along with mechanical cooling. It was observed that supplementation of bypass fat in the feed helped to reduce heat stress.

Agonda Goan first livestock breed of the Goa and the only pig breed of the coastal region was recognized by the ICAR breed recognition committee. Boar Semen Extender was formulated which has got capacity to store boar semen at 15-17 °C for 96 hours fulfilling qualities of liquid semen. This formulation is under test at different places and patent was also filed. Artificial Insemination in pig is popularized among farmers of Goa and Maharashtra through DBT program.

Low cost hydroponic unit was created and is under testing for maize fodder production. Feeding of bypass fat was tested at farmers field and 4.5 tons of bypass fat was sold.

Brewers' dried grains can be included in the concentrate mixture of dairy animals up to 25% by completely replacing the rice bran. Fresh hydroponics maize fodder can be fed to heifers up to 21 kg per day and is a good alternative to conventional green fodder. When limited concentrate mixture and green fodder are fed to heifers, the TDN content of the ration is very low. Increase in the milk production of about 0.5-2.0 kg per cow per day; and increase in the fat% by 4.3-87.5% was observed due to feeding of bypass fat prepared indigenously to the animals @ 15-20 g/ kg milk production.

In poultry, the early mortality of Srinidhi chicks during 0-6 weeks of age is 1.79 percent.

The average body weight of female Srinidhi chicken at 20<sup>th</sup> week is 2.020 kg in deep litter, 2.082 kg in cage system and 1.983 kg in farmers' field. At 28<sup>th</sup> week, the Hen-day egg production in deep litter, cage and farmers' field is 70.8 %, 93.95 % and 19.04 % respectively.

### Fisheries Science

For the deployment of artificial fish habitats (AFHs) in Zuari estuary, the pre-deployment gillnet fishing experiments were carried out at the selected sites. 186 aquatic species comprising of 150 finfish and 36 shellfish species were described. The major fisheries resource groups were white sardine, penaeid shrimps, silverbellies, crabs, mullets, shads and moustached anchovies. The species richness, evenness and overall diversity indices were least during the monsoon season in comparison with pre-monsoon and post-monsoon seasons. Thus, there was a distinct temporal pattern observed in the diversity of fish species. After considering the substratum (rocky) and bathymetric profile of the selected sites, three rectangular AFHs with circular holes (diameter of 10 cm) were designed and constructed with RCC. With the participation of fishermen community, a total of six AFHs with marker floats were deployed at two locations (rocky grounds) in Zuari estuary.

In order to catalogue the freshwater fish diversity of the Western Ghats region of Goa, NBFGR Kochi Unit in collaboration with ICAR-CCARI conducted fishing surveys of freshwater habitats in Goa. The sampling yielded 55 fish species and 13 crustacean species.

To popularize and standardize the mussel rack culture technology in Goa, demonstrations were carried out in two different systems; a semi-enclosed water body (SEW in Goa Velha) and an open-water system (OWS in Batim). During the culture period, environmental variables showed a significant difference between the two culture systems. The chlorophyll-a concentration and plankton density were more in the SEW than in the OWS. The prediction of SGR using generalised liner model has indicated that the plankton density and nitrate are the important



parameters which influence the SGR positively. The economic analysis of the culture operations have also indicated that the SEW system is more profitable compared to OWS. As a parallel culture initiative, culture of locally demanded finfish, Pearlsplit (*Etroplus suratensis*) was initiated in Goan coastal water bodies based on periphyton based system and biofloc based system. Fish growth, biochemical parameters and environmental parameters were also monitored during the culture experiments.

Breeding and seed raising methods of both egg layers and live bearers of many fresh water ornamental fishes namely gold fish (normal, shubunkin, redcap, black moor, silver), koi carp, gourami, (blue, yellow, pearl), angel, sword tail, guppy varieties and molly were developed. Live feeds like *Spirulina*, infusoria are produced and fed to young ones and adults. There was an improvement in seed production of gold fish varieties. Experimental trails were initiated to enhance the colour of the ornamental fishes gold fishes, koi carps and platies by incorporating different locally available colour enhancing biological compounds like marigold and rose powder in feed.

### Rashtriya Krishi Vikas Yojana

Currently there are nine RKVY funded projects running in the institute, with total funding of six crores. Out of these, six projects are under Horticulture and three are under Animal Sciences. Under these projects, infrastructures like Polyhouses, shadenet houses, low cost shade chambers, Hydroponic unit *etc.* have been created. Besides, mass production of by-pass fat is also being done. Advanced technologies like, protected cultivation, precision farming, hydroponic fodder production *etc.* are disseminated to farmers, besides which, supply of quality planting material and by-pass fat is also being continued for the benefit of farmers.

### Tribal Sub Plan

Under TSP programme, tribal farmer groups were identified. The farmer groups were provided with farm machinery, post-harvest machinery, sprayers, grass cutting machines, water pumps, fishing nets and farm inputs like seeds, planting material, fertilizer, plant protection chemicals. Awareness and training programmes were also conducted during implementation. Through the above programme, the livelihood of almost 200 tribal farm families improved.



## Introduction

Goa is situated in Western India along in the region, also the Konkan tract and is bounded by Arabian Sea and the states of Karnataka and Maharashtra. It has a warm humid and equanimous coastal climate which is ideally situated for all kinds of agricultural activities viz. annual crops, horticultural crops, livestock enterprises and fish farming. Due to increasing labour costs, cultivation of field crops especially rice is becoming unprofitable. The farmers of the state are therefore increasingly taking up to horticultural crops with emphasis on mixed farming where in farming system research including watershed management is gaining importance.

The Indian Council of Agricultural Research, New Delhi therefore established the erstwhile ICAR Research Complex for Goa, in April, 1976. To begin with, the complex was under the administrative and technical control of Central Plantation Crops Research Institute, Kasaragod. After functioning at different Government farms, it was finally shifted to its present location at Old Goa in 1982. In order to intensify further the transfer of technology and to impart grass root level vocational training, a Krishi Vigyan Kendra was established at the Research Complex in 1983.

Keeping in mind the ever-growing needs of agricultural research, education and extension of the State of Goa, ICAR, New Delhi upgraded the Research Complex to a full fledged Institute in April, 1989. In all, the Research Complex has 53.37 ha land of which 33.67 ha was acquired during 1987. The Research Complex carries out basic, strategic and applied research in Natural Resource Management, Crop Science, Horticultural Science, Animal Sciences and Fisheries Science.

The Institute is headed by the Director, who is supported by 20 Scientists, 18 Technical, 21 Administrative and 28 Skilled Support staff, making the total staff strength of the Complex to 88. KVK is headed by Programme Co-ordinator

who is supported by 10 Technical, 2 Administrative and 1 Skilled Support Staff, in total 14.

Salient research achievements of the Institute during the last one year include, Identification of promising crop varieties/accessions of field and horticultural crops; Development of suitable soil and water conservation measures in cashew, coconut and mango; Development of integrated farming system models; Development of eco-friendly management practices of major insect pests and diseases in plantation field crops and vegetable crops; Development and standardization of production technologies for field and horticultural crops of Goa; Standardization of low cost protected structures for vegetable and flower crop production; Standardization of packages for rearing cattle, goat, buffalo, pig and poultry; Standardization of hydroponics green fodder production and bypass fat production; Disease diagnosis and animal health management; Standardization of ornamental fish culture, carp culture and brackish water fish farming; Standardization of mussel farming practices; Dissemination of PFZ advisories and validation of advisories; and Exploration of fish diversity of Goa.

The Institute celebrated silver jubilee during 2014. Considering the impact created by the Institute in coastal agricultural research, Indian Council of Agricultural Research, New Delhi has upgraded the Institute and changed the name of the Institute as ICAR-Central Coastal Agricultural Research Institute (ICAR-CCARI) to facilitate research along the coastal regions of India.

### Mission

- 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**

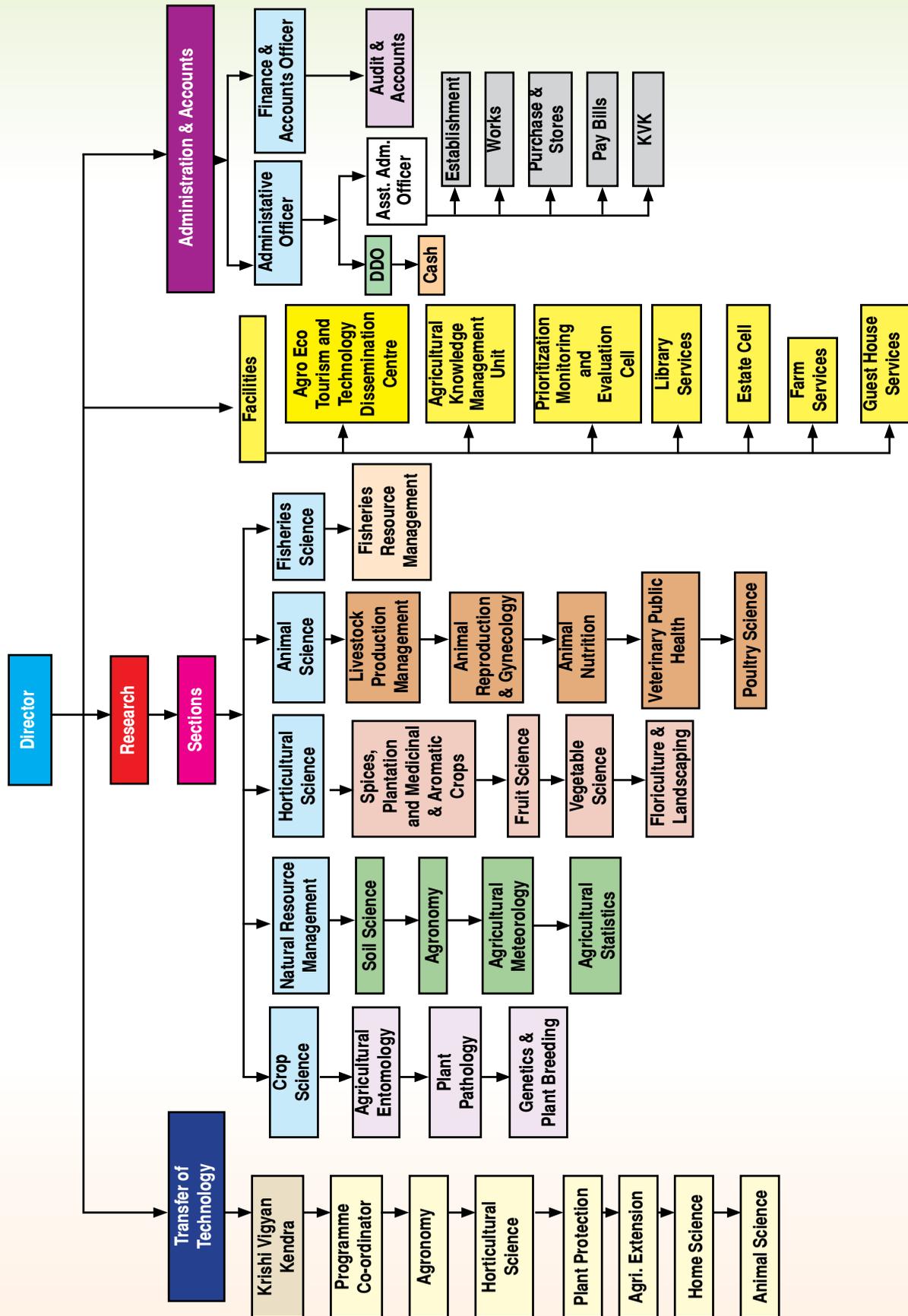
- To undertake basic, strategic and applied research on field and horticultural crops, livestock, and fisheries relevant to natural resources base of coastal India for sustainable increase in productivity.
- To develop appropriate and climate resilient land use and farming systems for improved and sustainable livelihood.
- To develop technologies for conservation and utilization of biological diversity in coastal region of India.
- To network with national and international organizations in developing and disseminating improved technologies.
- To act as a centre of excellence and knowledge repository on agricultural and allied sectors for coastal region of India.
- To act as a centre of agro-eco-tourism.
- To organize capacity building programmes and provide consultancy services to stake holders in agriculture and allied sectors.

**Staff Position as on March 31, 2015**

Category	Sanctioned post	Posts filled	posts vacant
RMP	01	01	-
Scientific	20	17	3
Technical	18	16	2
Administrative	21	17	4
Skilled Support Staff	32-4* = 28	28	-
Total	92-4* = 88	79	9

\* Four posts (redeployed to Ranchi Regional Centre of the ICAR Research Complex for Eastern Region)

**Organisational Set up**





**Financial Achievement for 2014-15 ICAR-CCARI**

(₹ In lakhs)

Budget Head	Non Plan		Plan	
	Revised estimate	Actual expenditure	Revised estimate	Actual expenditure
<b>Grant-in-Aid Capital</b>				
Equipments	6.00	5.86	44.62	44.62
IT..Equipments			3.98	3.97
Furniture			1.40	1.40
Library	1.00	0.94	20.00	20.00
Works			40.00	40.00
<b>Total</b>	<b>7.00</b>	<b>6.80</b>	<b>110.00</b>	<b>109.99</b>
<b>Grant-in -Aid Salary</b>				
Establishment Charges	515.00	508.11		
OTA	0.10	0.09		
<b>Total</b>	<b>515.10</b>	<b>508.20</b>	<b>0.00</b>	<b>0.00</b>
<b>Grant-in -Aid General</b>				
Pension	50.00	47.62		
TA	7.50	7.49	15.00	15.00
Research & Operational Expenses	100.00	99.98	65.00	64.98
Administrative Expenses	607.60	386.44	37.00	36.99
Misellaneous Expences	5.95	5.93	3.00	2.97
<b>Total</b>	<b>771.05</b>	<b>547.46</b>	<b>120.00</b>	<b>119.94</b>
<b>Tribal Special Program (TSP)</b>				
1. Contingencies			20.00	20.00
2. Equipment/Works			50.00	50.00
<b>Total</b>			<b>70.00</b>	<b>70.00</b>
Personal Loans & Advances	3.00	2.93		
<b>Total</b>	<b>1296.15</b>	<b>1065.39</b>	<b>300.00</b>	<b>299.93</b>

Attributes	Remittance	Expenditure
Plan Schemes	200.37	166.40
External Aided Project	129.58	210.07

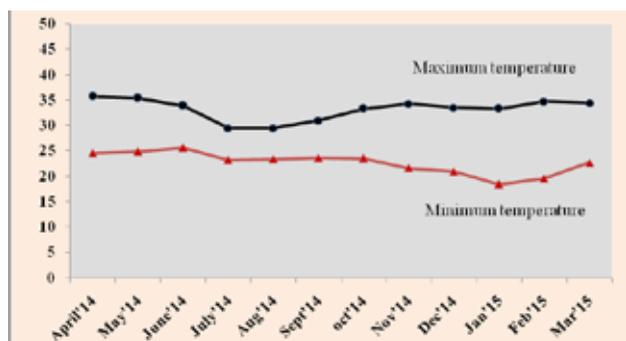
Attributes	Target	Actual
Revenue Receipt	75.70	59.07
Interest on short term Deposit		45.63
Recovery of Loans & Advances		9.33

## Weather Report

Information on weather is of paramount importance for agricultural production. Observation of weather parameters during April 2014 to March 2015 at the Institute Meteorological Observatory are discussed here under.

### Air temperature

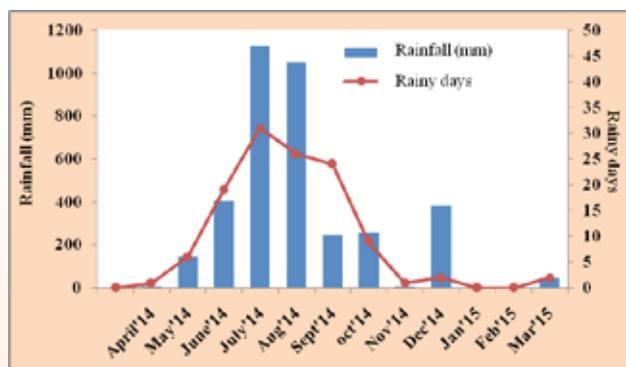
Mean maximum temperature during April 2014 to March 2015 varied from 29.5 °C (July, August 2014) to 35.7 °C (April 2015), whereas mean minimum temperature varied from 18.4 °C (January 2015) to 25.6 °C (June 2014).



Mean maximum and minimum air temperature during April, 2014 to March, 2015

### Rainfall and rainy days

The total rainfall received during April 2014 to March 2015 was 3630.8 mm. Total of 2835.4 mm was received during *kharif* (June 2014 to September 2014). The annual rainfall of this year was 289.8 mm higher than that of 2013-14 (3341 mm). Total number of rainy days observed was 119 and was lesser compared to last year (135 days).



Trend of mean monthly rainfall and number of rainy days

### Evaporation and relative humidity

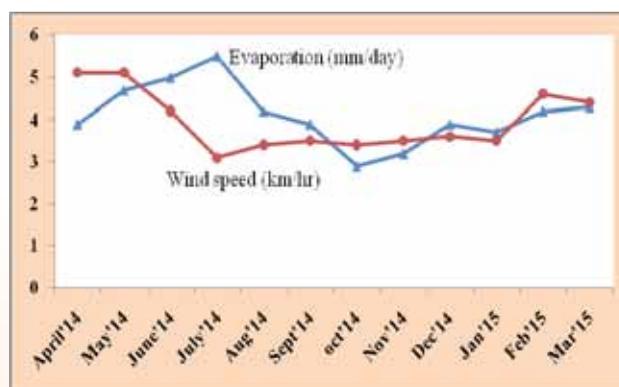
Sum of monthly mean water evaporated from April 2014 to March 2015 was 43 mm. The highest morning as well as afternoon relative humidity was observed during June to October, 2014, whereas the corresponding lowest afternoon humidity was recorded during December 2014.



Mean monthly evaporation and morning and afternoon relative humidity

### Wind speed

Mean monthly wind speed ranged from 2.9 km/hr (October 2014) to 5.5 km/hr (July 2014). Mean monthly wind speed started decreasing from September 2014 to November 2014 and it increased thereon till February 2015.



Mean monthly wind speed and evaporation

### Sunshine hours

The mean monthly sunshine hour recorded ranged from 1.6 hours (July 2014) to 9.6 (February 2015).

### Soil temperature

The ranges of mean monthly soil temperature recorded in morning hours at 5, 10 and 15 cm depths were 22-32.8 °C, 25.3-35.1 °C and 26.2-35.8 °C, respectively, where as the corresponding ranges for afternoon observation were 27.4-48.3 °C, 27.2-42.2 °C and 26.9 -38.8 °C.

### Mean monthly weather parameters recorded at ICAR-CCARI from April, 2014 to March, 2015.

Parameter	Months											
	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar
Mean max temp (°C)	35.7	35.4	33.9	29.5	29.5	31.0	33.3	34.3	33.5	33.3	34.7	34.4
Mean min temp (°C)	24.6	24.9	25.6	23.2	23.4	23.6	23.5	21.6	20.9	18.4	19.5	22.7
Mean morning R.H. (%)	87.6	86.6	93.7	94.6	96.0	96.3	93.5	85.5	79.5	84.2	87.7	83.2
Mean afternoon R.H. (%)	51.7	56.8	73.1	87.8	83.3	75.4	64.8	45.9	42.4	35.9	36.7	53.5
Mean wind speed (km/hr)	3.9	4.7	5.0	5.5	4.2	3.9	2.9	3.2	3.9	3.7	4.2	4.2
Sunshine (hr/day)	7.0	7.9	5.2	1.6	2.5	3.9	5.9	7.9	7.6	7.4	9.6	7.4
Total rain (mm)	4.8	144.6	406.1	1129.6	1052.9	246.8	257.6	5.4	383.0	0.0	0.0	46.8
Total rainy days	1	6	19	31	26	24	9	1	2	0	0	2
Evaporation (mm/day)	5.1	5.1	4.2	3.1	3.4	3.5	3.4	3.5	3.6	3.5	4.6	4.4
Cloudiness morning (hrs)	3.0	2.8	4.8	5.0	5.0	4.5	3.4	3.0	3.3	2.4	1.6	4.5
Cloudiness afternoon (hrs)	1.8	2.9	4.7	5.0	4.8	4.3	3.6	2.2	1.6	1.3	0.8	1.3

### Important dates of observations during April, 2014 to March, 2015 with highest and lowest values of weather parameter

Particular of weather parameter	Value	Date
Highest maximum temperature	38.3 °C	20/04/2014
Lowest minimum temperature	15.3 °C	13/01/2015
Highest rainfall	162.4 mm	29/08/2014
Highest evaporation	6.4 mm	04/09/2014
Highest wind speed	10.4 km/hr	11/06/2014
Maximum sunshine hours	11.5 hr	15/05/2014

# **ICAR - CCARI, Goa**

**Annual Report 2014-2015**

## **RESEARCH ACHIEVEMENTS**

- ❖ **Natural Resource Management**
- ❖ **Crop Science**
- ❖ **Horticultural Science**
- ❖ **Animal Science**
- ❖ **Fisheries Science**
- ❖ **AICRP Main Centres**
- ❖ **AICRP Voluntary Centres**
- ❖ **Externally Funded Projects**



## Natural Resource Management

**Project: Development and evaluation of soil and water conservation measures and land use systems for sustainable production of major horticultural crops in Goa. (PI: G. R. Mahajan)**

### Soil and water conservation studies in cashew

#### Carbon sequestration and microbial activity

Observations on 13 year old soil and water conservation experiments on cashew were recorded to study the effect of the different soil and water conservation experiments on soil fertility, microbial and enzyme activity and carbon sequestration at different depths. The physical structures are in field while the live barriers are not present currently. After 13 years, the Continuous contour trench + *Stylosanthes scabra* + *Glyricidia maculate* (CCT+SC+VB) in the 6×6 m spaced cashew could sequester the highest amount of carbon of 5.78 Mg ha<sup>-1</sup> up to 0-0.90 m depth. The carbon sequestration was highest (6.51 Mg ha<sup>-1</sup>) in the top 0-0.3 m depth. In closely spaced (4×4 m) cashew experiment, the Continuous contour trench + *Stylosanthes scabra* + *Vetiveria zizanoides* (CCT+SC+VB) sequestered 6.59 Mg ha<sup>-1</sup> carbon up to 0-0.90 m depth. This indicates a tremendous scope of using the soil and water conservation measures to capture the atmospheric carbon into soil. Besides carbon sequestration, CCT+SC+VB in the 6×6 m and the 4×4 m spaced cashew recorded highest soil microbial biomass carbon of 33.9 and 39.2 µg g<sup>-1</sup> soil. This explains the positive effect of the soil and water conservation measures on the microbial activity.

### Soil and water conservation studies in coconut and mango

#### Run-off, soil, soil organic carbon and nutrient loss

In the mango crop, Continuous contour trench + vegetative barrier (*Vetiveria zizanoides*) (CCT+VB), Staggered contour trench vegetative barrier (*Vetiveria zizanoides*) (SCT+VB) and vegetative barrier (*Vetiveria zizanoides*) (VB) reduced the runoff loss by 44.8%, 32.7% and

16.1% and soil loss by 84.1%, 72.5% and 33.4% over control, respectively. The efficiency of the different soil and water conservation measures to arrest the soil and water erosion under coconut was observed as: circular trenching > Circular terraces > Control. In control 534 and 501 kg ha<sup>-1</sup> soil organic carbon eroded along with the soils in mango and coconut, respectively. The most effective SWC measures in mango and coconut were CCT+VB and Circular trenching which allowed erosion of only 74.2 and 64.8 kg ha<sup>-1</sup> soil organic carbon. The order of total soil nitrogen, phosphorus and potassium loss was noticed as - Mango: CCT+VB > SCT+VB > VB > Control and coconut: circular trenching > Circular terraces > Control.



Continuous contour trenching in cashew

### Plant growth parameters

Different plant growth parameters – collar girth, leaf bearing portion, height, number of leaflets on one side, leaf length, leaf width and total number of leaves differed significantly in order as: circular trenching > circular terraces > control in coconut.

## Crop Science

### Project : Breeding high yielding salt tolerant rice varieties for coastal saline soils (PI: Manohara K. K.)

This project aims at the development, evaluation and dissemination of high yielding salt tolerant rice genotypes for coastal saline soils of Goa and adjoining regions.

#### Registration of Korgut, with NBPGR (INGR 14055; IC0599689).

Korgut, a traditional rice landrace of Goa, has been registered as unique germplasm, for tolerance to salinity stress at seedling stage, with the National Bureau of Plant Genetic Resources (NBPGR), New Delhi. It has assigned the national identity number INGR14055.

Phenotyping for salt stress tolerance at seedling stage under artificial screening condition using hydroponics culture with  $EC = 12 \text{ dSm}^{-1}$ , showed its tolerance (SES score 3) to salinity stress at seedling stage.

The tolerance of korgut was associated with low ratio of  $\text{Na}^+/\text{K}^+$  (0.18) in shoot as compared to susceptible check variety IR-29 (0.68). In addition, the evaluation of korgut for yield and its contributing characters, under natural coastal salinity conditions in Goa at farmers' field, for past four years confirmed its adaptation to coastal saline soil.

Korgut is a medium duration (120 – 125 days), tall growing (145 cm) rice germplasm, having bold sized grains (3.26 gm per 100 seed). It can be used as a genetic stock for future breeding programmes aiming at development of salt tolerant rice varieties for coastal saline areas.

#### Evaluation of selections from Korgut under coastal salinity conditions

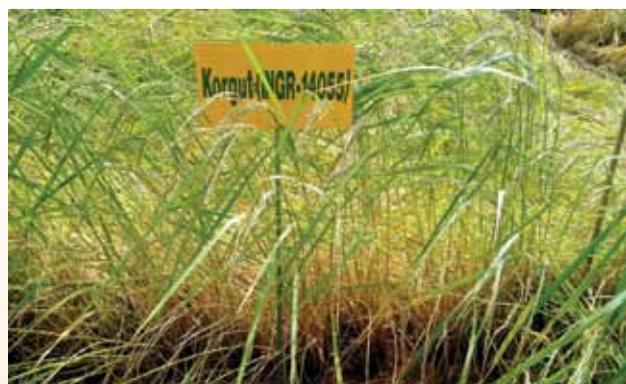
The variability present in Korgut landrace was exploited through pure line breeding approach to derive promising selections.

Six promising lines, resulted from five cycles of selection, were evaluated under natural coastal salinity conditions in farmer's field at chorao Island along with the original bulk Korgut.

Data were recorded on all yield and its contributing characters. Among the six selections tested, KS-17 recorded highest grain yield followed by KS-17, KS-4 and KS-16-1.

#### Performance of traditional rice landraces under coastal salinity (stress) and normal conditions (non stress)

Seventeen landraces along with check variety CST 7-1 (National check variety for coastal salinity condition) were included in the present



*Korgut (INGR-14055)*



*Red kernelled coarse grain type with long awns*

**Mean performance of selections from korgut under coastal salinity condition (farmers field)**

Genotypes	DM	PHT	NPT	GY
KS-17	134.0	149.9	4.7	1837
KS-4	135.7	149.7	4.1	1820
KS-16-1	133.0	163.8	3.3	1577
KS-12	144.0	110.3	4.7	1376
KS-19-2	133.7	162.1	4.5	1099
KS-2	153.3	115.7	4.5	1025
Korgut (check)	127.7	115.8	6.8	599
Mean	137.33	138.19	4.66	1333.33
SE	3.22	4.23	0.63	250.32
CD @ 5%	7.02	9.21	1.39	545.40
CV (%)	2.87	3.75	16.77	22.99

**DM-** Days to maturity

**NPT-** No. of productive tillers per hill

**PHT-** Plant height (cm)

**GY-** Grain yield (kg/ha)



*KS – 17 (a red kernel selection)*



*KS – 12 (a white kernel selection)*

investigation to assess their performance under stress and non-stress condition. The trial was laid out in randomized complete block design with three replications in both the condition.

Under stress condition, Check variety CST 7-1 recorded highest grain yield of 2331 kg/ha. Among the landraces tested, top five entries with respect to grain yield are Saalsi (1666 kg/ha) followed by Patni-1 (1630 kg/ha), Walayo (1577 kg/ha), Korgut (1553 kg/ha) and Shidde (1488 kg/ha).

Among the genotypes tested under non stress condition, at the institute farm, genotype Panyo recorded highest grain yield (5550 kg/ha). Second highest was CST 7-1 which recorded 5250 kg/

ha. The top five entries under normal conditions are Panyo, Kalabelo, Walayo, Xitto, Saalsi which recorded grain yield of 5550 kg/ha, 5250 kg/ha, 4773.33 kg/ha, 4330 kg/ha, 4276 kg/ha and 4230 kg/ha, respectively.

Comparison of performance of landraces under both stress and normal conditions revealed that, only Saalsi and Walayo, remained among the top five entries in both the condition along with the check variety CST 7-1. This indicated that these genotypes can perform better under salinity stress situation.

**Mean performances of top five entries of landraces under stress condition (farmers field)**

Genotypes	DM	PHT (cm)	NPT	GY (kg/ha)
CST 7-1 (Check)	158.33	113.60	5.50	2331
Saalsi	149.33	134.40	5.20	1666
Patni-1	113.67	136.60	4.83	1630
Walayo	135.67	142.93	5.40	1577
Korgut	131.33	118.93	6.67	1553
Shidde	139.33	150.93	3.73	1488
Mean	132.69	139.34	5.13	1327.83
SE	3.40	7.18	0.74	327.39
CD @ 5%	6.91	14.60	1.51	665.33
CV (%)	3.14	6.31	17.76	30.20

**DM-** Days to maturity

**NPT-** No. of productive tillers per hill

**PHT-** Plant height (cm)

**GY-** Grain yield (kg/ha)

**The performances of top five entries of landraces under non-stress condition (Institute farm)**

Variety	DM	PHT (cm)	PT/hill	GY (kg/ha)
Panyo	128.00	164.67	6.33	5550
CST 7-1 (Check)	135.67	138.07	8.25	5250
kalabelo	123.67	175.80	6.73	4773
Walayo	134.00	199.53	6.07	4330
Xitto	128.00	176.80	7.67	4276
Saalsi	136.00	178.47	7.07	4230
Mean	125.31	175.80	6.65	3702.41
SE	0.73	23.86	1.18	707.45
CD @ 5%	1.49	48.48	2.39	1437.72
CV (%)	0.72	16.62	21.64	23.40

**DM-** Days to maturity

**NPT-** No. of productive tillers per hill

**PHT-** Plant height (cm)

**GY-** Grain yield (kg/ha)

**Development of promising advanced breeding lines and mapping populations through hybridization and generation advancement**

**Hybridization**

During *kharif* season of 2014-15, new crosses were attempted using high yielding popular varieties *viz.*, Karjat-3, Naveen, Pusa-44, Chandan, MTU-1001, MTU-1010 and Jyothi with the salinity tolerant donors *viz.*, KS-17, KS-19-

2, KS-16-1, KS-4 (selections from Korgut) and Shidde. About 47 crosses were produced using above parental combinations.  $F_1$ s were raised during *Rabi* season along with the respective parents. True  $F_1$ s were identified on the basis of morphological characters and their seeds were collected for advancing to next generations.



Crossing in rice



Rice hybridization facility

### Seed multiplication of promising salt tolerant rice cultures

Promising cultures IR87848-301-2-1-3-B and IR87848-301-2-1-1-B were developed and identified from the salinity breeding programme of the institute, were multiplied during *Rabi* season 2014-15. The entries will be tested under multi location trials in Goa and in coastal salinity tolerant variety trial of AICRP on rice.



IR87848-301-2-1-3-B - Promising high yielding line



IR87848-301-2-1-1-B - Promising high yielding line

### Generation advancement

275 segregants from the cross Jyothi x Korgut were advanced to  $F_4$  and  $F_5$  generations during *Kharif* and *Rabi* season of 2014-15, respectively, for developing them into Recombinant Inbred Lines (RILs).



Seed multiplication in promising salt tolerant cultures

**Project : Insect pest management strategies for major crops of Goa region  
(PI: Maruthadurai R.)**

**Screening of cashew varieties and hybrids against tea mosquito bug**

Screening of the cashew varieties and hybrids against tea mosquito bug were carried out and the infestation was recorded from first week of December 2014 to last week of February 2015. Both shoot and panicle damage was recorded and damage score was assigned based on 0-4 scale (Score : Grade 0 = no damage, 1 = 1-3 necrotic lesions, 2 = 4-6 coalescing lesions, 3 = > 6 coalescing lesions and 4 = complete drying).

Field screening revealed that varieties such as DHV-1, Balli-1, RL-2, and Balli-2 showed least shoot and panicle damage scores (0.55, 0.67, 0.9, 1.03 and 0.35, 0.42, 0.52 and 0.87 respectively). The varieties Tudal -3, BKL2 and Tiswadi-3 had higher shoot and panicle damage scores (3.27, 2.75, 2.32 and 1.93, 1.58 and 1.97 respectively).

Among hybrids, entries such as HB-26, HB 12/05 and HB 11/05 showed least shoot and panicle damage scores (0.25, 0.92, 0.95 and 0.15, 0.75, 1.05 respectively). The hybrids HB 5/05, HB-30 and HB 23 had higher shoot and panicle damage scores (3.07, 3.05, 2.80 and 1.42, 1.40 and 1.75 respectively).

**Augmentation of Red ant (*Oecophylla smaragdina*) for managing tea mosquito bugs**

Tea mosquito bugs *Helopeltis* spp (Hemiptera: Miridae) are very serious pest on cashew and causes damage to an extent of 30-40% yield loss. Red ant or Weaver ant, *Oecophylla smaragdina* (Fabricius) (Hymenoptera: Formicidae) is a potential biological control agent for tea mosquito bug (TMB). An experiment was carried out to manage TMB in cashew through augmentative use of red ants. Predatory ant nest colonies (75 Number) were brought from distant tree and introduced in cashew trees. Thirty per cent of the plants were colonized by red ants. The results revealed that the damage score of 0.8 to 1.2 was recorded in trees colonised by red ants whereas maximum damage score of 2.98 to 4 was recorded



*Established predatory ant nest*

in trees without red ants. Tea mosquito bug adult and nymph population was significantly lower in plants colonised by red ants. Other polyphagous predators *viz* spiders, reduviids, preying mantids and coccinellids populations were significantly higher in ant colonised trees whereas no predatory population were observed in insecticide sprayed trees.



*Predatory ants protecting nuts*

**Management of cashew stem and root borers with newer insecticides**

Three insecticides namely Imidacloprid, Fipronil and Thiamethoxam were screened for the management of CSRB through microinjection. Scoring of trees was given based on the severity of infestation. Concentration of above said insecticides was at 3 ml/ litre of water. The insecticides were injected on the infested trees through syringe. Results revealed that 58% of treated trees got recovered under microinjection method.

### Bionomics of invasive mealybug *Phenacoccus solenopsis* on cashew

The invasive mealybugs *P. solenopsis* were cultured at 25–30°C and 70–75% R.H. Tender leaves and twigs of cashew were fed to mealybugs in petri plates on daily basis. The pre oviposition, oviposition and post oviposition period were 4.02 days 10.84 days and 2.14 days, respectively and the total nymphal development period ranged from 23–29 days with an average of 25.20 days. Fecundity varied from 142–217 young ones/ female. The endoparasitoid *Aenasius bambawalei* Hayat (Hymenoptera:Encyrtidae) was also recorded from mummies of *P. solenopsis*. Parasitoid *A. bambawalei* adults are blackish in color, females having a shiny blackish body with large thimble-like setigerous punctures on the head. Parasitization (6.31% to 35.52%) of *P. solenopsis* by *A. bambawalei* was recorded in cashew.



Aphids on under surface of leaf



Aphids infested nuts

### Infestation & seasonal occurrence of Cashew aphid *Toxoptera odinae*

Infestation and unusual occurrence of aphid *T. odinae* was observed on cashew plantations. The population of aphids and its natural enemies were counted on weekly basis. Seasonal occurrence was first week of January to fortnight of March, 2015. Initially the aphid population was noticed on young growing shoots and undersides of young leaves and later migrated to floral parts and nuts. The observations revealed that minimum population of (84.44 aphids/leaf) was recorded during third week of January and maximum population of (203.06 aphids/ nut) was recorded during second week of February, 2015.



Mealy bug infestation

Thereafter, the aphid populations were decreased due to significant predator activity. Three species of coccinellids and three species of syrphids were found predated on aphids. The aphidophagous predators comprising of coccinellids and syrphids were quite effective in managing *T. odinae* in cashew plantations under natural conditions.

### Influence of border crops and food baits on management of cucurbit fruit fly *Bactrocera cucurbitae*

An experiment was conducted to study the effect border crops and food baits on the incidence of cucurbit fruit fly *B. cucurbitae* on cucumber. The local variety cucumber was sown as main crop. The roosting crops viz., maize, castor, sorghum and fodder grass (Co-3) was sown as border crops two weeks before the main crop. Simultaneously, control plot was maintained without border crops and food baits. Locally made food baits containing jaggery + 50 ml of nimbizidine was sprayed weekly on the border crops. Treatments were maize + food baits spray ( $T_1$ ), castor + food baits

spray (T<sub>2</sub>), sorghum + food baits spray (T<sub>3</sub>), Co-3 fodder grass + food baits spray (T<sub>4</sub>) and control (T<sub>5</sub>). Percentage of fruit fly infestation and yield was recorded on every harvest. Results revealed that, least percentage of fruit fly infestation (16.38) was recorded in T<sub>2</sub> (castor + food baits spray) followed by in T<sub>1</sub> (19.14) (maize + food baits spray) whereas highest percentage of fruit fly infestation (32.44) was recorded in control (T<sub>5</sub>).

### Management of sweet potato weevil *Cylas formicarius*

Sweet potato is an important crop in rice based cropping system. It is heavily infested by the sweet potato weevil *Cylas formicarius*. A field trial of sweet potato variety (local white) was undertaken with seven insecticidal treatments.

Insecticidal applications were made at two stages of growth *viz.*, (i) at planting, by dipping plant cuttings in insecticides solution *viz.*, T<sub>1</sub> (lambda cyhalothrin, 0.005%), T<sub>2</sub> (Imidacloprid, 0.009%) and T<sub>3</sub> (Fipronil, 0.002%) for 30 minutes before plantings. Spraying of above said insecticides was done at 45 DAP. Analysis of data revealed that, least percentage of infested tubers (8.26) was recorded in T<sub>3</sub> under vine dippings whereas maximum percentage of infested tubers (16.3) was recorded in control. In case of vine dipping followed by spraying, the least percentage of infested tubers (2.25) was recorded in fipronil (T<sub>6</sub>+T<sub>3</sub>) as against control (16.3). Maximum percentage of marketable tubers and yield was also recorded in vine dipping followed by spraying at 45 DAP.

### Record of other insect pests and natural enemies in cashew and other ecosystem

S. No	Common name	Scientific name	Crop	Pest/natural enemies
1	Red banded thrips	<i>Selenothrips rubrocinctus</i>	cashew	Pest
2	Leaf beetle	<i>Monolepta longitarsus</i>	cashew	Pest
3	Hairy caterpillar	<i>Metanastria hyrtaca</i>	cashew	Pest
4	Pentatomid bug	<i>Erthesina fullo</i>	cashew	Pest
5	Gundhi bug	<i>Leptocorisa acuta</i>	Cashew	Pest
6	Green lacewing	<i>Crysoperla spp</i>	cashew	Predator
7	Reduviid bug	<i>Isyndus heros</i>	cashew	Predator
8	Pentatomid bug	<i>Udonga montana</i>	forest trees	Pest

**Project : Plant disease management by bacterial, fungal agents and other non-conventional methods under coastal ecosystem**  
(PI: R. Ramesh)

**Field evaluation of integrated strategies for the management of black pepper foot rot**

Treatments for the integrated management of foot rot in black pepper were laid out. The treatments include soil drenching with copper oxychloride/ metalaxyl mancozeb, foliar spray with Bordeaux mixture/ metalaxyl mancozeb, soil application of phorate/ carbosulfan independently or in combination with talc formulation of *Trichoderma harzianum*, *T. viride*, *Pochonia clamydosporia* and capsule formulation of *Trichoderma harzianum*. Organic manure/ FYM were applied to the treatments where bio-agents were included. The application of bio-agents was repeated in the second year.

Results of the field experiment conducted at Torla, Shiroda indicated that plants treated with talc formulation of biocontrol agent (*Trichoderma* sp) protected the black pepper plants from foot rot for almost 18 months. None of plants died due to foot rot in the treatments, whereas in non-treated plants showed complete mortality. It is observed that the biocontrol treatments improved plant growth which is evident from the increased plant height (146-165 cm) and number of fruiting branches (6.0-7.7).

**Demonstrations**

In an existing plantation (app. 8-9 yrs) one demonstration was taken up with the drenching of Carbosulfan as symptom of slow wilt was observed. Carbosulfan application was followed by drenching with Copper oxychloride. However, most of the plants died due to foot rot and slow wilt. In a second demonstration, 50 existing plants in a plot where symptoms of foot rot was observed were treated with capsule formulation of *Trichoderma harzianum* and another 50 plants were treated with talc formulation of *Trichoderma*. Almost 90% black pepper plants have died within 3-4 months in both the treatments.



Application of talc formulation of *Trichoderma*

One more experiment with talc formulation of bio-agents (*Trichoderma* sp., and *Bacillus* sp) was laid out in Netrawali. The treatments were applied while planting during September 2015. The plants are being monitored for the incidence of foot rot regularly.



Black pepper plants treated with biocontrol agents (12 months old)

**Evaluation of unconventional methods for the management of bacterial wilt in brinjal**

**Grafting of cultivated brinjal on wild brinjal**

Locally preferred brinjal cultivars, *Agassaim* and *Taleigao* are highly susceptible to bacterial wilt and a wild relative of cultivated brinjal is identified as resistant to this disease. Seedlings of the wild type and cultivated species were raised and the susceptible plants were grafted on the wild types. The resulting



**No bacterial wilt in the grafts**



**Bacterial wilt in the seedlings**

grafts were hardened. Successful grafts were planted in the field which produced fruits of the *Agassaim* and *Taleigao* type. Consumer preference for the fruits from grafts is similar to the fruits from the seedling type. As grafting of cultivated brinjal on wild type controlled bacterial wilt, grafting technique was standardized. 45-60 days old wild type and 30-35 days old cultivated types were used for grafting. Success of grafting was 72-78 %.

Grafts are planted in the field and were evaluated for wilt management. Two field evaluation trials were completed and third trial is in progress. Zero mortality was recorded in the trial 1, where *Agassaim* and 3 lines (5\_1\_16, 49\_1\_1 and 36\_1-5) from segregating population were used in the experiment. Mean number of fruits per plant ranged from 6.5-7.0 from almost 10 harvests. Yield per plant is also higher in *Agassaim* grafts (1.55 kg) compared to the seedlings. In trial 2, grafts and seedlings of *Agassaim* and *Taleigao* were planted alternatively in the field where bacterial wilt incidence is common. Two lines (1\_1\_26 and 47\_1-22) from segregating population were also planted in the experiment. No other plant protection treatment was given. Wilt incidence was recorded regularly. None of the grafted plants died during the entire crop period. However, 48% and 76% wilt was recorded in *Agassaim* and *Taleigao* seedlings. Grafts were also distributed to many farmers as part of demonstration.

#### **Application of lime to the soil and its effect on bacterial wilt incidence in brinjal**

Six levels of lime (@2, 4, 6, 10, 12 and 20 t/ha) was applied to the experimental soil and the experiment was conducted under greenhouse

condition. Bacterial wilt susceptible *Agassaim* plants were planted in the experiment and were treated first with antagonistic bacteria (K1 and EC13) (@10 ml/ plant; 8.0-9.0 Log CFU mL<sup>-1</sup>) and 15 days later inoculated with *R. solanacearum* (@10 ml/ plant; 10.0 Log CFU mL<sup>-1</sup>). Incidence of bacterial wilt was recorded regularly. Results indicated that bacterial wilt incidence reduced at 10 and 20 t/ha applied treatments irrespective of antagonist treatment. Analysis of soil pH during the experimental time indicated that the soil pH of above 6.4 where the lime application was 10 and 20 t/ha. It indicates soil pH may play a role in the incidence and its manipulation would help in containing the bacterial wilt incidence.

#### **Study on the etiology of mortality of papaya**

All the papaya plants showed PRSV infection and the symptoms vary from mild to severe. Other forms of infection as reported in the previous year were not observed during this year.

#### **Production of talc formulation of biocontrol agents**

Talc based formulation of *Trichoderma* was produced and was used in various experiments and field trials of the Institute. Some of the experiments where the products used are black pepper foot rot, papaya evaluation and etc. over 110 kg of the talc formulation of *Trichoderma* was produced and used in field experiments as well as distributed to various sections in the Institute. Bacterial antagonists (EB69 and RP7) was produced and given to the farming system experiment to treat the brinjal crop for bacterial wilt management.

## Horticultural Science

### Project : Allele mining of banana genome sequences for genetic improvement (PI: V. Arunachalam)

Productivity of banana in coastal regions of India is half or one-third when compared to national average of India. Wind stress and salinity are two major problems in coastal locations. Short statured plants are able to withstand moderate wind stress. Salt tolerant genotypes are identified using physiological tests elsewhere. Banana is often grown as inter/mixed crop in coconut and arecanut gardens in coastal zone. The current objective of the project is to mine the genome sequence information to develop reliable markers associated with salinity tolerance and short stature. Published SCAR markers derived from OPJ04 RAPD associated with dwarf stature was validated in ten individual banana plants.



*Dwarf plant of Robusta banana*

Published marker OPA-02-240 associated with salt resistance in banana was mined in whole genome sequence of *Musa acuminata* and expressed sequence tags of banana using marker express 2.0 and banana genome hub. Two locations, one at chr3:18,709,636 to 18,710,108 and another at chr7:17,969,872 to 17,970,338 matched with predicted band. The later one at Chr 7 matched with a domain of carbon catabolite repressor protein on blast search using banana genome hub web server. The SCAR primers hence can prove a good candidate for validation in wet lab PCR experiments. Two in silico SCAR markers

were designed. PCR amplification was optimized for the two SCAR primer pairs with genomic DNA samples of five banana individuals. One Mb genomic region spanning Chr5:13154102 to 14154101 in *M. acuminata* genome where OPA02 priming sites were found was mined for simple sequence repeats using MISA perl script. A total of 167 SSRs were identified in the region, of which 45 were compound SSRs. 75 monomeric, 78 dimeric, 10 trimeric, 3 tetrameric and one hexameric repeats were found in the region. Physiological performance of banana varieties grown in the interspaces of coconut gardens was evaluated using photosynthetic rate and stomatal conductance. Morphological description of the banana varieties in the interspaces was carried out.

### Gentic Resources

#### Amaranthus

Nine accessions of *Amaranthus tricolor* collected from Goa were conserved in National Gene Bank New Delhi along with assigned IC numbers IC 0611598 to 0611606.

#### Chilli

An accession (IC 0611608) of chilli from Balli village of Goa was collected and planted for multiplication. One chilli accession with white immature fruit color was collected and confirmed by field planting and progeny data. The accession was deposited at NBPGR, New Delhi with IC No. 0611607. White immature fruit color in chilli was confirmed by open pollinated progenies in two seasons. Morphological characters of the leaf, flower and fruit of white immature fruited chilli (IC 0611607) and the green immature fruited one (IC 0611608) was compared. Third chilli accession (IC 0610165) collected from Gaondongri village, Canacona Taluka of Goa was conserved at NBPGR, New Delhi.



(leaves and petiole)  
White colored (IC 0611607) immature fruits in chilli and normal green immature fruited type



(immature and mature fruits)

## Genomic resources

Published random molecular markers for genetic diversity/ linkage analysis need to be converted to precise SCAR markers to increase the effectiveness and ensure repeatability. Based on 32 published reports and our database [www.bioinfoindia.org/fv-iscardb](http://www.bioinfoindia.org/fv-iscardb), major markers for diversity, dwarfness, salinity tolerance, disease resistance and other desirable traits were predicted.

## Coconut

Coconut is an important plantation crop of Goa next only to cashew. Calangute, Benaulim and Nadora are the major coconut populations native to Goa. Benaulim variety has unique traits of tasteful kernel and unique 'V' shape canopy. Benaulim, the land race of coconut from Goa possess the firm tepals and fruits that prevent eriophyid mite entry. The variety possesses fruits

and tepals with high penetrometer reading values than Chowghat Orange Dwarf and Malayan Yellow Dwarf. It has been submitted for registration with NBPGR New Delhi as a genetic stock. Tender coconuts of the plant of the Benaulim pani were harvested at 6, 7 and 8 months of maturity where the volume of the water was 300, 280 and 250 ml/nut respectively. TSS of the water was 6.86, 6.66 and 7.36 degree brix in 6,7 and 8 months old nuts. Sodium content was 22 to 23 ppm and potassium content ranged from 1267 to 1366 mg/l. Organoleptic test revealed the taste of the water with very good score. Annual yield ranged from 67-74 nuts/palm. Fruit component analysis of mature nuts revealed that it contains water of 160 ml/nut with 6.53° brix. Copra weight and dry weight of the fruits was 266 and 194 g/nut respectively. Open pollinated nuts were harvested from the selected single palm and the nursery is raised to develop a block of the selection.



Goa Benaulim Pani – a tender nut selection

OPE18 RAPD primer associated with eriophyid mite resistance in coconut was analyzed for developing SCAR marker based on sequencing of band and available sequences in public domain. Blast results of OPE18 amplicon matched with a gag-pol protein.

## Coconut based cropping systems

An experiment was laid out in coconut garden with kokum, jackfruit, champa, karonda, lemon, aonla, rambutan and cashew. Details of the growth performance of selected perennial intercrops in the system are studied. Papaya

cultivar Arka Prabhat performed well under the coconut shade. A cross involving Arka Prabhat and Pusa Nanha was made. Four progenies from the cross were planted and monitored. One of them was early flowering male. Pollen from this plant was used to make BC1 (back-cross) with Arka Prabhat. Banana varieties Velchi, Saldatti, Amti, Rasbali, Red Poovan, Myndoli were planted and evaluated in coconut shade. Amti variety of banana gave high yield (14 Kg/bunch) under coconut shade.

## Pepper

A block of Panniyur-5 black pepper plants were established with glycidia support in coconut garden in 2011. Some of these pepper plants are performing well and many of them died.

## Arecanut

A local selection from Khandola village with excellent fruit quality was compared with improved arecanut variety Mangala for the fruit and seed traits. The shell thickness (cm), seed length (cm), seed thickness (cm) and firmness (lb/sq. inch) were recorded as 0.31, 2.35, 2.14 and 10.4 for the local selection whereas Mangala recorded 0.68, 2.58, 1.45 and 8.3, respectively.

## Areca based cropping systems

Three black pepper lines (Panniyur-5, collections from Ponda (Goa) and Vengurla), a betel vine accession and *Piper colubrinum* were planted in arecanut support. Border of the block is planted with noni and crossandra.



*Cross section of Aracanut fruit*

## Dwarf areca

About 196 open pollinated progenies of six dwarf arecanut palms were planted at high density for evaluation.



*Segregating progenies of dwarf arecanut*

**Project: Collection, evaluation and management of fruit and spices germplasm**  
(PI: A.R.Desai)

**Conservation of mango germplasm**

A total of 123 accessions / varieties of mango collection is being maintained in field germplasm block, of which, 87 are of local varieties, 15 are introduced hybrids, 12 are introduced varieties and 9 are variants of local Mankurad type. Besides this, another set of 18 Mankurad variants is also being evaluated in the field. Two wild relatives of mango namely, *Mangifera camptosperma* and *M. griffithi* are also maintained.

In addition, eight different types of mankurad were also identified and their fruit quality parameters were studied. The fruit weight varied from 178 g in Dauji – Mkd-2 to 298 g in Mkd Achut and fruit pulp content (%) ranged from 61.2 to 67.4 in Mkd Achut. Aldona -4 recorded less fibre content of Fruits of Mankurad accessions namely MKD Achut-1, MKD Kudjo-1, MKD Daji-2, MKD Kini, MKD Mandrekar and Hilario-Dauji recorded higher total soluble contents of more than 20° B. Nicolau Affonsa local variety was also located in Dauji. These accessions were clonally propagated and added to Institute germplasm collection.

A very early flowering type of Mankurad was located, whose matured fruits were harvested as early as in the month of November. The average fruit weight was 264g, TSS 17° B with 71.12 % of pulp and 0.25 % of total acids.



*Mankurad*

**Performance of mango hybrids**

Mango hybrids developed at other research centres were introduced for evaluating their performance under coastal agro-climatic conditions of Goa. All mango hybrids showed regular bearing habit with time of bearing varying from mid season (March – April) to late (May–June). Growth of Arka Aruna hybrid was observed to be dwarf stratured while that of Amrapali was observed to be vigorous under Goa conditions, unlike its original dwarf and semi vigorous nature.

Mango hybrids varied with respect to physico-chemical characteristics. Fruit size was observed to be bigger with average fruit weight of 412g in Arka Aruna, while it was small in HB-151 (246g) with 78.9 and 62.4 per cent pulp contents respectively.



*Hilario- Dauji in cluster bearing*



*Bearing of Nicolau Affonsa and matured fruits*



The highest fruit yield of 42.6 kg/tree was recorded in Amrapali with mean fruit size of about 311g and excellent fruit quality. The fruits matured late in the month of May and were susceptible to fruit fly if not managed. K x B was the second highest yielder with 37.4 kg of fruit yield per tree with excellent keeping quality of the fruits though fruits matured late. HB-56 though yielded better, the fruit quality was poor, while HB-87 recorded fruit yield of 30.8 kg per tree with medium sized fruits of good quality having acceptable sugar acid blend. Arka Anmol also recorded a high yielder with uniform fruit size and attractive yellow colour, fruits had slightly higher total acids which may not be liked by the Indian consumers for table purpose. Arka puneet, a medium yielder (26.6 kg/tree) had the excellent fruit quality with attractive skin colour having red blush on the shoulders. The highest Total soluble solids of 24.2<sup>o</sup> B was recorded in Arka Aruna followed by 23.4 and 22.4<sup>o</sup> B in Amrapali and HB-87 respectively. Total acids varied from 0.09 (Arka Aruna) to 0.42 % (Arka Anmol). In general Ratna and Amarapali recorded medium sized fruits with sweet (TSS 22.2 – 23.4<sup>o</sup> B) orange coloured pulp contents of more than 70 per cent.

### Evaluation of Mankurad variants

Eighteen Mankurad accessions are under evaluation. Nine accessions came to flowering first time in 2014 and observation on yield and fruit quality is under progress.



First year bearing of Mankurad genotype (2/1)

### High density planting of Guava

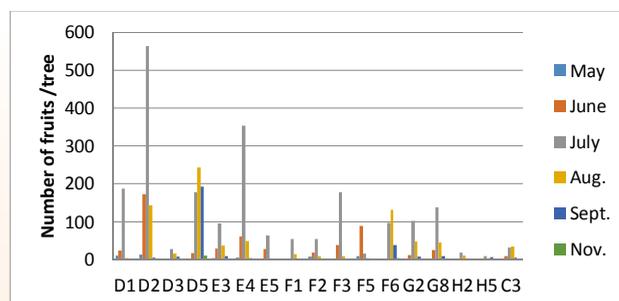
Two high density plots, each with varieties, namely, Shweta (White flesh) and Lalit (Pink flesh) were established. One year old grafts were planted at a spacing of 2m X 2m to accommodate 2500 grafts per hectare. Suvarna, Suguna, Sudarshan, Alleppey Supreme varieties of turmeric and Varada, Garo local and Himachal varieties of ginger were inter cropped in the interspace available in the initial period.



High density planting in Guava

### Nutmeg genetic resources and their characterization

Fruiting period among the genotypes scattered from 3.0 months (NMC2) to 5.5 months (NMD1, NMD2 and NMD5). Major harvesting period for all the genotypes except NMD5 and NMF6 (for which fruit yield was higher in August) was observed to be July. The fruit yield in terms of number of fruits per tree was observed to be the highest (897 fruits /tree) in NMD2 followed by NMD5 (639 fruits/tree) and NME4 (473 no / tree).



Nutmeg fruit yield distribution from different genotypes



*Nutmeg genotypes*

By and large, the fruit maturity was observed to be maximum during the month of July in all the genotypes, followed by May and June months. NMF5 conspicuously recorded the maximum fruit maturity right in the month of April, while, the genotypes namely, NMD1, NMD2, NME4 and NMF2 recorded considerable fruit maturity in the month of May which was easy for drying as it did not coincide with rainy season.

A high yielding new local genotype “Tamsuli-2 was located in Tamsuli farm. The tree is young, 8-10 years of age. Fruits are round with bolder seed nut and mace covering the seed completely to yield higher mace yield per fruit. In general, the selection is showing higher number of fruits per tree.



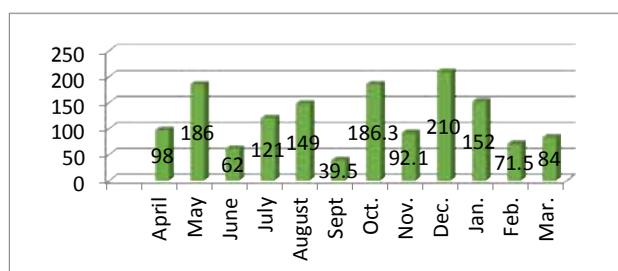
*Tamsuli-2 – high yielding local genotype of nutmeg*

### Coconut based multi-species cropping system

This cropping system model comprises of coconut as main crop and intercrops like nutmeg trees, various multi-species namely, banana

(local varieties: Saldattim, Savorbonim, Velchi, Myndolim, Sakri, Nendran Red banana, Rasa Bale and Paccha Bale), black pepper (Paniyur-1, Karimunda, Sreekara, Subhkara) and Nutmeg varieties (Konkan Swad and Vishvashree), betel leaf, elephant foot yam, Drumstick and papaya in the border line. Bee hive colonies were also introduced.

Coconut based multiple species farming system yielded 3913 nuts of coconut, 1303 kg of banana hands, 3826 number of nutmeg fruits which yielded 2.5 kg of nutmeg nuts and 0.45 kg of mace on dry weight basis, from the total area of 5103 m<sup>2</sup> of the system. Banana fruit yield was available round the year which would fetch continuous income from the system.



*Flow of banana yield (kg) round the year (2014-15) from the system*



*Bunches of Sakri and Saldatti varieties of local banana harvested from the coconut based cropping system*

### Value addition in nutmeg

On fresh weight, nutmeg fruit comprises of about 80 percent of pericarp (rind) biomass, only the remaining 20 per cent being the economic spice products like nutmeg seed and mace *i.e.*, aril



*Nutmeg rind mouth refreshner*



*Betel leaves harvested from coconut based multispecies cropping system*

covering the seed. Such huge pericarp biomass, being 5-6 times more than that of economic spice products, is mostly left behind in the field for rotting, although the pericarp also has spicy flavor and contents. This can be converted into a number of value added products such as pericarp candy, pickle, jam, mouth refreshener, syrup, dehydrated powder, *etc.* These value added products not only contribute to the economic benefits but also generate employment opportunities through secondary agriculture activities in the rural area.

### Betel vine as intercrop in coconut

Betel leaf vines also started yielding. First harvesting of leaves yielded about 1600 leaves. This also will contribute to routine biweekly income from the system.

Papaya and drumstick planted along the southern border of the system also contributed to the regular income from the system. Besides this, Cinnamon, Clove and Birds chilli were also added to the system.



*Nutmeg candy*



*Nutmeg pericarp pickle*



*Nutmeg pericarp syrup*



*Nutmeg pericarp jam*

**Project : Survey, collection and evaluation and management of under utilized fruits of coastal regions**  
(PI: S.Priya Devi)

Various important fruit crops have got the potential to be commercially cultivated in Goa and other coastal regions of the country. Therefore biodiversity documentation and conservation are being focussed upon fruit crops like jack fruit and bread fruit, whereas, evaluation studies are being carried out on other fruit crops like, aonla, citrus, pomegranate, sapota *etc.*

**Jack fruit**

In order to study the variability in jack fruit, field surveys were conducted in Bicholim, Canacona, Pernem and Bardez talukas for jack fruit during, May-July 2014. Based on descriptor, fruit characters of the accessions were recorded.

There was wide variation recorded in traits like, stalk length (2.3 to 9.8 cm), stalk girth (6.9-10.3 cm), fruit weight (5.57 to 16.10 kg), fruit length (33.9 to 68.2 cm), fruit girth (59.80 to 90.80 cm) rachis length(15.8 to 38.2 cm), number of bulbs per fruit (83 to 271) *etc.* The study will be continued and promising accessions will be identified.



*Local germplasm collection of jackfruit*

**Papaya**

A segregating population was been developed from a promising open pollinated papaya plant. Plant height ranged from 70-284 cm, plant girth from 10-30 cm, height at which first fruit was found from 73-200 cm; the petiole colour green and purple. There was segregation into male, female and bisexual sex forms. Promising plants were selected based on yield, quality and tolerance to biotic stress. Either selfing or sibmating was effected depending on the sex of the selected plant. In case of the selected plant being a pistillate, a promising staminate plant was also being selected from the population for pollination, whereas hermaphrodite flowers are bagged as such. Seeds have been extracted from three crosses like, 27/16 x 24/18, 8/4 x 12/4, 21/7 x 21/9 and selfing of hermaphrodite plant no.15/1.



*Field view of segregating pappya*

**Aonla**

Evaluation of Aonla varieties *viz.* Krishna, Kanchan, NA-7, NA-10 and Chakaiya is being continued. The trees bear twice a year during Oct-Nov and March-April. Maximum yield of one graft of Krishna of 6 years age is 102 kg per year inclusive of both the seasons.



*Aonla variety Krishna*

Organoleptic studies were conducted on Aonla muraba prepared without and with liming (24 and 48 hours) before preparation of muraba. After preparation, the product was stored under ambient as well as refrigerated conditions. After eight months of storage, it was found that the overall acceptability of aonla muraba prepared without liming and stored at ambient condition was the highest (7.4 out of 9.0) as compared to scores ranging from 4.8 to 5.6 for other treatments.



*Aonla Muraba stored at ambient condition*

### Sapota

Planting of supota was done during July, 2013. The vegetative growth parameters recorded during the year of report shows that, DHS-1 recorded better plant height, number of branches and canopy spread when compared to other treatments.

### Acid lime

An evaluation trial was laid out in field with six varieties of acid lime viz., Vikram, Pramalini, Kasi Pentla, Sai Sharbati, Tenali and PKM-1 in RBD with four replications. Planting was done in July 2012. The vegetative traits were recorded during 2013 and 2014 consequently which shows that there is remarkable progress in growth in all the varieties. Kasi Pentla recorded the highest plant height of 117.42 cm during the second year.

In addition to this, a new field was developed in which, fifty plants each of acid lime varieties, Vikram, Pramalini, Sai Sharbati and Nag Nimbu were planted during July 2014. Besides these, ten plants each of Pummelo, Sweet orange, Mandarin, Rough lemon and Rangpur lime were also planted in the field. This field will act as a repository of citrus germplasm future

### Lemon

Performance evaluation of lemon variety Seedless lemon was done in the field. The plants are nearly three years old and started yielding. The fruits are harvested in July –August and also to some extent during Feb-March. The total yield per plant inclusive of both the seasons is 3 kg for 45 fruits with average individual fruit weight of 66 g.

### Pink Wax jambo jam

Jam was prepared from pink coloured wax jambo fruits and shelf life studies were conducted. After seven months of storage, the overall acceptability was recorded as 6.5/9.0 as against 5.8/9.0 for jam made with 75% Pink wax jambo and 25% roseapple.



*Pink Wax jambo plant*

**Project: Standardization and validation of Precision Farming Technologies (PFT) for major vegetable crops under climatic conditions of Goa**  
(PI: M.Thangam)

Precision Farming Technologies (PFT) in horticultural crops are widely practised for its unique advantage of quantum increase in yield per unit area with efficient usage of inputs like water, nutrient, plant protection chemicals *etc.* It is successfully demonstrated in states like Tamil Nadu, Maharashtra, Karnataka for different horticultural crops. It has great scope and potential for land scarce state like Goa. The available technologies elsewhere need to be standardized in a location specific experimental trial for suitable crops and standardization of PFT for Goa. With this background, this project was envisaged to standardize and validate different PFT for major vegetable crops of Goa like brinjal, chilli, okra, ridgegourd and cucumber, and to demonstrate the identified technologies in farmers field for large scale adoption. In order to develop a permanent plot for PFT project, an area of 2500sq.m. has been cleared and prepared for the experiment.

Crops shortlisted for field trial

- Brinjal (Agassaim and Surya)
- Chilli (Khola chilli and Kashi Anmol)
- Okra (Local and F<sub>1</sub> hybrid)
- Ridge gourd (Local and F<sub>1</sub> hybrid)
- Cucumber (Local and seedless F<sub>1</sub> hybrid)

**Evaluation of chilli varieties under drip and fertigation system in Goa**

The experiment was laid out with two varieties viz., Kashi Anmol and chilli hybrid-Nisha under conventional as well as drip-fertigation system.



General view of chilli crop under drip irrigation



Chilli (Hybird-Nisha)



Chilli (Variety-Kashi Anmol)

In general, early flowering was noticed in chilli plants grown under drip - fertigation system than in conventional method of cultivation. The hybrid-Nisha took 22 days for first flowering followed by Kashi Anmol (24 days) under drip irrigation. Under conventional method, the earliest flowering was noticed in hybrid-Nisha (30 days) followed by Kashi Anmol (32 days). The trial is under progress.

**Evaluation of okra varieties under drip and fertigation system in Goa**

The experiment out laid out with two varieties viz., Local type and okra hybrid-Jai Kisan under conventional as well as drip-fertigation system. The trial is under progress.



Okra (local type and Jai Kisan) selected for trial

## Project : Conservation, Evaluation and Cataloguing of Germplasm of Ornamental crops of Goa and adjoining regions (PI: Safeena S. A.)

### Screening of tuberose (*Polyanthes tuberosa* L.) cultivars under agro climatic conditions of Goa

Tuberose (*Polyanthes tuberosa* L.) is one of the important tropical ornamental bulbous plants cultivated for production of long lasting flower spikes. Total six cultivars (Mexican Single, Pearl Double, Suvasini, Bangalore local Double, Calcutta Double and Pune local) were evaluated during the study period. All cultivars differed in their growth and flowering behaviour. Maximum plant height (52.21cm) and maximum no. of leaves per plant (59.63) were recorded in cultivar Suvasini. Leaf length was significantly higher (52.93 cm) in Pearl double whereas leaf width (2.04 cm) was maximum in Calcutta Double. Minimum days taken for appearance of initial spike and opening of basal floret (84.88 days) was observed in Suvasini, while it was late in Bangalore local Double. Maximum no. of florets/spike (47.00) was observed in Pune local whereas length of spike (75.59 cm) was maximum in Mexican Single. Spike girth (0.68 cm), Spike fresh weight (69.06 cm), floret stalk length (3.6 cm), diameter of floret (5.24 cm), weight of individual floret (3.49g) and vase life (7.93 days) was significantly maximum in cv. Suvasini followed by cv. Pearl Double. On the basis of observations recorded for growth and floral parameters cv. Suvasini and Pearl Double are recommended for commercial cultivation under agroclimatic conditions of Goa.



Performance of different tuberose varieties

### Vase life studies in tuberose cv. Pearl Double

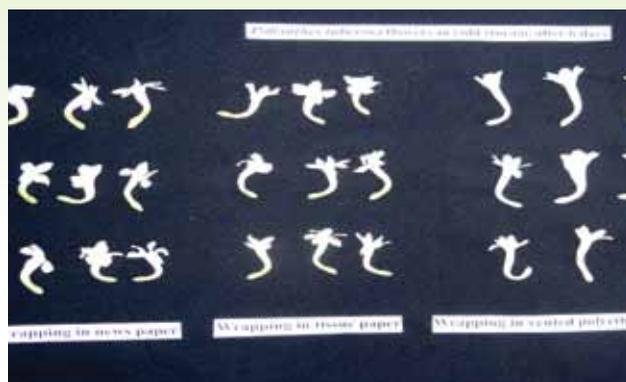
The experiment was conducted to study the effect of some preservative materials viz. Sucrose 3%, Gibberellic acid ( $GA_3$ ) 25ppm, Silver nitrate 50 ppm, Citric acid 50 ppm as well as their combinations as holding solutions on post harvest characters, water relation characters and vase life of cut spikes of tuberose cv. Pearl Double. Treatments used were T1:8HQS 200ppm+  $GA_3$  25 ppm +Sucrose 3%, T2:8HQS-200ppm+ $GA_3$  25ppm+ $AgNO_3$  50ppm+Sucrose 3 %, T3 :8HQS-200ppm+ $GA_3$  25ppm+ $AgNO_3$  50ppm+Citric acid 50ppm+Sucrose 3%, T4:Sucrose 3% alone and T5:Control (distilled water). Out of all treatment combinations applied, higher quality and longest vase life of cut spikes of tuberose were obtained by using holding solution containing 8HQS 200ppm+ $GA_3$  25ppm+ $AgNO_3$  50ppm+Citric acid 50ppm+Sucrose 3%. Spikes of cv. Pearl Double were able to remain afresh for longer duration (10.75 days) when kept in the above holding solution as compared to other treatments.

### Efficacy of various wrappings for packaging along with storage temperature and duration on vase life of Tuberose cv. Mexican single

Standardization of technology for wrapping and storage of single florets of tuberose is important for maintaining tuberose flower quality. Experiment was conducted with five different



View of vase life study taken up at the laboratory

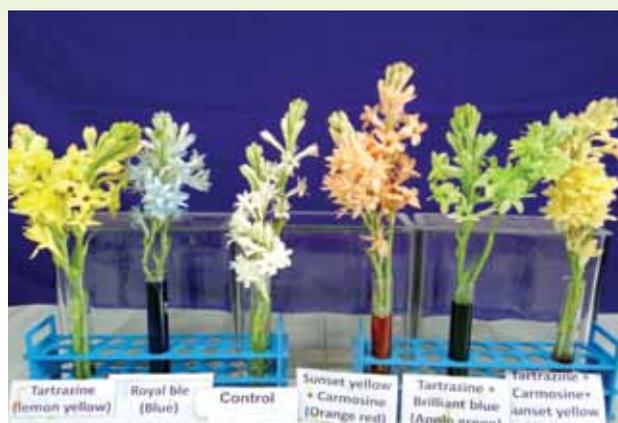


Single florets of *Polianthes tuberosa*  
cv. 'Mexican single' in cold storage after 6 days

wrapping materials, five storage durations and two different storage temperatures. The individual florets were packed in different wrapping materials viz., wrapping the florets in 100 gauge vented polyethylene (P<sub>1</sub>), 100 gauge non vented polyethylene (P<sub>2</sub>), news paper (P<sub>3</sub>), tissue paper (P<sub>4</sub>) and control (P<sub>5</sub>) in which the florets were kept without wrapping. Packages were stored both in cold storage (4°C) and ambient temperature for 2, 4, 6, 8 and 10 days. Results showed significant effect of packaging material and storage on all quality parameters evaluated. The florets wrapped in non-vented polyethylene (100 gauge) recorded longest vase life, least physiological loss in weight, better freshness, fragrance and turgidity. Poor response was obtained by packing in tissue paper and control. It is concluded that wrapping the flowers in non-vented polyethylene (100 gauge) and storing at 4°C improved the vase life.

### Value addition of tuberose spikes

Studies were carried out to evaluate the ability of cut spikes of tuberose to obtain and retain different colour shades. Tinting the cut spikes of tuberose with edible dyes can also provide a great variety of colours for aesthetic beautification. Five different dyes viz., Tartrazine, Sunset yellow + Carmosine, Tartrazine + Brilliant blue, Tartrazine + Carmosine + Sunset yellow and Royal blue ink were used as colouring agents at 3 different concentrations (0.5%, 1% and 1.5%). Flower spikes were immersed in dyes for three different time of immersion i.e.) 4 hours, 15 hours and 24 hours. After treatment, the basal portions of the flower stalks were dipped in molten wax



Spikes of tuberose (*Polianthes tuberosa* L.)  
tinted with different dyes

which arrested leaking of the chemicals and flower discoloration and the flower spikes were kept in water-filled vases. It has been recorded that various colouring agents successfully induced colour in the cut spikes without affecting their vase life. Chemicals induced colour changes ranging from lemon yellow, Orange red, Green, orange and blue. The colour shade obtained on flower spikes was directly dependent on the dye concentration and time of immersion. The shades of colour deepened as the concentration and time of immersion was increased. Results obtained in colour retention at the end of vase life indicated that higher time of immersion (24 hours) and maximum concentration (1.5%) allowed more dye to be translocated throughout the flower spike. In all treatments, there was no adverse significant effect of dye concentration, time of immersion on the vase life and quality of tuberose cut spikes.

### Germplasm resources of ornamental coleus in Goa

*Coleus (Solenostemon scutellarioides)* is the common name for a group of plants with large colorful leaves. Coleus is grown primarily for the impact of its foliage. Nineteen types / varieties have been collected, maintained and evaluated for their suitability for landscape use. Significant variation was noticed among different coleus cultivars used in the study for various morphological and quality parameters. Plant height, number of leaves, stem girth, length of leaf with petiole, petiole length, leaf width, length of leaf without petiole varied from 10.77

to 22.13 cm, 4.96 to 19.44, 0.39 to 0.54 cm, 4.51 to 8.21 cm, 0.75 to 2.09 cm, 2.03 to 4.18 and 3.67 to 6.52 cm respectively at one month after planting. Plant height, number of leaves, number of branches, stem girth, length of leaf with petiole, petiole length, leaf width, length of leaf without petiole and petiole girth varied from 42 to 89.67cm, 24.89 to 72, 3 to 8.67, 0.56 to 0.82cm, 11.03 to 18.83cm, 2.07 to 6cm, 5.5 to 10.83 cm, 8.3to 14.78 cm and 0.18 to 0.42 cm respectively at 6 months after planting.



*Diversity observed in different varieties of ornamental coleus*

### Effect of different media on rooting of cuttings of different varieties of ornamental coleus

Rooting media is considered an integral part of the propagation system since the survival percentage, rooting and quality of roots produced are directly influenced by the medium. Experiment was laid out in factorial CRD with 4 replications and 2 factors i.e. 17 coleus varieties and 5 growing media [M<sub>1</sub>:sand, M<sub>2</sub>:saw dust, M<sub>3</sub>:sand+Vermicompost (1:1), M<sub>4</sub>:saw dust + Vermicompost (1:1:1), M<sub>5</sub>:sand + saw dust + Vermicompost(1:1:1)]. Experimental results show that, high rooting percentage was achieved in cuttings planted in sand+saw dust+vermicompost (1:1:1) with average of 75.88%, while the lowest (57.79%) was obtained in sawdust. Highest (10.62) and lowest (6.55) no. of fully developed leaves was achieved in sand+saw dust+vermicompost (1:1:1) and saw dust respectively which showed significant difference, Similarly, highest number of cuttings rooted, shoot length, leaf length and width, petiole length, shoot girth *etc* was achieved in sand+saw dust+vermicompost (1:1:1). Hence



*Effect of media on rooting of cuttings of different varieties of ornamental coleus*

in order to promote mass production of coleus varieties, sand+saw dust+vermicompost (1:1:1) is recommended.

### Studies on the performance of rose varieties under open field conditions of Goa

Present investigation was carried out to study the performance of different rose varieties under open field conditions in Goa. A total number of 21 cultivars were evaluated during the study period. Significant variation was noticed among different rose cultivars used in the study for various floral quality and yield parameters. Neck length, stalk girth, neck girth, no. of petals per flower, petal length, petal width, flower diameter and vase life varied from 2.96 to 6.67 cm, 0.16 cm to 0.33 cm, 0.17cm to 0.42cm, 13.33 to 29.67, 1.47 to 3.53 cm, 1.30 to 4.17 cm, 1.83 to 8.50 cm, 2.67 to 6.0 days respectively. Jubileums performed very well with respect to various floral characters which recorded maximum stalk girth (0.33 cm), petal length (3.53 cm) and vase life (6.0 days). Restless performed better with respect to various floral characters like neck length of flower (6.67 cm), stalk girth (0.32 cm), neck girth (0.42 cm), flower diameter (6.17 cm) and vase life (4.67days) followed by Brisbane blush which recorded maximum no. of petals/flower (29.67) and better vase life (4.33 days). Month wise flower production as well as total yield of flowers (No's / plant) after pruning was highest in Jubileums, Restless and Brisbane blush. Hence, these three varieties were judged as ideal varieties for using as loose flower under open field conditions of Goa.



Rose varieties under evaluation in Goa

### Dehydration studies in different rose varieties for value addition through embedding technique

Fresh look of rose flowers can be retained only for a short period even with the use of preservatives for prolonging vase life. By using dehydration technique, dried flowers can be stored for a very long period without losing their appearance, colour, form and decorative value. The two different drying methods employed were air drying and embedded drying method using silica gel as the desiccant. Twelve different rose varieties *viz.*, Jubileums, Winnipeg parks, Cardinal Song, Brisbane blush, Contribute, Restless, Royal occasion, Mount Shastha, Tonimbuk, Glenara, Wild fire and Janet Morrison were used in the present experiment. Time taken for drying was less

for air drying (3.39 days) while it was 8.42 days for silica gel embedded drying. On an average, time taken for drying of different varieties ranged from 3.0 to 9.33 days. Scores for quality attributes like colour, appearance / shape, texture, retention of petals and overall acceptability was significantly maximum in silica gel embedded drying method which recorded scores of 3.70, 3.78, 3.71, 3.59 and 3.64 respectively. With respect to interaction between varieties and different methods of drying, varieties *viz.*, Jubileums, Brisbane blush, Royal occasion and Tonimbuk which were dried by embedding in silica gel recorded significantly higher scores for various quality attributes assessed with scores of 4.12, 3.33, 3.50 and 3.28 respectively for overall acceptability.



Flowers of rose varieties dried with silica gel embedded method

**Project : Design of protected cultivation structures for Year round utilization in western region**  
(PI: M.J. Gupta)

**Studies under single span greenhouse**

Crops of cucumber with varieties Seminis – RS 03602833 (F1 Hybrid), Pyramid – Gypsy (F1 Hybrid), Nunhems –Kian (F1 Hybrid) were evaluated for two seasons (June-Sep and Sep-Jan). The crop growth parameter like plant height, number of leaves, disease and pest incidence, production, number of fruits, fruit weight *etc.* as influenced by microclimate in the greenhouse *viz.*, temperature, humidity, dew point temperature, air velocity, solar radiation *etc.* were recorded. The acceptability of the fruits was assessed by sensory evaluation. Storage studies also were conducted for Gypsy and RS-03602833 varieties. Under green house condition, yield of RS-03602833, Gypsy and Kian was 26.22 kg/m<sup>2</sup>, 19.87kg/m<sup>2</sup> and 33.28kg/m<sup>2</sup>, whereas under open field total yield was found to be negligible for all the three hybrids. Fruit drop and leaf blight were encountered during the crop period. Single Factor Anova showed significant difference between the yield of hybrids inside and outside the greenhouse. Further, no significant difference

in the yield between the hybrids was observed inside the greenhouse. Yield of Gypsy was significantly higher than that of RS 2833 outside the greenhouse.

**Effect of air velocity on crop productivity and health**

The effect of air velocity in the polyhouse as affected by the ambient wind flow on the crop productivity was assessed using the data obtained by ultrasonic anemometers.

The airflow has very significant effect on productivity of the crop as it can be seen that the crop productivity is higher in the windward side and lower in the leeward side. Single factor anova showed that the air velocity in the structure was significantly different among windward, leeward and centre. The incidence of disease too was found to be higher on the leeward side of the structure. Hence it is evident that the natural ventilation is not effective in the single- span polyhouse.



Cucumber hybrid RS2833



Cucumber hybrid – Gypsy

**Effect of air velocity on yield and microclimate**

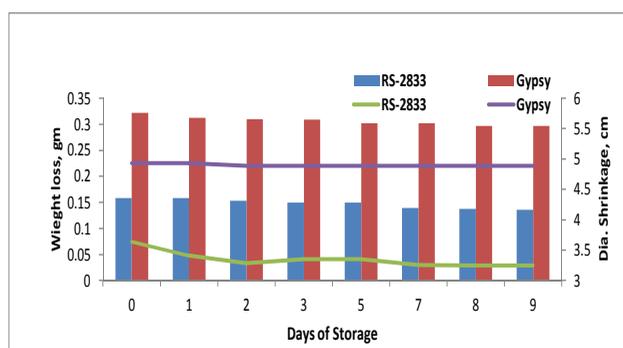
	Leeward Bed	Central Bed	Windward Bed
Average yield (kg/plant)	1.53	1.78	2.41
Average air temperature (°C)	25.87	26.15	25.93
Average relative humidity (%)	77.49	74.80	75.76
Average dew point temperature (°C)	21.06	20.85	20.92

Single factor anova shows no significant difference in any parameter but the yield is definitely higher in windward side as compared to leeward side rows. The microclimate data shows no significant difference in temperature, humidity and dew point temperature but air velocities are higher in windward side as compared to leeward

side. Various other configurations (Total 11) with and without crop were used for collection of airflow patterns to be used in the CFD analysis.

### Storage studies

Both the cucumber varieties exhibited excellent storage characteristics as the products showed negligible weight loss and shrinkage in storage.



Storage studies on polyhouse cucumber

### Sensory evaluation

The sensory evaluation of the varieties was done to evaluate the acceptability of the varieties among locals.

Results indicated that there was no significant variation in the acceptability of the two varieties.

#### Hedonic score (1 to 9) of cucumber in sensory evaluation

Average acceptability	Var. Gypsy	Var. RS2833
Whole cucumber	7.10	6.81
Cucumber slices	6.64	6.43
Chopped cucumber	6.24	5.83

### Microclimate studies under double span polyhouse and the effect on tomato and capsicum

Studies on five hybrids of Capsicum (Indus-11 popti, Indra, Bomby, Orabelle, Swarna), four hybrids of beef tomato (Arka Raskshak, Indam Rakshita, GS 600, Heem Sona) and two varieties

of cherry tomato (Olleh, Tomato cherry) were conducted to see the effect of crop on the microclimate in a double-span polyhouse and *vice versa* effect on crop health and productivity. Crops of Tomato and Capsicum were grown in Randomized Block Design (RBD) with four replications.

Nine layout combinations for air flow analysis were used for data collection and these will be further used for analysis and CFD modelling.

The double-span polyhouse showed more uniform air velocity patterns inside the structure as compared to single span as the structure had vents on all four directions. But still the air flow induced by natural ventilation could not maintain uniform temperature and humidity conditions as single factor anova showed significant variation of temperature and humidity both along width and length of the polyhouse as we move away from the vents.



Capsicum crop under polyhouse

The analysis of the varietal yield showed no significant effect of variety on yield under the structure but the variation within replications was very high showing significant effect of crop



Tomato - Beef type

microclimate. The average yield was found to be low and mortality of plants very high due to unsuitable microclimate.

### Cost effective structure for hydroponic fodder production

The construction of the cost-effective structure for hydroponic fodder production has been completed. The testing of the structure to provide suitable microclimate for hydroponic fodder production has been started. The microclimate of the structure without operating any of its environment modification system was evaluated.



*Low cost structure for hydroponic fodder production*

### Post-harvest losses in Paddy

Results of survey and sampling indicated that there were 53.66 per cent farmers with land holdings of <1 acre, followed by 34.15 per cent farmers with 1 < 5 acres land holdings, 8.54 per cent with 5 < 10 acres landholdings and 3.66 per cent land holdings with more than 10 acres. Out of the ten villages studied, four viz., Chodan, Nuvem, Matol, Maina (Curchorim) were under Khazan topography; Amona, Torse, Sangolda

were under Kher type of topography and Morpirla, Copordam, Adni and Warkhand were under Morod kind of topography.

The secondary data *i.e.* as reported by farmers for the period year 13-15, showed that maximum losses in paddy have been recorded in harvesting (3.3 kg/q), followed by collection-packaging-transportation (1.66 kg/q), winnowing (5.4 kg/q), threshing (0.64 kg/q) and parboiling (0.49 kg/q).

### Analysis of primary data of paddy

Primary data has revealed that harvest losses are maximum for manual harvesting followed by combine and brush cutter with paddy reaping attachment. Also the effect of variety and harvest moisture content on losses was quantified. The losses were found to be maximum in Jothi (1.4%) followed by Walio (0.79%) and Jaya (0.67%), the traditionally grown varieties in Goa. Effect of moisture content could not be isolated as it is different for each variety, but safe moisture content for varieties need to be standardized in terms of days after sowing too.

### Storage pests

The analysis of the stored rice samples collected at periodic intervals of 3 months from the farm was done and the overall average losses on farm was found to be 5.16 kg/q. The major pests infesting the grains were found to be Rice weevil (*Sitophilus oryzae*), Lesser grain borer (*Rhyzopertha dominica*), and Rice moth (*Corcyra cephalonica*). The infestation increased with storage period, however, further studies is required to give specific recommendation.

## Animal Science

### Project: Economic milk production under climate change scenario (PI: S. K. Das)

#### Performances of Buffalo (Murrah Cross) under different interventions for enhancing milk production and reducing heat stress

Effort was taken to reduce heat stress on milk production in buffalo by managerial intervention i.e. manual cooling of buffalo by splashing of water twice daily and by nutritional intervention i.e. supplementation of bypass fat to the feed @ 20 g / lit of milk. Analysis of data revealed that in Murrah cross buffalo highest daily milk yield was attained upto 9.412 lit in the month February, with overall mean value of  $7.786 \pm 0.120$  lit / head / day. There was highly significant ( $P < 0.01$ ) differences of average daily milk yield between the months. Average daily intake of concentrate pellet feed was approximately 6.15 kg in dry pregnant buffalo and 6.90 kg in lactating buffaloes. Average daily intake of dry fodder was approximately 6.30 kg. Data analysis also revealed that milk yield of buffalo was significantly ( $P < 0.05$ ) reduced by 272 ml per unit increase of temperature humidity index (THI). Milk yield was not reduced due to increase of air temperature, but it was reduced by 8 ml per % increase of relative humidity. Milk yield was reduced by 333 ml and 15 ml per unit increase of maximum temperature and minimum temperature respectively. All the effects were non-significant. It was noted that heat stress was overcome by 24.71 % and milk yield was increased substantially i.e. around 9.36 % by supplementation of bypass fat along with manual cooling.

Study on physiological response of buffaloes revealed that rectal temperature, skin temperature, respiration rate and pulse rate were  $100.29 \pm 0.14$  °F,  $36.40 \pm 0.17$  °C,  $18.06 \pm 0.95$  numbers / min and  $60.29 \pm 2.05$  numbers / min respectively. All the values were reduced except skin temperature from that recorded from buffaloes not fed bypass fat with the feed,



Murrah buffalo

indicating that bypass fat feeding reduced heat stress on the animal.

Overall mean air temperature, relative humidity (RH), temperature humidity index (THI), maximum and minimum temperature in buffalo farm were 28.79 °C, 70.50 %, 79.52, 31.83 °C and 25.76 °C respectively during this period. Highest air temperature (31.06 °C), highest maximum temperature (33.86 °C), highest minimum temperature (28.25 °C), highest THI (82.18) were recorded in the month May. However highest RH (88.73 %) was recorded in the month July. Highly significant ( $P < 0.01$ ) differences of all the microclimatological parameters were observed between the months.

#### Productive Performances of dairy cattle under the feeding of bypass fat for enhancing milk production and reducing heat stress

Effort was made to reduce heat stress on cattle by supplementation of bypass fat @ 20 g / calf to the feed along with mechanical cooling. Data analysis indicated that heat stress was overcome by 25 % and growth was enhanced by 17 % due to fortification of feed with the bypass fat along with mechanical cooling. Average daily gain in Sahiwal and Cross bred calves of age group 6 - 7 m were found to be  $420.00 \pm 26.31$  and  $446.90 \pm 38.27$  g / day respectively. Average daily gains in

male and female calves were found to be  $435.95 \pm 26.02$  and  $430.85 \pm 32.92$  g / day respectively. Overall mean growth irrespective of breed and sex was found to be  $433.45 \pm 27.46$  g / day. Highest growth was observed at the age of 2.5 month.

Study on physiological response of calves revealed that overall mean rectal temperature, skin temperature, respiration rate and pulse rate were  $101.17 \pm 0.10$  °F,  $33.59 \pm 0.28$  °C,  $24.00 \pm 1.35$  numbers / min and  $77.87 \pm 4.14$  numbers / min respectively. It was observed that all the values except rectal temperature were lower than that recorded in calves without supplementation of bypass fat in the feed indicating that its supplementation helped to reduce heat stress. Skin temperature was higher in Sahiwal breed whereas rectal temperature, respiration rate and pulse rate were higher in Cross bred calves. It indicated better thermal adaptability of Sahiwal breed of calves. Respiration rate was higher in male, whereas rectal temperature, skin temperature and pulse rate were higher in female. It indicates better thermal adaptability of males than female.

Highest air temperature ( $30.00^{\circ}\text{C}$ ), highest maximum temperature ( $33.75^{\circ}\text{C}$ ), highest minimum temperature ( $26.25^{\circ}\text{C}$ ) and highest temperature humidity index ( $85.56$ ) were recorded in the month May, whereas highest relative humidity ( $93.26\%$ ) was observed in the month July. Multiple regression analysis revealed that growth of calf was not affected by change of air temperature due to feeding of bypass fat in addition to mechanical cooling. However growth was reduced by  $19.95$  g and  $36.23$  g per unit increase of relative humidity and THI respectively, but the effect was non-significant. Moreover reduction of growth due to change of RH was minimized by  $25\%$  due to supplementation of bypass fat in the calf ration besides mechanical cooling.

Multiple regression analysis revealed that change of air temperature had not found to have any adverse negative effect on average daily milk yield and average monthly milk yield due to feeding of bypass fat in addition to cooling arrangement. However, average daily milk yield was reduced significantly by  $102$  ml ( $P < 0.01$ ) and  $312$  ml ( $P < 0.01$ ) per unit increase of RH and THI in Sahiwal cow only. In other two breeds adverse effect of change of RH and THI on average



Sahiwal cow

daily milk yield was found to be non significant. It was also observed that effect of other microclimates such as RH, THI, maximum temperature and minimum temperature on average monthly milk yield was found to be non significant due to feeding of bypass fat in addition to cooling arrangement.

In goat, twenty does delivered during this period, out of which six twin birth and fourteen single births were recorded. Total twenty six kids were born, out of which nine male and seventeen female kids were born with a sex ratio of 9: 17 ie 1: 1.88. Average birth weight of male and female kid was  $2.809 \pm 0.180$  kg and  $2.530 \pm 0.145$  kg respectively with overall mean value of  $2.669 \pm 0.127$  kg. Breed wise average birth weight was found to be  $2.866 \pm 0.260$  and  $2.472 \pm 0.185$  kg in Konkan konyal and Crossbred (K x O) kids respectively with overall mean value of  $2.669 \pm 0.127$  kg. Growth rate in Konkan Kanyal and Crossbred (K x O) grower goats in semi intensive system of management were observed to be  $122.96 \pm 7.10$  and  $107.37 \pm 6.24$  g / day respectively with overall mean value of  $115.17 \pm 6.95$  g / day. Average feed intake in grower, finisher and adult goat was  $95.25$ ,  $144.30$  and  $191.75$  g / day respectively. Highest air temperature ( $29.55^{\circ}\text{C}$ ), highest maximum temperature ( $31.55^{\circ}\text{C}$ ) were recorded in the month April. Highest minimum temperature ( $27.67^{\circ}\text{C}$ ), highest THI ( $83.58$ ) were recorded in the month May. However highest RH ( $91.48\%$ ) was recorded in the month August. During this period only one grower goat died due to cyst. No mortality was observed in adult goat.

**Project : Preparation/formulation of boar semen extender and pre-insemination fluid for artificial insemination (AI) in pigs**  
*(PI: E. B. Chakurkar)*

The production of pork and pork products is a traditional household activity in most of coastal areas of our country. Availability of higher quantity of pork for preparing the products will help to make the activity self sustainable. The activity may become self sustained over a period of time only when there is use of advance techniques like AI for improvement in pig stock.

The most important component for AI in pigs is Boar semen extender. As per literature

and market survey no indigenous boar semen extender is commercially available. The current project was proposed to formulate indigenous boar semen extender. For better conception rate pre-insemination fluid is also essential. It was proposed to formulate this product also in the present project. During the current year different formulations were tried and one formulation NBSE is found to be useful and could store more boar semen at 15-17°C for more than 72 hours period. Same is also applied for patent.



*Artificial insemination in pigs at the farmers field*



*Sow with litter after AI*

## Project : Nutritional Interventions for Optimization of Economical Milk Production in Goa (PI: PK Naik)

### Effect of feeding brewers' dried grains as replacement of rice bran on nutrient digestibility, milk production and milk composition of cows

Six dairy cows (avg. BW 402.5 kg; avg. milk yield 5.34 kg) were divided into two equal groups (GRB and GBDG) and were randomly fed two iso-nitrogenous concentrate mixtures with 22% rice bran (CMRB) or 25% BDG (CMBDG) along with ad lib. jowar straw and limited green fodder. Although, both CMRB and CMBDG had similar ( $P>0.05$ ) CP and CF content, the TA and AIA content of the CMBDG (5.48 and 0.62, %) was lower ( $P<0.05$ ) than the CMRB (7.78 and 2.95, %). There was no difference ( $P>0.05$ ) in the DM intake between the groups. The roughage: concentrate ratio in GRB (50: 50) was similar ( $P>0.05$ ) to GBDG (52: 48). There was increase ( $P<0.05$ ) in the digestibility of DM (53.72 vs 59.88, %), CF (46.70 vs 56.33, %) and NFE (66.19 vs 69.47, %) of the cows fed BDG; however, the increase ( $P>0.05$ ) in the digestibility of OM (57.61 vs 62.90, %), CP (65.90 vs 67.35, %), and EE (72.21 vs 79.75, %) was non-significant. The TDN content (63.96 vs 69.07, %) of the ration increased significantly ( $P<0.05$ ) due to feeding of BDG; however, the CP (12.87 vs 12.79, %) and DCP (8.47 vs 8.64, %) content was similar ( $P>0.05$ ). The milk yield, 4% FCM yield and milk compositions (fat% and SNF%) was similar between the groups. There was no difference ( $P>0.05$ ) in the FCR in terms of DM (1.69 vs 1.57), CP (0.22 vs 0.20), DCP (0.15 vs 0.14) and TDN (1.08 vs 1.08) between the groups. The cost of the feed/d ( $P<0.05$ ) was lower in GBDG (Rs. 109.61/- vs Rs. 103.53/-); however, the cost of milk increased non-significantly ( $P>0.05$ ) in GBDG (Rs. 210.84/-) than the GRB (Rs. 199.08/-), which led to the higher net profit of Rs. 17.84/- per cow per day due to feeding of BDG. It can be concluded that brewers' dried grains can be included in the concentrate mixture of dairy animals up to 25% by completely replacing the rice bran.

### Voluntary intake and digestibility of nutrients in heifers fed hydroponics maize fodder

A study was conducted to find out the effect of feeding hydroponics maize fodder (HMF) on voluntary feed intake and nutrient digestibility of heifers. HMF of 7 days growth was fed to 3 heifers (BW 308.9 kg). Animals were offered 2 kg concentrate mixture, 2 kg jowar straw along with ad lib. fresh HMF for 30 days followed by a digestion trial of 6 days duration. The HMF had 15.39% DM, 13.56% CP, 2.46% EE, 8.98% CF, 73.45% NFE and 1.56% TA. The HMF intake was 3.23 kg on DM basis and 20.98 kg on fresh basis. The DMI (kg/ d) and DMI (% BW) was 6.80 and 2.25, respectively. The roughage: concentrate ratio was maintained at 73: 27. The digestibility (%) of DM, OM, CP, EE, CF and NFE was 65.62, 68.06, 69.36, 80.95, 59.70 and 69.87; respectively. The CP, DCP and TDN content (%) of the ration was 12.73, 8.81 and 68.71; respectively. It can be concluded that fresh HMF can be fed up to heifers 21 kg per day and is a good alternative to conventional green fodder.

### Digestibility of nutrients in crossbred heifers fed concentrate mixture and green fodder

Three heifers (Mean BW 303.83 kg) were offered 2 kg concentrate mixture and 10 kg fresh green fodder (napier bajra hybrid) along with ad lib. jowar straw for 30 days followed by a digestion trial of 6 days duration. The green fodder (napier bajra hybrid) had 18.52% DM, 11.90% CP, 3.09% EE, 22.33% CF, 54.33% NFE and 8.35% TA. The DMI (kg/ d) and DMI (% BW) was 7.35 and 2.43, respectively. The roughage: concentrate ratio was maintained at 75: 25. The digestibility (%) of DM, OM, CP, EE, CF and NFE was 65.21, 66.92, 68.42, 80.05, 53.87, 62.27; respectively. The CP, DCP and TDN content (%) of the ration was 9.41, 6.64, and 49.04; respectively. It can be concluded that the when limited concentrate mixture and green fodder are fed to heifers, the TDN content of the ration is very low.

**Project : Evaluation of Srinidhi chicken performance under different rearing systems in Goa**  
(PI: K. Muniswamy)

Srinidhi is a dual purpose improved chicken variety developed by Directorate of Poultry Research (DPR), Hyderabad. Srinidhi like desi chicken has multi coloured plumage, produce brown egg (220-230/yr), higher immune competence, and grow faster than desi chicken. The rural areas have plenty of feed resources like fallen grain, earth worm and insects. Hence in rural areas small number of 10-25 birds/household can be reared for egg and meat purpose under free range condition. The backyard poultry farming with improved chicken variety like Srinidhi gives eggs and meat which is less expensive and readily available. It also provides better livelihood security to the poor farmers. The day old chicks purchased from DPR were given nursery management upto 8 weeks of age. On the basis of different rearing systems, the Srinidhi

chicken were divided into three groups ie. Deep litter, Cage and Farmers' backyard. The study of Srinidhi chicken performance in three groups based on different parameters is continuing.



Srinidhi reared in deep litter system

**Comparative performance of Srinidhi chicken**

S.No	*Parameters	Deep litter	Cage	Farmers' field
1	Mortality (0-6 wks)	1.79 %		
2	Avg body wt at 6 wks	549.706 ± 9.45 gm		
3	Avg body wt at 20 wks (kg)	M - 2.612 ± 0.022 F - 2.020 ± 0.011	F - 2.082 ± 0.023	M - 2.735 ± 0.171 F - 1.983 ± 0.035
4	Age at first egg of flock (days)	127	128	147
6	Avg body wt at 28 wks (kg)	M - 2.763 ± 0.080 F - 2.176 ± 0.019	F - 2.268 ± 0.032	M - 3.647 ± 0.124 F - 2.452 ± 0.047
7	Avg egg wt at 28 wks (gm)	49.025 ± 0.190	50.122 ± 0.349	48.027 ± 0.995
8	Hen-day egg production at 28 wks (%)	70.8	93.95	19.04

\*Avg-Average, wt-weight, wks-weeks, F-female, M-male

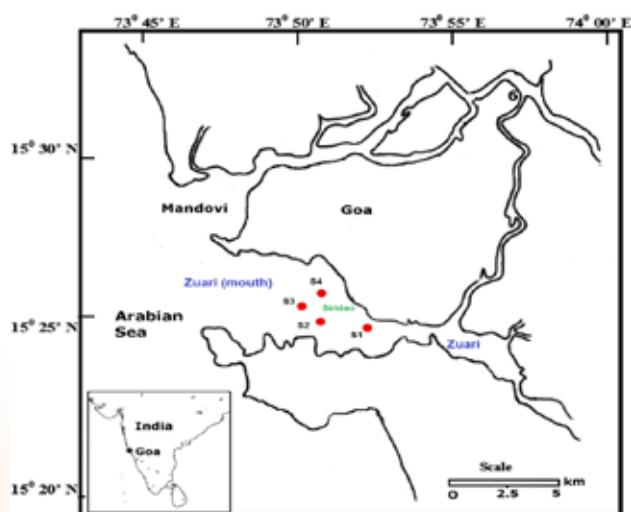
## Fisheries Science

### Project : Augmentation of fishery and fish biodiversity in the near shore marine areas of Goa through artificial fish habitats

(PI: Sreekath G. B.)

#### Pre-deployment fishery and fish biodiversity assessment

The sites for the deployment of Artificial Fish Habitats (AFH) were selected in the Zuari estuary. The selected sites were Siridao, Cakra, Bamolim and Nauxim where traditional and motorised fishermen were dominant. The sites were selected with due consideration of ecological, socio-economic and fishermen perspectives. The participatory gillnet and hook and line fishing experiments (with fishermen) were conducted during October, 2013 to September, 2014 in selected sites to study the fishery and fish biodiversity of these regions prior to the deployment of AFHs. A total of 186 aquatic species comprising 150 finfish species (Pelagic-65, Demersal-85) and 36 shellfish species (17 crustacean species and 19 molluscan species) were collected during the study. The 50 finfishes were belonging to 45 families (Pelagic-18, Demersal-27). The 36 shellfish species were belonging to 19 families (Crustaceans-4, Molluscs-15).



Fishing experimental sites in Zuari estuary

#### Fish species abundance

The descending order (on the basis of average abundance during the study period) of major fisheries resource groups were white sardine, penaeid shrimps, silverbellies, crabs, mullets, shads, moustached anchovies, carangids, bony breams, sardines, croakers, Indian mackerel, whitebaits, bigjawed jumper, catfishes, silverbiddies etc. The uneven occurrence was observed for breams, toadfish, bamboo sharks, eels, flatfishes, polynemids, driftfishes, groupers, rays, pufferfishes, snappers, tiger perches, sweetlips, rubberlips, scat, flatheads, golden anchovies, ribbonfishes, tarpon, tenpounder, fullbeaks, halfbeaks, squids, cuttlefish, octopus etc. The catch of golden anchovies in small quantities was noted along the coastal ecosystem after a gap of 2 years.



Species collected during the study from Zuari estuary

#### Temporal patterns in fish assemblages

The study revealed that the species richness, evenness and overall diversity indices were least during the monsoon season in comparison with pre-monsoon and post-monsoon seasons. The pre-monsoon season has been found to be a less turbulent and calm period from February to May

in the coastal ecosystem. The absolute abundance was high during the monsoon season for majority of the commercial pelagic groups such as the white sardine, whitebaits, mackerel, moustached anchovy, mullets, sardines, bigjawed jumper, silver bellies, stomatopods and penaeid shrimps. The present study however, doesn't suggest the absolute dominance by one or two species. On the other hand, it underlines the low relative dominance of a number of species of low or high trophic level. However, the seasonal species were abundant during the monsoon season (sardines, mackerel, stomatopods and bigjawed jumper). The increase in diversity during the post-monsoon and pre-monsoon season has resulted in the evenness in abundance for all the species.

### Construction and deployment of AFHs

After considering the substratum (rocky) and bathymetric (depth) profile of the selected sites, three rectangular AFHs (see table) with circular holes (diameter of 10 cm) were designed and constructed with RCC. With the participation of fishermen community, a total of six AFHs with marker floats (B and C- three numbers each) were deployed at two locations (rocky grounds) in Zuari estuary.

#### Summary of AFH numbers and designs

Design	Length (m)	Breadth (m)	Height (m)	No. of holes	No. of AFH
A	1	1	1	24	4
B	1	1	0.5	20	4
C	1	0.5	0.5	18	4



Construction and installation of AFHs

### Exploration freshwater fish diversity of Goa

Of the states in Peninsular India with rivers originating in the Western Ghats, Goa remains the least explored. As part of our efforts to catalogue the freshwater fish diversity of the Western Ghats, NBFGR Kochi Unit in conjunction with ICAR Research Centre Goa conducted fishing surveys of freshwater habitats in Goa in 2013 and 2014. Nine sampling locations covering the two major river systems in Goa, Mandovi and Zuari, were sampled intensively using cast nets, drag nets and scoop nets. The survey yielded a total of 40 species of freshwater fish and 7 species of crustacean up to March 2014. The final round of sampling was conducted from 15-19 September 2014, where, in addition to previous locations, the lower reaches of the Zuari and Mandovi basin up to the estuarine zone, as well as the Chapora river, which originates in Maharashtra and enters the Arabian Sea in Goa were sampled. The complete list of sampling locations is given in the map. The latest round of sampling yielded 15 additional species of fish, along with 6 species of crustaceans, bringing the total number of fish species to 55 and crustaceans to 13.



Species collected from freshwater habitats of Goa



Sampling sites for the fresh water fish surveys along Goa

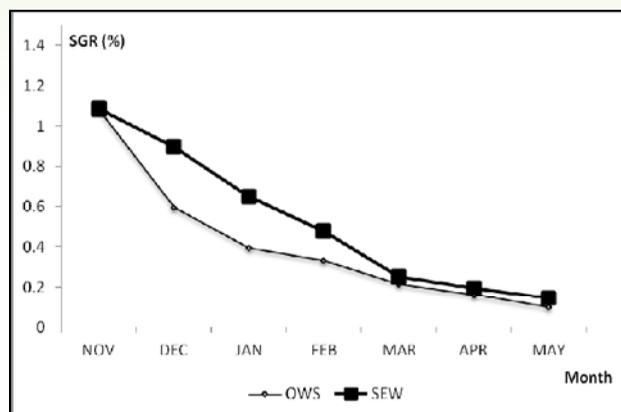
## Project : Development of coastal mariculture in brackish water areas of Goa (PI: Manju Lekshmi N.)

### Shell fishes

Coastal mariculture project started with mussel culture demonstrations in Goa. To popularize and standardize the mussel culture technology in Goa, demonstrations were carried out in two areas of Goa, namely Batim and Goa Velha. The spats were collected from Kerala and pre-stitched bags were made with mosquito net and nylon rope. Rack method of culture was adopted (5\* 5 m). The mussel bags were filled with 1 kg of seed (100-300 nos.). The seeded bags were kept vertically on the bamboo racks at 0.5 m off bottom to prevent attacks from predators. Water, sediment and meat samples were collected from their respective sites during pre and post deployment of the rack with mussels. A total of 30 specimens were randomly sampled for their length, width and weight measurements. One of the objectives of culture experiment is to compare the environmental parameters, growth rate and length-weight relationship of *P. viridis* cultured in two different systems; a semi-enclosed water body (SEW in Goa Velha) and an open-water system (OWS in Batim).

During the culture period, environmental variables showed a significant difference between the culture systems. The chlorophyll-a concentration and plankton density were more in the SEW than in the OWS. The plankton density and chlorophyll a-content have indicated a positive correlation ( $<0.01$ ) with the specific growth rate (SGR) of *P. viridis*. The growth indicators of the species; 'b' value of length-weight relationship and SGR were higher in the SEW than in the OWS. The prediction of SGR using Generalised Liner Model has indicated that the plankton density and nitrate are the important parameters which influence the SGR positively.

The economic analysis has shown that the total production cost for the culture operation of a single rack was ₹ 12,000 and the total returns from the semi-enclosed culture system were ₹



Month-wise variation in SGR for the two culture systems

28,510 and the net profit earned was ₹16, 510. The culture operation has revealed enterprising results for the coastal mariculture in Goa using the semi-enclosed water systems.

After the first successful demonstration of mussel rack culture in Goa, more than fifteen farmers have expressed their interest for the same culture method. Hence, a total of four units (one unit of rack/ farmer group) were selected for successive trials in different areas of Goa (Batim, Goa Velha Madkai and Pernem of Goa under the financial assistance of National Fisheries Development Board (NFDB), Hyderabad. The stocking of mussel spats were carried out on 05<sup>th</sup> December, 2014.

### Finfishes

Locally demanded finfish, Pearlsport (*Eetroplus suratensis*) culture initiated in Goan coastal water bodies including experimental ponds in Institute.

### Periphyton based Pearlsport culture

Pearlsport seeds collected from the wild (Curtorim) and stocked in an area of 300m<sup>2</sup> closed pond. Bamboo poles were driven into the bottom of the pond and kept one metre apart. There was no external feeding for the culture. Fish growth parameters, environmental parameters will be monitored for six months.



*Mussle harvest*

### Biofloc based Pearls spot culture

An indoor culture experiment of Pearls spot based on a biofloc system was initiated. This study aims to generate information about the ecological and economic impacts of biofloc based aquaculture system in fish growth and water

quality parameters. Weekly sampling and analysis will be carried out for water quality parameters like DO, ammonia nitrogen, pH, nitrite nitrogen, nitrate nitrogen, BOD etc., growth parameters like length and weight of fish and enzymes like lipase, amylase and protease.



*Pearl spot growth analysis and Biofloc measurement*

## AICRP Main Centres

### Project : All India Co-ordinated Research Project on Integrated Farming Systems (ICAR) (PI: Narendra Pratap Singh)

#### Economics of the low land integrated farming system model

A rice based farming system model (crop-livestock-mushroom) has been developed on 0.7 ha area for typical lowland situations of Goa. Different enterprises of the model are crops (rice followed by sweet corn/brinjal/groundnut/cowpea – 0.4 ha), forage grown bunds (Hybrid napier - 0.032 ha), Dairy (24 m<sup>2</sup>), mushroom (21 m<sup>2</sup>), Vermicomposting (10 m<sup>2</sup>) and kitchen garden (80 m<sup>2</sup>). The net return from the above-mentioned model was ₹ 1.17 Lakhs during one year and this is excluding the cost of farm employment generated and products recycled within the system. The value of the farm employment generated and value of products recycled within farm was ₹ 1.01 lakh and ₹ 0.32 lakh. Besides the higher net profit, the system also has an advantage of the round the year income and positive effect on the soil health.

#### Cropping systems and their relative contribution in gross and net returns of the crop enterprise

The rice-sweet corn-dairy was the most profitable of the four systems fetching net returns of ₹ 55904 and gross returns of ₹ 73056 whereas, net returns and gross returns earned by the rice-brinjal-dairy system are ₹ 13734 and ₹ 27546 respectively, making it the least profitable of the four cropping systems.

#### Livelihood analysis of integrated farming systems

Out of the total value of the farm produce i.e. ₹ 3.45 Lakh, the marketable surplus was around ₹ 3.13 Lakh. As the unit doesn't have a farm family, the value of marketable surplus is higher. The total value of all farm commodities produced from the crop and cropping system component during one

complete farming system cycle was ₹ 1,58,894, of which the marketable surplus available is ₹ 1,41,534. Appreciable marketable surplus was also achieved through dairy unit and its value was ₹ 69,600. Of all the enterprises included in the integrated farming system model, the dairy component showed maximum economic returns, contributing 43.6 % to net returns and 23 % to gross returns, followed by the crops/cropping enterprise which made a contribution of 43.4 % towards the net returns and 45.9 % to gross returns. Net returns of 0.58 % were obtained from the horticultural component which is the least in comparison to all other farm enterprises.

#### Total inputs cost and percent share of the inputs purchased/generated and recycled within the system

The value of inputs purchased from market and farm labour engaged is ₹ 0.77 lakh and ₹ 0.83 Lakh, respectively. The value of inputs generated and recycled within farm is ₹ 0.32 Lakh. The total cost of input sums up to ₹ 0.19. The cost of input can be further reduced by increasing the inputs generated and recycled within the farm. The benefit: cost ratio was calculated and found to be 0.79 excluding the farm employment generated and 2.15 if the farm employment generated included to the net income.



Lowland integrated farming system model

**Project : All India Co-ordinated Research Project on Cashew (ICAR)**  
(PI: A. R. Desai)

**Germplasm collection, conservation, evaluation, characterization and cataloguing**

During season, four new accessions were identified for their traits like higher nut yield, bold nut coupled with higher kernel recovery and bigger apple size.

Shiroda-1/14 and Shiroda -2/14 accessions are of bold nut and higher nut yield traits while Tiswadi-9/14 is having sweet apples with less tannin contents. Valpoi-9/14 is a cluster bearing accessions with more than 10 nuts per panicle, and higher nut yield also. Clonal propagation of all these four accessions has been done, so as to enrich our germplasm bank.

With addition of these new four accessions, the strength of our germplasm bank is as follows

- Jumbo nut types : 14 accns
- Bold nut types : 36 + 2 accns
- Medium nut and high yielders : 13 +1 accns
- Other high yielders / cluster bearers irrespective of nut size : 23 +1 accns
- Dwarf canopy types : 3 accns
- Total germplasm collection : 89 + 4 = 93



*Shiroda-1/14, A new accession selected for bold nut and higher nut yield and bigger apple*



*Valpoi-9/14 , A cluster bearing accession*

**Characteristics of mother trees of four new accessions identified during 2014 season**

Sl. No.	Accession	Special feature	Approx. age (yrs)	Nut yield (kg/tree)	Average nut weight (g)	Apple characters		
						Average apple weight (g)	Colour	TSS (°B)
1	Shiroda-1/14	Bold nut	>28	18	8.4	85.6	Red	11.2
2	Shiroda-2/14	Bold nut	>32	12	9.0	81.4	Yellow	10.6
3	Tiswadi-9/14	Medium nut	>20	18	7.1	61.5	Yellowish orange	12.8
4	Valpoi-9/14	Medium nut cluster bearing	>28	25	6.9	52.0	Yellow	10.8

## Varietal evaluation trial (MLT-VI)

### Evaluation of new hybrids / varieties introduced from other cashew research stations

During the year, Bhaskara and Vengurla-8 continued to record significantly higher nut yield of 3.4 and 3.7 kg/tree respectively followed by Priyanka (2.6kg/tree). In the current season also, the trees of all the varieties were severely affected by Tea mosquito bugs.

## Hybridization and selection

### Evaluation of 1<sup>st</sup> set of hybrids

Evaluation of hybrid progeny was continued. Among the first set of 12 hybrids, planted during 2006-07, hybrids namely, H-31/05, H-27/05 and H5/05 showed vigorous growth habit recording the higher tree height and canopy spread. H-31/05 recorded the highest tree height of 6.4m followed by H-27/05 (5.7m) and H-5/05 (5.5m). Similar trend was also observed with respect to collar girth and canopy spread.

### Growth parameters of cashew hybrids

Accn. No	Tree height (m)	Collar girth (cm)	E-W spread (m)	N-S spread (m)
H-5/05	5.50	100	7.70	7.20
H-11/05	4.0	68	6.90	6.20
H-12/05	4.90	71	4.90	4.40
H-13/05	6.0	56	4.60	4.90
H-14/05	5.20	69	5.30	5.50
H-21/05	5.0	87	7.5	9.0
H-22/05	4.90	72	6.0	7.0
H-23/05	4.05	61	4.40	5.10
H-27/05	5.70	91	8.20	8.40
H-29/05	4.40	80	6.80	6.40
H-30/05	4.0	55	5.0	4.70
H-31/05	6.40	101	10.0	9.20

The vigorous growth habit and hence the bigger canopy size coupled with cluster bearing

trait contributed to the higher nut yield per tree in HB-31/05 which recorded the highest nut yield of 14.56 kg/tree, however with smaller nut size of 7.12g and smaller apple size (55.65 g) during fifth harvest. The shelling percent was recorded to be 29.02. HB-21/05 was the next highest yielder with 6.7kg/tree of nut yield having fairly bolder nut size of 8.6 g, kernel out turn of 29.15 per cent and apple size of 90.55g. Hybrid HB-12/05 was third better yielder recording 5.85 kg/tree of nut yield which had the mean nut size of 7.82g and apple size of 80.5 g. Other hybrids like HB-11/05Hb-27/05 and HB-22/05 were next better performers with nut yield in the range of 2.87 – 4.41 kg/tree. Hb-22/05 had the boldest nuts (9.02 g) and biggest apple size (100.4 g) among the hybrids. In general all the hybrids were observed to be affected by tea mosquito bug, especially severe incidence observed in HB-13/05, Hb-14/05, HB-30/05 and HB-31/05.

### Nut characteristics and yield of first set of hybrids during 2014 (Fifth harvest season)

Hybrid	Nut weight (g)	Nut yield (kg/tree)	Shelling (%)	Apple size (g)
H- 5/05	7.8	1.65	28.22	60.55
H- 11/05	7.80	4.41	28.86	65.40
H- 12/05	7.82	5.85	29.45	80.50
H- 13/05	7.91	0.89	27.92	85.5
H- 14/05	8.12	1.81	28.00	79.55
H- 21/05	8.6	6.7	29.15	90.55
H- 22/05	9.02	2.87	29.21	100.4
H- 23/05	7.9	2.02	28.86	75.25
H- 27/05	7.56	3.35	28.55	70.65
H- 29/05	7.60	1.55	28.00	68.33
H- 30/05	7.62	1.01	27.68	65.68
H- 31/05	7.12	14.56	29.02	55.65

Cashew apples were processed for preparing value added products like Ready To Serve (RTS) beverage and cashew apple jam and the protocol



Value added products of cashew apple - ready to serve beverage, apple jam and candy



was standardized. Besides this, protocol for preparation of cashew apple candy was also standardized which is ready for pilot scale trial.

Nutritive characterization of cashew apple candy is under process for commercializing the technology.

### Project : All India Co-ordinated Research Project on Pigs (ICAR) (PI: E. B. Chakurkar)

As per the technical program of the AICRP on Pigs, crossbred pigs of 75% exotic blood were produced and studied for their performance.

#### Breeding strategy of the farm

Four breeds namely Agonda Goan (Local), Large White Yorkshire, Crossbred 50% and crossbred 75% are maintained at the farm. Breeding policy is followed as per the technical program of AICRP where experimental animals are crossbred 75%. One breeding boar is allotted for three breeding females. AI is the common practice for breeding. Agonda Goan, Large White Yorkshire and crossbred 50% are maintained for production of crossbred 75% so as to avoid inbreeding. Artificial Insemination is the only breeding method followed for all the experimental groups. This AI technology is also transferred in the farmer's demonstration unit.

#### Management improvements

Modification of housing was done where watering nipples were fixed in each pig pen. This is providing clean adlib drinking water round the clock. This helps normal healthy physiological health of the stock. Bird protection net was fixed on all the pig pens as there is problem of migratory birds which are creating nuisances for the pigs.



Pig breed - Large White Yorkshire

**Nutritional experimentation (Use of location specific economic ration along with detail feed composition of different category of feed):**

Swill feeding is a common practice in pig rearing in the area but the quality of material is not sure. Many times only poor carbohydrates like rice or barkers products are available and most of the time very low proteins are available. To study scientific way of utilizing biological waste a trial on feeding of broiler offal is initiated. Proximate analysis of different parts of offal like head, shanks, and skin viscera was undertaken. Skin/subcutaneous portion had very high crude fiber. To prepare balanced diet head and shanks were minced and used as major portion of ration. Feeding trial is in progress.

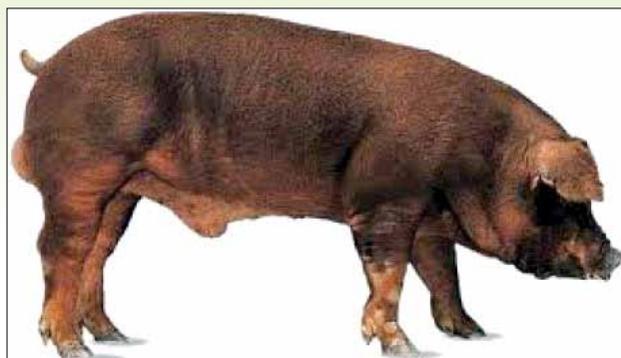
More than 250 farmers, commercial pig growers and professionals have approached for the technical advice. Technical advice as well as practical training was demonstrated to them.



*Agonda Goan pig*



*Cross breed pig of Goa Local X Yorkshire*



*Duroc pig*

**Success story**

Mr. Custodio Fernandes, Salcete - Goa has started a pig farm maintaining about 100-150 pigs in remote areas of Canacona taluka of South Goa district. First he started with local ND pigs as trial but with AICRP pigs Goa centre's intervention he has modified housing, feeding and introduction of crossbred pigs has increased the margin of profit. He is able to sell at least 2-3 animals per week and is able to earn 3500 profit per week. Hotel kitchen waste is the major part of feeding which is fortified with maize powder and mineral mixture.



*Visit of Scientist to pig farm*

## AICRP Voluntary Centres

### Project : All India Co-ordinated Research Project on rice (ICAR)

(PI: Manohara, K. K.)

#### Coastal Salinity Tolerant Variety Trial (CSTVT)

This trial consisted of 33 rice cultures including 3 check entries namely CST 7-1 (Coastal saline), Jaya (Yield check) and local check Korgut. The trial was laid out in RBD design with three replications in farmers' field at Chorao Island, North Goa. Soil EC ranged from 2.68 to 5.95 dS/m and soil pH from 5.26 – 5.54.

#### Mean performance of the top 5 entries in CSTVT Trial, Kharif-2014

Genotypes	DM	PHT (cm)	NPT/hill	GY (kg/ha)
DRR H 102 (Hybrid)	154.0	119.8	5.4	2202.5
CR 2839-1-S-11-1-B2-B-46-2B	145.0	107.3	4.9	1842.5
CR 2814-1-19-4-2-1-1-5	143.0	108.5	3.8	1705.0
CR 2815-5-1-3-S-1-2-1	142.0	106.5	4.9	1552.5
IR 83421-6-B-3-3-1-1-CR 3364-S-2B-14-2B	145.5	105.1	5.0	1485.0
Korgut (Local check)	134.0	121.2	6.8	1172.5
Mean	111.77	78.07	3.82	734.69
SE	51.26	32.64	3.82	419.09
CD@5%	104.42	66.48	7.79	853.66
CV (%)	45.86	41.80	53.26	57.04

**DM**- Days to maturity      **PHT**-Plant height  
**NPT**-No. of productive tillers      **GY**-Grain yield

Days to maturity ranged from 81 days (2429) to 166 days (2403), plant height ranged from 47.35 cm (2412) to 156.3 cm (2415), productive tiller per hill ranged from 2.4 (2412) to 7.2 (2430), while grain yield ranged from 85 kg/ha (2412) to 2202.50 kg/ha (2433)

Among the test entries, the top 5 ranking entries are DRR H 102 (Hybrid) (2202.5 kg/ha), CR 2839-1-S-11-1-B2-B-46-2B (1842.5 kg/ha), CR 2814-1-19-4-2-1-1-5 (1705.0 kg/ha), CR 2815-5-1-3-S-1-2-1 (1552.5 kg/ha) and IR 83421-6-B-3-3-1-1-CR 3364-S-2B-14-2B (1485.0 kg/ha). Only DRR H 102 recorded significantly higher grain yield compared to the check variety Korgut (1172.5 kg/ha).



A view of CSTVT trial at farmers field in Chorao Island

#### International Network for Genetic Evaluation of Rice (INGER): International Rice Soil Stress Tolerance Nursery – Module-1.

This trial consisted of 41 rice cultures including one local check Korgut. The trial was laid out in RBD design with two replications in farmers field at Chorao Island, North Goa. Soil EC ranged from 2.68 to 5.95 dS/m and soil pH from 5.26 – 5.54. Days to maturity ranged from 66 days (IRR 123) to 155 days (IR12T198), plant height ranged from 47.8 cm (IR 89609-8-2-B)

to 151.3 cm (Pokkali), productive tiller per hill ranged from 1.2 (Nona Bokra) to 7.0 (IR12T193), while grain yield ranged from 25 kg/ha (Nona Bokra) to 2733.50 kg/ha (CSR-28).

**Performance of the top 5 entries in IRSSTN Trial, Kharif-2014**

Genotypes	DM	PHT (cm)	NPT/hill	GY (kg/ha)
CSR-28	140.0	110.0	5.6	2733
A 69-1	145.0	99.6	5.4	2458
IR13T135	146.5	99.0	5.9	2192
CSR-90IR-2	136.5	106.0	6.2	2042
IR12T156	143.5	108.1	5.4	1983
Korgut (Local Check)	132.5	106.8	5.9	817
Mean	117.85	86.24	4.16	1163.21
SE	47.50	34.10	1.53	700.48
CD @ 5%	96.00	68.93	3.10	1415.73
CV (%)	40.30	39.54	36.87	60.21

**DM**-Days to maturity      **PHT**-Plant height  
**NPT**-No. of productive tillers      **GY**-Grain yield

Among the test entries, the top 5 ranking entries with respect to grain yield are CSR-28 (2733 kg/ha), A 69-1 (2458 kg/ha), IR13T135 (2192 kg/ha), CSR-90IR-2 (2042 kg/ha) and IR12T156 (1983 kg/ha). Entries CSR-28 and A 69-1 recorded significantly higher grain yield compared to the local check variety Korgut (817 kg/ha).

**Response of improved rice varieties under rainfed shallow lowland situation, Kharif, 2014**

Rainfed shallow lowland ecology occupy maximum area of rice in Goa covering more than 50% (27,000 ha) of the total rice area. In order to introduce new set of high yielding varieties to this ecology, a set of 22 improved varieties were evaluated during wet season 2014 to identify promising high yielding types.

The experiment was laid out at Experimental field of the Institute in Randomized Block Design (RBD) with three replications. Data recorded on all the yield and its attributing characters. Analysis of data showed that, significant differences existed among the tested genotypes for all the characters.

**Mean performance of the top five entries under rainfed shallow lowland situation, Kharif-2014**

Genotypes	DFE	DM	PHT (cm)	NPT/hill	GY/ (kg/ha)
MTU-1001	108.0	136.3	131.9	7.1	7648
MTU-7029	114.0	145.3	105.5	6.1	7285
Karjat-3	102.0	134.0	113.6	9.9	7170
Hiranmayee	101.0	134.0	138.9	8.1	7104
Konark	94.0	129.0	122.5	8.1	6652
Jaya	98.3	135.0	122.3	5.9	5104
Jyothi	94.0	124.0	114.1	6.2	4611
Mean	97.36	129.42	118.96	7.26	5789.39
SE	1.39	2.14	3.39	0.85	651.42
CD @ 5%	2.81	4.32	6.84	1.73	1314.62
CV (%)	1.75	2.02	3.49	14.49	13.78

**DFE**-Days to 50% flowering      **DM**-Days to maturity      **PHT**-Plant height  
**NPT**-No. of productive tillers      **GY**-Grain yield

Days to fifty per cent flowering (DFF) ranging from 88.3 days (MTU - 1010) to 114 days (MTU - 7029), days to maturity ranging from 118.7 (MTU - 1010) to 145.3 (MTU 7029), plant height (PHT) ranging from 102.9 cm (Daya) to 138.9cm (Hiranmayee), Number of productive tillers per hill ranging from 5.6 (Mandakini) to 9.87 (Karjat - 3) and grain yield ranging from 4037 kg/ha (MTU - 1010) to 7648.1 kg/ha (MTU - 1001).

Among the 22 test entries, top five entries with respect to grain yield are MTU-1001 (7648 kg/ha) followed by MTU - 7029 (7285 kg/ha), Karjat - 3 (7170 kg/ha), Hiramayee (7104 kg/ha), and Konark (6652 kg/ha). Check varieties Jaya and Jyothi recorded grain yield of 5104 kg/ha and 4611 kg/ha, respectively. All the top five entries

recorded significantly higher yield compared to both the check varieties Jaya and Jyothi.



*Field view of medium duration rice evaluation trial under rainfed shallow lowland condition*

## **Project : All India Co-ordinated Research Project on Arid Legumes (ICAR)** *(PI: Manohara, K. K.)*

### **Evaluation of Cowpea lines, Rabi, 2014-15**

The Cowpea trial comprising of 32 advanced breeding lines laid out in randomized complete block design in two replications. The local selection, Alsando-1, was used as a check variety. Data recorded on all the yield and its attributing characters. Analysis of data showed that, significant differences existed among the tested genotypes for all the characters.

#### **Mean performance of top five Cowpea entries**

<b>Genotypes</b>	<b>DFF</b>	<b>DM</b>	<b>PHT (cm)</b>	<b>GY (kg/ha)</b>
CP- 36	61	82.5	33.27	2752
CP- 32	64	90	40.3	2463
CP- 41	52	73.5	30.17	2429
CP- 14	49	80	22.84	2424
CP- 25	53	83.5	35.51	2342
Alsando - 1	59	90	32.15	2207
MEAN	54.73	79.65	32.08	1839.17
SE	0.99	1.29	3.31	378.53
CD @ 5%	2.02	2.64	6.75	772.02
CV(%)	1.81	1.62	10.32	20.58



*Field view of Cowpea trial*

Days to 50% flowering ranged from 47 days (CP-15) to 68.5 days (CP-13), days to maturity ranged from 72 days (CP-39) to 92 days (CP-13), plant height ranged from 20.30cm (CP-35) to 45.05cm (CP-35) and seed yield ranged from 1077.7 kg/ha in CP-26 to 2751.8 kg/ha in CP-36. None of the entries recorded significantly higher grain yield compared to the local check variety. Alsando-1 which recorded seed yield of 2207 kg/ha.

## Project : All India Co-ordinated Research Project on Palms (ICAR) (PI: V. Arunachalam)

Under the ICAR-All India Coordinated Research Project on Palms, the Institute has been sanctioned a project for experiments covering improvement, seed production and cropping system research of coconut and arecanut with financial outlay of Rs. 30.7 Lakhs during 2015 to 2017. The project aims at evaluating technologies generated by ICAR-CPCRI for agro-ecological

situations of Goa.

Nursery was raised with seed nuts of varieties *viz.* Kalpa Dhenu, Kalpa Mitra, Kalpa Raksha, Kalpa Pratibha received from CPCRI, Kasargod along with two varieties Chowghat Orange Dwarf and Benaulim. Seedling characters were recorded in each of the seedlings.

## Project : All India Co-ordinated Research Project on Vegetable Crops (ICAR) (PI: M. Thangam)

ICAR RC, Goa is one of the voluntary centres under AICRP on Vegetable crops, IIVR, Varanasi since 2005-06. Under this national programme, multilocation trails are carried out in brinjal (varietal and disease resistant trial) and chilli (varietal trial) at Goa centre.

In varietal trial, the observations on days to first flowering, number of fruits per plant, yield per plant, individual fruit weight *etc* are being recorded and the trial is under progress.

In the bacterial wilt resistant trial, observations on wilt incidence was recorded during 30 days and 45 days after transplanting. The wilt incidence ranged from 15.55 to 100 per cent. The highest incidence of bacterial wilt was noticed in Pusa Purple Long, Arka Kusumakar where as resistant checks *viz.*, SM-6-6 and Arka Nidhi recorded almost zero incidence of bacterial wilt under field condition. The observations on other horticultural traits are being recorded and the trial is under progress. The varietal trial in chilli is under progress.



Brinjal bacterial wilt trial (AVT-1 and AVT-2)



Crop stand in resistant check (SM-6-6) and susceptible check (Pusa Purple Long)

## Externally Funded Projects

### Project : Amelioration and management of coastal saline soils for rice production in Goa, (DST&E) (PI: G. R. Mahajan)

#### Coastal saline soils of Goa behaves spatio-temporally different

Analysis of the soils of four typical salinity groups – non-saline, weakly saline, moderately saline and strongly saline in three different seasons – monsoon, winter and summer exhibited typical variations in the chemical and microbiological properties. The soils were most biologically active during the monsoon followed by winter and lowest in summer. The order of biological activities during all three seasons was observed as: non-saline > weakly saline > strongly saline.

The lowest soil microbial biomass carbon (21.1 mg kg<sup>-1</sup> soil) was recorded in strongly saline soils during summer season, whereas the highest was recorded in non-saline soils during monsoon (112.75 mg kg<sup>-1</sup> soil) and winter (112.84 mg kg<sup>-1</sup> soil). In all the seasons, a significant negative relation between salinity levels and fraction of

organic carbon as microbial biomass carbon was observed. It was 2.28 times lesser than that of non-saline soils. The soil salinity had an adverse effect on the microbial growth and caused lesser utilization of the carbon present in soil. Like soil microbial biomass carbon, soil enzyme activities significantly reduced with increasing levels of salinity. Reduced microbial and enzyme activities in turn reduces the nutrient mineralization and thereby the plant growth. The metabolic quotient of strongly saline soils was 2.4 times higher than that of non-saline soils. Under this situation, microorganisms have to spend more energy on maintenance than the growth. The soil organic carbon stock correlated positively and strongly with the biological activities, suggesting addition of organic matter as a countermeasure to manage the coastal saline soils of Goa.



*Typical coastal saline soils of Goa*

**Project : Stress Tolerant Rice for Poor Farmers of Asia and South Asia (BGMF)**  
*(PI. Narendra Pratap Singh)*

**Evaluation of *Saltol* introgressed rice lines under coastal soil salinity condition**

About 45 *Saltol* introgressed rice lines received from IRRI, Philippines were tested under natural coastal salinity conditions of Goa for the second consecutive year. The trial was taken in farmer's field at Choroa Island, North Goa district. The trial was laid out in randomized complete block design with CST 7-1, CSR-27, CSR-36 and Korgut as check varieties.

The result indicated that, the genotype IR87848-301-2-1-3-B recorded highest grain yield (4713 kg/ha) followed by IR 87831-3-1-1-2-2-BAY B (4525 kg/ha), IR87848-301-2-1-1-B (4234 kg/ha), IR 87938-1-1-3-1-2-B (4116 kg/ha) and IR 87952-1-1-1-2-3-B (4113 kg/ha). Among the check entries, best check variety was CSR-



*View of STBN trial at farmers field in Choroa Island*

27 which recorded grain yield of 3572 kg/ha followed by CSR-36 with 3408 kg/ha, CST 7-1 (2261 kg/ha) and local check variety korgut with 1775 kg/ha.

**The performances of top five entries along with check varieties**

Genotypes	DM	PHT (cm)	NPT hill	GY (kg/ha)
IR87848-301-2-1-3-B	133.0	121.4	7.6	4713
IR 87831-3-1-1-2-2-BAY B	153.0	132.1	5.4	4525
IR87848-301-2-1-1-B	140.5	121.4	7.2	4234
IR 87938-1-1-3-1-2-B	150.5	104.4	6.4	4116
IR 87952-1-1-1-2-3-B	154.5	123.0	6.5	4113
CSR-27 (Check-1)	145.0	102.3	5.7	3572
CSR-36(Check-2)	142.5	124.0	6.9	3408
CST 7-1(Check-3)	160.5	107.2	4.9	2261
Korgut (Local Check)	137.5	130.2	8.2	1775
Mean	146.63	111.21	5.94	3255.00
SE	5.74	8.31	1.01	1053.68
CD @ 5%	11.58	16.74	2.03	2123.55
CV (%)	3.92	7.47	16.95	32.37

**DM**-Days to maturity

**NPT**-No. of productive tillers

**PHT**-Plant height

**GY**-Grain yield

**Project : Agro-morphological characterization and DNA finger printing of rice landraces of Goa (DST&E)**  
(PI: Manohara, K. K.)

Exploration conducted for four years (*Kharif* season of 2010-13) has resulted in the collection of 17 landraces and 28 wild relatives. The present investigation to characterize all the 17 landraces was carried out at the Institute farm during *Kharif* season 2014-15. Observations were recorded at four phases *viz.*, Seedling Phase, Vegetative Phase, Reproductive Phase and at Maturity Phase. All the agro-morphological and yield and its related parameters were recorded based on DUS guidelines on rice.

**Description of few agro-morphological characters**

Out of thirty morphological characters studied characters *viz.*, basal sheath colour, leaf pubescence, node colour, lemma and palea colour, awn colour, awn length and distribution, secondary branching and panicle exertion showed variability among the tested genotypes whereas, rest of the characters showed only two classes of different genotypes.

**Basal leaf sheath colour**

Nine genotypes showed green colour and seven genotypes showed purple lines. Only one genotype “Babari” showed uniform purple colour.

**Leaf pubescence**

Leaf pubescence showed wider variability among the tested genotypes. Seven genotypes displayed strong pubescence, two displayed very strong and three genotypes displayed weak pubescence and in rest three genotypes it was medium. In one genotype, “Saalsi” there was absence of pubescence.

**Lemma and Palea colour**

Ten genotypes recorded straw coloured lemma and palea while six genotypes had brown furrows on straw background and only one genotype i.e. Kalo Belo displayed brown colour.



Field view of land race evaluation and wild rice multiplication block

**Awns, its distribution and colour**

Awning is an important character, only six genotypes showed the presence of awns, in other genotypes it was absent. Among the genotypes having awns, it was yellowish white in three genotypes (Damgo, Walayo, Korgut) and was yellowish brown in genotypes Belo, Kalo Belo, Saalsi.

The distributions of awns were on the tips of all the genotypes except for Korgut wherein awns were present throughout the panicle. Secondary branching was found to be strong in majority of genotypes except for Mudgo, Kalo Belo, Korgut, White Kochri wherein it was weak.



Diversity in grain type among the rice land race

**Project : Outreach project on *Phytophthora*, *Fusarium* and *Ralstonia* diseases of horticultural and field crops (ICAR)**  
(PI: R. Ramesh)

**Collection of *R. solanacearum* infecting solanaceous vegetables and their characterization**

Nineteen *R. solanacearum* have been deposited at NBAIM, Mau. The accession numbers are given below.

Strain	NBAIM accession number
Rs-08-11	NAIMCC-B-01613
Rs-08-55	NAIMCC-B-01614
Rs-09-151	NAIMCC-B-01615
Rs-09-202	NAIMCC-B-01616
Rs-10-204	NAIMCC-B-01617
Rs-10-250	NAIMCC-B-01618
Rs-10-253	NAIMCC-B-01619
Rs-10-292	NAIMCC-B-01620
Rs-10-336	NAIMCC-B-01621
Rs-09-94	NAIMCC-B-01622
Rs-09-131	NAIMCC-B-01623
Rs-10-244	NAIMCC-B-01624
Rs-09-189	NAIMCC-B-01625
Rs-10-257	NAIMCC-B-01626
Rs-09-198	NAIMCC-B-01627
Rs-09-193	NAIMCC-B-01628
Rs-10-215	NAIMCC-B-01629
Rs-09-161	NAIMCC-B-01630
Rs-10-216	NAIMCC-B-01631

The whole genome sequenced strains viz. Rs-09-161 and Rs-10-244 are deposited at MTCC, Chandigarh.

**Analysis of genetic diversity of *R. solanacearum***

To study the diversity within a small geographical region, ten *R. solanacearum* isolates from Goa and adjoining region of Maharashtra

were selected. Six genes (*mutS*, *ppsA*, *adk*, *gapA*, *egl*, *fliC*) were aligned based on their alignment in GMI1000 and concatenated sequences were analyzed. The phylogenetic relationships of these 10 isolates were compared with whole genome sequenced Phylotype I strains Rs-09-161 and Rs-10-244 along with GMI1000. The results indicated that Rs-08-44, Rs-09-172, Rs-11-344, Rs-10-278, Rs-11-376 were 100 % identical with the Indian strain Rs-09-161 isolated from brinjal. Three isolates Rs-10-332, Rs-10-325 and Rs-09-83 were closely related to the other reference strain Rs-10-244.

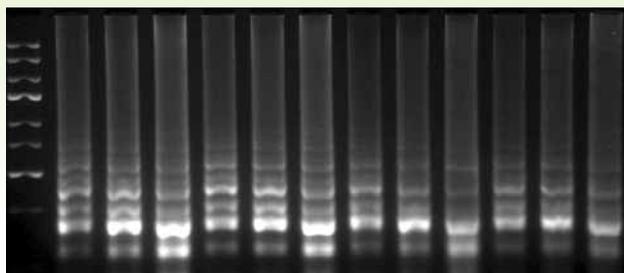
The MLST analysis of the selected 10 isolates was carried out. Nucleotide diversity was in the range of 0.0041-0.00207 across all the genes. It was highest in case of *mutS* gene (0.0041) and lowest in case of *ppsA* gene (0.00207). Haplotype numbers for each of the 6 genes ranged from 2 (*mutS*) to 6 (*gapA*). Five isolates viz. Rs-08-44, Rs-09-172, Rs-10-278, Rs-11-344 and Rs-11-376 were 100% identical to each other and belonged to haplotype1 and all were from brinjal and their sequevars are unknown. The frequency of mutations was more in *egl* as compared to other genes.

**Standardization of detection of *R. solanacearum* by LAMP**

**Loop-Mediated Isothermal Amplification (LAMP) PCR for detection of *R. solanacearum***

Primers were designed for LAMP PCR. Several parameters of reaction mix and PCR cycle were optimized to obtain discrete ladder type banding pattern. Primer specificity was determined using DNA from commonly found soil and plant associated bacteria.

LAMP PCR was standardized to detect the bacterium directly from soil and the minimum threshold of detection from soil was 70 CFU. Using water bath similar pattern of amplification



LAMP PCR for detection of *R. solanacearum*

and intensity of bands as obtained using PCR machine was observed from positive samples. Suitability of several dyes for visual observation of positive LAMP reaction for detection of *R. solanacearum* under field conditions without the need for agarose gel electrophoresis was standardized. Results of visual observation using dyes were comparable to those obtained by agarose gel electrophoresis. The results indicate that using water bath and dye, *R. solanacearum* could be detected under field conditions using LAMP PCR.

### Isolation of xylem bacteria from eggplant and screening XRB against *R. solanacearum*

#### Colonization of xylem residing bacteria (XRB) in brinjal

Antagonistic XRB of genera *Agrobacterium* sp. (XB1, XB86 and XB165), *Enterobacter* sp. (XB99 and XB123), *Pseudomonas aeruginosa* (XB7 and XB122) and *Bacillus cereus* (XB177) which prevented wilt were found to re-colonize brinjal stem and rhizosphere. Studies using GFP tagged XB177 proved that bacteria isolated from xylem could re-colonize xylem vessels of stem and also rhizoplane of brinjal, tomato and chilli when tested under greenhouse conditions. Further, it was found that pre-treatment of brinjal by the antagonistic bacteria is an important pre-requisite for effective wilt prevention.

#### Degradation of 3OH-PAME

Eight strains out of 167 XRB degraded 3OH-PAME, a quorum sensing molecule of *R. solanacearum*. Two of the 3OH-PAME degrading XRB (XB7 and XB122) were antagonistic to *R. solanacearum*. Degradation of 3OH-PAME to 3OH-palmitic acid was confirmed by HPLC-MS. Crude quorum quenching molecule from six XRB

had high specific activity towards 3OH-PAME degradation. Five XRB (XB7, XB102, XB109, XB115 and XB122) which degrade 3OH-PAME were able to re-colonize and prevent wilt in brinjal.

#### Development of suitable mapping population for bacterial wilt management

21 lines of F<sub>4</sub> and 102 F<sub>5</sub> lines were raised and seeds were collected from different plants which vary in fruit colour, fruit shape, colour pattern and bearing habit.

#### Evaluation of various strategies for the management of *R. solanacearum*

#### Management of bacterial wilt using biocontrol agents

Six strains of biocontrol agents able to prevent wilt in brinjal in the greenhouse conditions are being evaluated for wilt prevention under field conditions. Four strains of xylem residing bacteria (XB86, XB122, XB102 and XB177) and two strains of endophytic bacteria (EB69 and RP7) were applied as talc formulations in the nursery and also during planting. Colonization of brinjal seedlings in the nursery by the introduced strains was determined before transplantation.

Field experiment was laid out to evaluate the efficiency of the biocontrol agents in reducing bacterial wilt in eggplant. The transplanted plants were drenched with the promising biocontrol suspension (50g lit<sup>-1</sup>) @ 50ml/plant immediately after planting. The treatment was repeated after 15- 20 days. All the antagonistic bacteria colonized (6.0 Log CFU g<sup>-1</sup> of soil) the rhizosphere of brinjal at 30 days of treatment in the nursery. RP7 colonized the stem and XB177 colonized stem and leaf tissues.

Incidence of wilt was recorded regularly. Wilt was started 30 days after planting and continued till the end of the crop duration. The lowest wilt incidence (3.33%) was recorded in EB69 treatment. XB177 and XB122 recorded less than 10% wilt where as control showed 41% wilt incidence. The highest yield was recorded in EB69 (45.5t/ha), XB122 (38.21 t/ha), XB177



Field evaluation of bio-control agents for bacterial wilt management in brinjal.

(33.35 t/ha) and RP7 (32.78 t/ha) treatments. Bio-control efficiency (BCE) and increase in yield was higher in EB69 (92% and 104 %), XB177

(84% and 50%), XB122 (80 % and 71%) and RP7 (64% and 47%) treatments.

### Project : Production and formulation technology refinement of bacterial bio-agents for soil borne plant disease management under coastal ecosystems (AMMAS) (PI: R. Ramesh)

Two antagonistic bacteria selected based on their pathogen inhibition and disease reduction against three fungal and bacterial pathogens were studied. The bacteria are *Bacillus amyloliquefaciens* and *Pseudomonas aeruginosa*.

#### Standardization of growth medium for mass multiplication of *B. amyloliquefaciens* (RCh6-2b)

Growth of *Bacillus* in various media indicated that nutrient broth (NB) is the better medium. The medium needs to supplement with A1 for better growth suitable for formulation. Growth reaches maximum (8.0-8.7 Log CFU mL<sup>-1</sup>) at 24-30 h. Growth of *Bacillus* with different supplements indicated that 1.0% NB is can be used for mass multiplication. Addition of A2 did not affect the growth.

Medium for higher sporulation (Medium II-A1+A2) was standardized. Higher sporulation

will means higher survival rate in the formulation.

#### Evaluation of talc formulation of *B. amyloliquefaciens* (RCh6-2b) for its viability

Talc based formulation was prepared and the population in the formulations was studied over a period of time. Population in the talc formulation is maintained over 7.0 Log CFU g<sup>-1</sup> (A1) and over 8.0 Log CFU g<sup>-1</sup> (A1+A2) after 180 days.

#### Standardization and evaluation of liquid formulation of *B. amyloliquefaciens* (RCh6-2b) for its viability

Population of *Bacillus* sp. (RCh6-2b) in different liquid formulation (A, B and C) indicated that the population is above 7.0 Log CFU mL<sup>-1</sup> after 210 days in all the cases. Spore population of *Bacillus* sp. (RCh6-2b) in different liquid formulation after 7 months indicated that most of the population is from the spores in the formulation.

When different liquid formulations (A, B and C) developed by growing the bacterium in the medium containing glycerol and without glycerol are compared, there is no significant difference in the population of bacterium in the formulation over the period of six months. It shows that any of these formulations could be used in disease management.

#### **Standardization and evaluation of emulsion formulation of *B. amyloliquefaciens* (RCh6-2b) for its viability**

An emulsion formulation of RCh62b was prepared wherein 24 hour old culture (100 ml) of *Bacillus* grown in modified medium with A1+A2. The bacterial growth was added with 100ml of emulsion mix. Results indicated that the population of bacterium in the emulsion was 9.0 Log CFU mL<sup>-1</sup> till 45 days.

#### **Standardization and evaluation of alginate formulation of *B. amyloliquefaciens* (RCh6-2b) for its viability**

Method for production of sodium alginate was standardized. One and two per cent alginate beads were prepared and evaluated. It was observed that the release of RCh62b from the beads into Phosphate buffer is maximum (8.73 Log CFU ml<sup>-1</sup>) at 72 hours. The population analysis showed that the bacterial count of over 7.0 Log CFU g<sup>-1</sup> of soil after 3 days of application. This indicated that the sodium alginate being used is degradable in the soil and release the bacterium.

#### **Standardization of growth medium for mass multiplication of *P. aeruginosa* (Rs-08-72)**

Growth of Rs-08-72 in various media indicated that KB is the better medium. Growth reaches maximum (9.0-9.5 Log CFU mL<sup>-1</sup>) at 24-48 h.

#### **Evaluation of talc formulation of *P. aeruginosa* (Rs-08-72) for its viability**

Talc based formulation was prepared and the population in the formulations was studied over a period of time. Population in the talc formulation was maintained over 7.0 Log CFU g<sup>-1</sup> till 60 days. After 60 days of storage, contamination in the talc formulation was observed.

#### **Standardization and evaluation of liquid formulation of *P. aeruginosa* (Rs-08-72) for its viability**

Population of Rs-08-72 in different liquid formulation (A, B and C) indicated that the population is above 7.0 Log CFU mL<sup>-1</sup> after 210 days in all the cases.

#### **Standardization and evaluation of emulsion formulation of *P. aeruginosa* (Rs-08-72) for its viability**

An emulsion formulation of RCh62b was prepared wherein 24 hour old culture (100 ml) of *P. aeruginosa* grown in KB medium. The bacterial growth was added with 100ml of emulsion mix. Results indicated that the population of bacterium in the emulsion was 10.0 Log CFU mL<sup>-1</sup> till 45 days and 8.0 Log CFU mL<sup>-1</sup> till 75 days.

**Project : Genetic diversity of noni in Konkan coast of India (World Noni Foundation)**  
(PI: V. Arunachalam)

Currently 131 *Morinda citrifolia* (noni) plants are maintained as field gene bank in Block B which includes 68 cuttings and 63 seedlings. A new noni block at Farm-C was established with 167 additional noni plants that include 18 cuttings, 149 seedlings and 7 hybrids (*Morinda citrifolia* x *Morinda tinctoria*) and four seedlings of *M. tinctoria*. Grafting technique has been standardized and 11 grafts planted are showing good growth and are also studied for various traits. About 17 variegated seedlings have germinated and are in the growing stage. Air layering was perfected in noni as a new method of propagation. Three noni accessions from Maharashtra were conserved at NBPGR New Delhi with IC numbers (IC0612951 to IC 0612953). Two more variegated bud-sports

on a single noni plant native to Vagator were also identified. Morphological traits were recorded on 167 additional noni plants in the Block- C.



View of Noni plot

**Project : Approaches towards combating zoonotic and food borne infections through community participation. (DBT)**  
(PI: EB Chakurkar)

This project has sanctioned duration from 13 March, 2012 to 12 March, 2015. Survey with 20 field visits for follow-up and awareness camps were conducted.

During the current year 20 field visits for conducted to understand the farmers limitations as well as to communicate the good production and reproduction practices in farm animals. After awareness camps samples like milk samples floor swabs of livestock shed, different exudates like cervical swabs etc from the farmers field were collected. There was a positive effect found of the campaigns on quality improvement. Along with the farm hygiene, disease status of the animals was determined. Prevalence of zoonotic diseases

listeriosis, brucellosis, hemorrhagic septicemia was determined. Cases of FMD, buffalo pox, classical swine fever and toxoplasmosis were identified based on clinical examination. Outbreaks of bovine and swine diarrhea were investigated for identification of causative agent. Infertility is a major impediment to profitability in livestock production. Some zoonotic infections like brucellosis can cause abortions and reproductive disorders in animals which are leading causes for infertility as well as production loss. Therefore infertility cases were examined for presence of zoonotic infections.

**Project : Augmentation of rural pig production for socio-economic upliftment of the rural poor in Goa through artificial insemination (DBT)**  
*(PI : E. B. Chakurkar)*

Work done under this project include establishment of semen collection, preservation and artificial insemination centre at ICAR-CCARI, Old Goa with facilities like dummy sow, Accucell photometer, computer assisted sperm class analyzer and BOD incubator. Boars (Large White Yorkshire, Agonda Goan, Crossbreeds) were trained for donating semen. During second year of the project 163 semen ejaculates have been collected, evaluated and preserved using short term and long term semen extenders. A total 220 artificial inseminations were carried out of which 133 in institute pig farm and 87 A.I at farmer's field were carried out. The average conception rate of 35.63% with average live litter size of  $7.429 \pm 0.669$  at the birth was achieved at farmer's

field and 50.37% conception rate with average live litter size of  $7.23 \pm 0.43$  at birth was achieved in institute pig farm. Estrous induction using PGF $\alpha$ 2 to perform mass A.I at both farmers field and Institute was standardized. Two professional training program on AI in pigs were organized in which one for Veterinary officers/Assistants from AHVS, Government of Goa and one for faculty members of Kerala Veterinary College Thrissur were undertaken. Besides this three training and demonstration program for progressive pig farmers from Goa and Maharashtra on scientific pig rearing and AI in pigs were organized.

**Project : Technology demonstration on mariculture for improving the livelihood status of youth and women in Goa (NFDB)**  
*(PI: Manju Lekshmi N.)*

The surveys were carried out for site selection and beneficiaries for the project was along coastal region of Goa. Four beneficiary groups were identified for mussel culture demonstrations during November, 2014 to May, 2015. Two

training programmes on "Secondary livelihood opportunities through fishery resources" including mussel culture technologies was conducted on 6<sup>th</sup> August, 2014 and 19<sup>th</sup> -21<sup>st</sup> March, 2015.



*Madkai self help group*



*Pernem Bamboo Structure*



*Pernem Self help group*

**Project : Seed Production in Agricultural Crops and Fisheries (ICAR)**  
(PI: Manohara K. K.)

The major objective of the project is to take up quality seed production in major field crops, horticultural crops and ornamental fishes.

seed production. Small quantity of seed was also produced in few local collections of cowpea and one improved variety of green gram *var* TM-96-2.

**Seed production in rice (Kharif season 2014)**

Through evaluation of promising improved varieties under different ecology prevailing in Goa, few varieties were identified by the Institute for cultivation in the state of Goa. During *Kharif* season 2014, seed production of rice varieties Karjat-3 and Jyothi was taken up in an area of 0.8 ha at the Institute farm. All the recommended package of practices were followed to take up the healthy crop.

**Details of seed production**

Crop	Varieties	Quantity seed produced (quintal)
Rice	Karjat-3	8
	Jyothi	10
Cowpea	Goa Cowpea-3	2
	Local Collections	0.5
Green gram	TM-96-2	0.2

**Seed production in Cowpea and Green gram (Rabi Season 2014-15)**

Cowpea is an important pulse crop in Goa grown under residual moisture conditions after the harvest of *kharif* rice crop. The seed production programme during the current year was focussed mainly on recently recommended variety Goa Cowpea-3 by the State Variety Release Committee of the state. About 0.3 ha area was taken up for its

**Horticultural planting material production**

Quality planting materials numbering 2947 covering 15 horticultural crops were generated and sold during the year. A revenue of ₹ 1,10,574/- was generated during the year. Other crops covered are lemon, drumstick, pumello and guava.



Seed production in rice (variety Karjat-3)



Seed production in rice (variety Jyothi)



Seed production in Cowpea (variety Goa Cowpea-3)



Seed production in green gram (variety TM-96-2)



Multiplication of local collections of cowpea

### Planting material sold

Crop	Propagule	Number sold
Banana	Sucker	426
Coconut	Seedling	418
Papaya	Seedling	241
Crossandra	Rooted cutting	248
Black pepper	Rooted cutting	224
Pine apple	Sucker	257
Arecanut	Seedling	792

### Seed production in fisheries

Breeding and seed raising methods of both egg layers and live bearers of many fresh water ornamental fishes namely gold fish (normal, shubunkin, redcap, black moor, silver), koi carp, gourami, (blue, yellow, pearl), angel, sword tail, guppy varieties and molly are developed after repeated trails. Live feeds like *Spirulina*, infusoria are produced and fed to young ones and

adults. The broodstock of gold fish, angelfish, black molly, koi carp, blue gourami and guppy are being developed for the ensuing breeding season.

Intensified the broodstock by adding new fish brooders including Gold fish varieties like red cap, black moor, shubunkin etc and also brooders of angels, silver dollars, black ghost etc. Propagation was started for aquatic plants like *Ceratophyllum*, *Cabomba*, *Hydrilla* and *Vallisneria* etc. Experimental trails were initiated to enhance the colour of the ornamental fishes gold fishes, koi carps and platies by incorporating different locally available colour enhancing biological compounds like marigold and rose powder in feed. There is a significant difference in colour for gold fish varieties, koi carps and platies by adding marigold and rose powders of different concentrations. More than 3000 different ornamental fish seed were sold. Indigenous fresh water ornamental fishes of Goa are collected and maintained in Institute hatcheries.



Ornamental fishes

## Project : Poultry Seed Project (ICAR) (PI: R. Solomon Rajkumar)

Goa produces approximately only 30% of its requirement of poultry eggs and meat and is solely dependent upon the neighboring states for the additional demand for chicken meat and the eggs. Though commercial poultry development in the country has taken a quantum leap in the last three decades, the growth has not penetrated into the state of Goa due to the unfavorable climatic conditions and the terrain for the commercial poultry. Therefore, the rural backyard poultry has been the most suitable alternative protein source for the Goan Population.

The Indian Council of Agricultural Research has initiated “Poultry Seed Project” (PSP) during the XI five year plan and. The main objectives of ICAR-Poultry Seed Project are production of improved poultry seed to target production enhancement of egg and meat covering 5,000-15,000 farm families per annum/centre for augmenting rural poultry production, socio-economic indexing of the target groups and linking small scale poultry producers with organized market.

The Indian Council of Agricultural Research has sanctioned a PSP center at ICAR-CCARI, Goa on 7<sup>th</sup> April 2014 during the XII five year plan. The ICAR has sanctioned the budgetary allocation of ₹ 203.57 Lakhs for 3 years (2014-2017). The activities of the project started from

the month of October 2014 with the procurement of Parent stock of *Gramapriya* day old chicks supplied by the ICAR-Directorate of Poultry Research, Hyderabad.

The Parent stock of *Gramapriya* day old chicks were cage brooded and reared under intensive system with strict biosecurity and best managerial practices. Currently the birds are of 23 weeks of age. Further, the Indian Council of Agricultural Research has sanctioned civil works for the construction of a Hatchery (1009 Sq. feet area), Brooder cum Grower House (2200 Sq. feet area) and the Parent house (3000 Sq. feet area) at this PSP center. The civil works are expected to be completed by next Financial Year. As the part of extension component of PSP, a training program on “Backyard Poultry” was conducted on 30-12-2014 in collaboration with the Krishi Vignan Kendra (North Goa), Old Goa.

### Hatchery Unit

A semi automatic Incubator cum Hatcher Unit of 5000 eggs capacity commissioned at this centre under RKVY project. The hatchery unit has air-conditioned egg storage unit, Candling facility and Generator facility. A total of 3000 poultry and quail chicks were produced in the last year and distributed to the various stakeholders.



*Gramapriya parent stock*



*Hatchery unit operations*

**Project : Generation of elite planting material in horticultural crops for Goa (RKVY)**  
*(PI: V. Arunachalam)*

Two shade-net houses each of 100 m<sup>2</sup> (pending irrigation) were established for plant propagation and nursery activities. Mother block of fruit plants *viz.* barbados cherry, wax jumbo,

rose apple, guava was established in Block C as avenue / border plantation. Mother blocks of sapota variety (Kalipatti, Cricket Ball) and guava were established in Block B and being maintained.

**Project : Establishment of protected structures for high value flower and vegetable crops for training and demonstration (RKVY)**  
*(PI: M.Thangam)*

**Evaluation of different gerbera varieties for cut flower production under naturally ventilated polyhouse**

Thirteen varieties of gerbera were planted under naturally ventilated polyhouse for evaluation. The tissue culture plants were planted during November, 2014 and commercial flower production started from March, 2015. The observations on flower yield per unit area, flower yield per plant, diameter of disc, No of petals per flower, stalk length and circumference *etc* are

being recorded and the trial is under progress.

**Evaluation of capsicum hybrids under naturally ventilated polyhouse**

Two commercial capsicum hybrids *viz.*, Bachata and Massilia were planted under naturally ventilated polyhouse for coloured capsicum production. The plants were pruned to have two stems per plant and four stems per plant. Standard package of practices is being followed to evaluate the capsicum hybrids. The study is under progress.



*Gerbera polyhouse at planting and flowering*



*Planting, flowering and fruiting of Capsicum under polyhouse*



*Fruiting in Capsicum hybrids under polyhouse*

(White), Den Charming white (White and Red), Den Sonia Earsakul (Red, Purple and White), Den Mona Red DC-0666 (Red) and Den Airy Red Bull (Red) were planted for an evaluation trial under shade net house. The trial is under progress.



*Planting of orchid tissue culture plants on coconut husk as growing medium*

### Evaluation of anthurium varieties under shade net house

Eight anthurium varieties viz., Cheers (Pink), Tropical (Red), Xacia (Pink), Savana (Red with white stripes), Moments (Cream white), Angel (White), Sumi (White mini anthurium) and Dakota (Red mini anthurium) were planted for an evaluation trial under shade net house. The trial is under progress.

### Evaluation of Orchid varieties under shade net house

Six varieties of orchids viz., Sonia (Purple), 5N

### Evaluation of Gladiolus varieties under open field condition

Nine varieties of Gladiolus viz., Souvenir Yellow, Summer Shine, Copper Orange, Summer Pearl, Doll Queen, Souvenir Saffron, Green Bay, Chipper White and Red Majestic were evaluated for different floricultural traits. The spike length



*Anthurium tissue culture plants on coconut husk as growing medium*





*Field view of Gladiolus evaluation under open field condition*

ranged from 47 cm (Red Majestic) to 66 cm (Souvenir Saffron). The number of florets was highest in Copper orange (12.67) followed by

Souvenir Saffron (11.67). The trial is under progress.

**Project : Conservation of traditional varieties of vegetable crops and entrepreneurship development for its seed production (RKVY)**  
*(P.I.: M.Thangam)*

During the extensive survey in Goa, local vegetable germplasm were collected for further seed production and evaluation. Varieties of Red Amaranthus , 5 - green amaranthus , 21 - varieties of chillies, 10 – okra, 3 –pumpkin, 1 -broad bean, 7 –cucumbers, 5 -snap melon, 15 -vegetable cowpea, 7 –brinjal, 4 -bottle gourd, 7 -ridge gourd, 3 - cluster beans, 2 -snake gourd and 2 -Onion were collected.

Out of 28 types of amaranthus evaluated for different traits, the highest whole plant weight was recorded in AMAR 4-18 Chimbel (33.25g) followed by AMAR 8-33 khaddem (29.65g). The highest moisture content in leaves was recorded in AMAR 5-25 Bendurem (88.08 %) followed by AMAR 29-155 Bhati (85.91%). The spike length was highest in AMAR 9-40 Gulem (33.90 cm) followed by AMAR 26-126 Shivdem (26.60 cm). The surveys will continue and the evaluation of collected types is under progress.



*Diversity in Okra for fruit size and length*



*Seed multiplication in Amaranthus*

**Project : Development of comprehensive e- agriculture portal for information and knowledge sharing in Goa (RKVY)**  
(P.I.: M. Thangam)

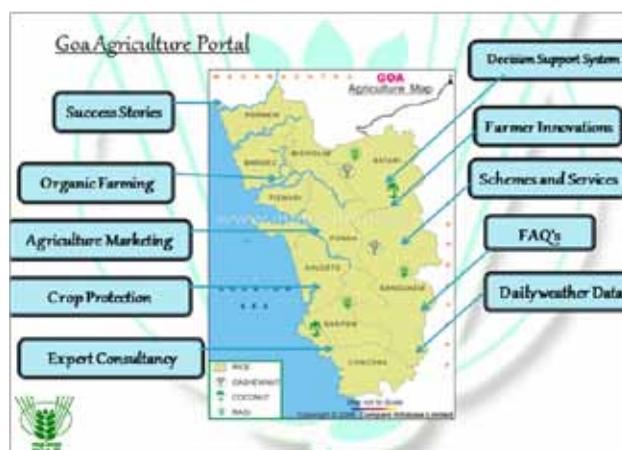
This portal aims to provide agri-relevant information and services to the farming community, researchers and general public through the use of information and communication technologies.

Some important Objectives of the portal are:

- Creation of an Information platform for agriculture
- Better production planning for farmers and other agricultural producers
- Providing solutions to farmers for the various problems they are facing with crops *etc.*
- Quick source of regional Information.
- Daily market updates and weather updates



The e-portal template developed for uploading purpose



Portal details with information for needy

**Project : Demonstration of Precision Farming Technologies (PFT) in banana, pineapple and papaya in farmers' fields of Goa (RKVY)**  
(PI: S. Priya Devi)

Demonstration plots for Precision Farming in banana, pine apple and papaya were established in Bardez and Canacona taluks and also in Institute farm. Initial soil analysis has been completed. The results show that, Nitrogen and Phosphorous content in the soil samples are low; potassium levels are medium to high. There is a trend of low EC and high organic carbon in the plots selected. Micronutrients like Fe, Zn, Mn, Cu and B are in low concentration in the soil.

Demonstration plots with drip irrigation systems have been laid out for banana, pineapple and papaya in Institute farm. Besides, demonstration plots for banana (TC & conventional) and pineapple hve been laid out along with drip irrigation facilities in farmers fields at Aldona and Gaodongrim.

**Project : Empowering Farmers of Goa for Sustainable Adoption of Low-Cost Protected Cultivation Structures through Training and Demonstration (RKVY)**  
*(P.I.: Mathala J Gupta)*

Two naturally ventilated greenhouse structures constructed last year were used for demonstration to farmers of Goa for cultivation of various vegetables crops. Two crop seasons of cucumber with varieties such as Kian, RS 2833 and Gypsy were successfully demonstrated to the farmers and the reports given to the funding agency regarding problems faced using this structure and feasibility of cucumber cultivation under modified design of single span naturally ventilated greenhouse.

Five hybrids of capsicum (Indus-11, Indra F1, Bombay F1, Orabele F1 and Swarna F1) and six hybrids of tomato (Arka Raskshak, Indam Rakshita,

GS-600, Heem Sona, Olleh and tomato cherry) were successfully demonstrated for farmers in a double span naturally ventilated greenhouse and the potential and threats of protected cultivation in polyhouse were identified. Continuous guidance for suitable structural and environment interventions to greenhouse growers in the state was given through this project.

Construction of a bamboo greenhouse for demonstration to the farmers of Goa has been started with both passive and active turbine ventilation options.



*Capsicum under polyhouse*



*Cherry tomato under polyhouse*



*Cucumber under polyhouse*

**Project : Production and supplementation of bypass fat to dairy animals for enhancement of milk production and livelihood security of dairy farmers of Goa (RKVY)**  
(PI: E. B. Chakurkar)

Project on production and testing of bypass fat was initiated under RKVY on March 2014. Bypass fat was produced using palm oil fatty acids and calcium salts. A total 8470 kg bypass fat has been produced till date, of which 7430 kg bypass fat was made available to the farmers. Since November, 2014, 4250 kgs of bypass fat was disbursed to dairy farmers of Goa State through Goa State cooperative Milk producers Union. Revenue of ₹ 1.125 lakhs was generated by selling bypass fat @ ₹ 25/ kg.

Benefits of bypass fat feeding as observed by the team and also farmers are increased fat content of milk, increase milk yield, improvement of animal health and fertility.



*Bypass fat*

**Project : Training, demonstration and research on hydroponic green fodder production (RKVY)**  
(PI: E. B. Chakurkar)

This project work was initiated in June, 2014. Till March, 2015 a total quantity of 19198.6 kg maize fodder was produced by using 4512 kg maize seeds. Five times fodder from 1 kg of seed was produced. Besides, different fodder species were tested under hydroponic condition and their performance varied from species to species.

Fodder type	Yield on the 7 <sup>th</sup> Day/ kg seed
White maize (GM-4)	5.5- 6.5 Kg
African tall maize	3.5- 4.5 Kg
Yellow maize	3.0- 3.5 Kg
Chavli (cow pea)	10.0- 11.0 Kg
Wheat	3.5 – 4.0 Kg

**Monthly biomass production**

Month 2014-15	Total seed used (kg)	Biomass produced (kg)	Average yield / kg of seed
June	300	1474.8	4.9
July	324	1407.6	4.3
August	92	314.54	3.5
September	210	736.53	3.7
October	534	2105.426	3.9
November	232	1074.776	4.9
December	540	2857.85	5.2
January	810	3194.65	3.9
February	860	3638.468	4.2
March	365	1530.298	4.3



# **ICAR-CCARI, Goa**

## **Annual Report 2014-15**

# **INSTITUTIONAL ACTIVITIES**

- ❖ **Transfer of Technology**
- ❖ **Intellectual Property Rights (IPR) Cell**
- ❖ **Education and Training**
- ❖ **Awards and Recognition**
- ❖ **Ongoing Projects**
- ❖ **Human Resource Development**
- ❖ **Publications**
- ❖ **Workshops, Seminars and other Events**
- ❖ **Committees and Meetings**
- ❖ **Visitors**
- ❖ **Personnel**



## Transfer of Technology

### Demonstration of rice varieties

The objective is to showcase the newly introduced rice varieties in the different groups to the farmers. Demonstration plots were laid out comprising 17 rice varieties representing medium duration, salt tolerant and scented rice varieties. 11 varieties were included in the medium duration group, three in salinity tolerant group and two in aromatic rice group. Varieties demonstrated are Jaya, Jyothi, Naveen, Karjat-3, Akshayadhan, Pusa-44, Chandan, TRC-2005-1, MTU-1010, MTU-1001 and MTU-7029, CSR-23, CSR-27, CSR-36, Korgut, PB-1121, Pusa Sugandh-5. Farmer's were briefed with the potentiality of each of these varieties during their visit to the field.

### Demonstration of Mussel culture technology

After the successful demonstration of mussel rack culture in the last year (2013-14) of Goa, more than fifteen farmers have expressed their interest for the same culture method. Hence, a total of four units (one unit of rack/ farmer group) were selected for successive trials in different areas of Goa (Batim-Chiral Bhat (2 units); Goa Velha (one unit), Madkai (one unit) of Goa under the financial assistance of National Fisheries Development Board (NFDB), Hyderabad. The stocking of mussel spats were carried out on 05<sup>th</sup> December, 2014. The scientific advisories on monitoring mussel growth parameters, environmental parameters



*Women group in Madkai stocking mussel seeds*

and culture maintenance upto the harvest will be provided by Fisheries section of ICAR-CCARI. The groups, who have undertaken the culture technique in the last period, are continuing the culture in the current year under the advisory of Fisheries Section, ICAR-CCARI. This will build a way of providing rural livelihood option for people residing along the coastal waters of Goa.

### Demonstration on cashew stem and root borer management

A training and demonstration on the management of cashew stem and root borer was organised at Parsem village, Pernem. During the demonstration egg, larva, pupa, adults and the actual damage done by the larva was shown to the farmers. In the management practices – removal of active larva, spraying with chloropyriphos was also demonstrated. About 35 farmers attended the demonstration.



*Demonstration on cashew stem and root borer management*

### Demonstration on beekeeping

A demonstration programme on beekeeping was organised. During the demonstration the experts from Beekeeper's co-op.Soc. Ankola,Karnataka,explained the aspects like types of bees, pre and post monsoon management, harvesting and packing of honey. The participants were taught the practical handling of bees. 14 participants were attended the programme.



*Demonstration on beekeeping*

### Demonstration on stingless bees

A demonstration on stingless bees was organised. During the demonstration the importance of stingless bees, method of capturing from nature, dividing of the colonies were demonstrated. The programme was attended by 25 participants.



*Demonstration on stingless bees*

### Demonstration programme on Virgin Coconut Oil Production and Value Added Products

Demonstration programme was organized at Krishi Vigyan Kendra, ICAR- ICAR-CCARI, Ela, Old Goa on “Virgin Coconut Oil Production and value added products” in view to popularize this technology in Goa as Goa being tourist place and lot of coconut is cultivated in Goa this technology is having good scope. The training was attended by 12 participants and demonstration was shown on how to extract virgin coconut oil by mature

coconuts. Demonstration of various value added products of coconut like tender coconut pudding, coconut chutney and coconut laddu was demonstrated to the participants.



*Demonstration programme on Virgin Coconut Oil Production*

### Soil Health Campaign

To create awareness about soil fertility, soil testing, soil health card and soil nutrient management on soil test based etc., soil health camp were conducted in 4 village namely Saligao, Guirim, Sangolda and Veiling-Priol of North Goa district on 23/6/2014, 4/7/2014, 20/10/2014, 22/10/2014, respectively. During the training/camp various work topics like Importance of soil testing, benefit of soil testing, methods of soil sampling, benefits soil test based fertilizers application, application of lime and other amendments, application of Phosphorus solubilizing bacteria (PSB). In the practical session, the methods of soil sampling were demonstrated and samples were collected from different farmers fields. The program was attended by 273 participants (farmers and students).



*Inauguration of Soil Health Campaign*

## Demonstration on scientific management of backyard poultry

Demonstration on scientific management of backyard poultry was organized by Krishi vigyan Kendra, ICAR –CCARI, Goa, Goa. In the technical session, there were classes on importance of backyard poultry farming, various strains, feeding, watering, housing requirements and economics. In the practical session, participants were exposed to various activities related to poultry farming with more emphasis on brooding management of chicks, housing, feeding, disease management, diagnosis, treatment and general management of backyard poultry birds. At the end of training session, during farmers–scientist group discussion, various technical queries raised by trainees were answered by the scientists and finally farmers feedback were recorded. Farmers were very much satisfied by practical and technical session on backyard poultry birds.



*Demonstration on scientific management of backyard poultry*

## TRIBAL SUB PLAN

### Improving livelihood security of tribal community by introduction of improved varieties of ornamental crops in the tribal areas of Goa

Under the Tribal Sub Plan, the Institute has been closely working with the tribal farmers of Canacona, with main focus on enhancing their livelihood security. The tribal sub plan project on “Improving livelihood security of tribal community by introduction of improved varieties of ornamental crops in the tribal areas of Goa” was initiated for the benefit of tribal farmers of Goa.



*Programme on flower cultivation*

Through this project, the Institute is engaged in imparting the technical knowhow to the farming community by way of providing quality planting materials of flower crops besides of capacity building activities. Different tribal farmers groups have been identified for executing the said programme. Under this programme, cultivation of two important bulbous flower crops namely gladiolus and tuberose were identified and supported. A training programme on “Adoption of improved technologies in cultivation of bulbous flower crops viz., gladiolus and tuberose for livelihood enhancement” was conducted for the tribal farmer groups of Canacona at Cotigao Panchayat hall, Canacona on 27<sup>th</sup> February 2015. A total of 62 tribal farmers from various parts of Canacona Taluka attended the same. During the training programme, planting material of bulbous flower crops viz., corms of fifteen different varieties of gladiolus and bulbs of three different tuberose varieties were distributed to the tribal farmers group. Besides, hands on training and field demonstration of cultivation of bulbous flower crops were provided to the farmers and they were apprised with the importance of taking up the cultivation of flower crops like gladiolus and tuberose for improving their livelihood. Further to assist the farmers, a technical bulletin titled “Ready Reckoner on cultivation of gladiolus” was printed and distributed. All scientific and technical help are being provided throughout the crop period by periodical visits. The crops are performing well and the farmers expressed their satisfaction and happiness about the kind of support given by ICAR. The programme has made a significant impact on the tribal farmers of

Canacona as it resulted in overall improvement in farm income and living standards of the tribal farmers.

### Empowering Tribes of Goa with post harvest machinery for processing and value addition in minor fruits

The programme on ‘Empowering Tribes of Goa with post harvest machinery for processing and value addition in minor fruits’ was proposed to create awareness on the processing potential of the under utilized fruit crops of Goa and to equip them with the technology and machinery required for the same. The trainees were demonstrated various value added products of Jack fruit viz., pickle, chips, *halwa*, leather, cake, jack seed *kheer*, *bajjas*, *papad*, squash, *xacuti* and *biryani*. They were also given hands on training for operating the processing machinery on second and third days. The fabricator of the machinery also trained the group on operation of the machines. They were also sensitized about the maintenance of the machinery. Besides this, resource person from Department of Food and Drugs, Panjim gave a lecture on “Significance, modalities and advantages of FSSAI license for value added products”. Another interesting feature of the programme was the recipe competition that was held for the participants. There was enthusiastic participation and mouth watering panos sanna types, panos cake, panos sheera, panos sweet vadas, stuffed dhones and patolis, crispy chips *etc.* were the attraction of the day. The preparations were adjudged and prizes were given away to the winners on third day.

During the training, the women were also trained for bulk production, packaging and labeling. They prepared items like pickle, papad, leather *etc* in bulk. They were also trained to stick labels, pack the produce and seal them with PP Sealing machine. This imparted interest and confidence in the minds of the participants, which made them vow to take up production of value added products from jack fruit in the ensuing season.

### Agricultural Mechanization Program for Small and Marginal Tribal Farmers of Goa

Following the same procedure as previous year for assessment of need and based on previous year’s feedback, it was felt that since power tillers were most popular among the farmers, only power tillers will be given so that more number of farmers can benefit. Also, to suit two type of topography prevalent in the area, the sloped high land (*morod*) where more of contour farming is done and flatter kher, two different HP of power tillers were chosen 13 and 9 HP. With the 9 HP power tillers, mini rotary tillers also were given to the farmers to facilitate contour farming. Also since lot of problems in maintenance and operation came up during feedback we decided this year to call 2 members from the beneficiaries’ groups and train them on the operation and maintenance of the power tillers. The training had very positive effect as the farmer womenfolk were motivated and started operating the machines after the training. The feedback for this year has commenced after *rabi* crop has been sown in January 2015 and is in progress.



Training on post harvest processing



Distribution of farm machineries

### Technology Intervention for higher productivity and production in Plantation, spice and fruit crops for improving livelihood security of tribes in Goa

Under the Tribal Sub Plan, ICAR-CCARI, Old Goa, has been closely working with Self Help Groups (SHGs) of tribal farmers of Cancona, Quepem and other zones for the last three years with main focus on enhancing livelihood security of the tribal farmers in Goa. The Institute is engaged in imparting the technical know how to the farming community by way of providing farm inputs, machineries, field demonstrations, quality planting materials, seeds, etc., to several SHGs besides capacity building activities. These activities mainly envisage the overall improvement in farm income and nutritional security and living standards of the tribal farmers of the region.



*Cashew grafts established in FLD plot at Talshir, Gaodongruim and Tiswadi-3 variety started yielding*

Front line demonstrations on cashew and mango production technology comprising of improved cashew varieties ( Balli-2, Tiswadi-3,



*One and half year old graft of Mankurad started bearing in FLD on Mango At Talshir., Gaodongruim*

GNJ-2, na Kn-2/98) and mango varieties like Mankurad, Kesar and Amrapali wer established in at Talehir in Gaodongruim village of Cancona. As part of integrated farming system, Taleshir Self Hep Group was also provided with planting material black pepper of Paniyur variety, besides the farm inputs like fertlisers and agrochemicals.

In order to continue the Productivity Maximization Practices for cashew, all the 16 SHGs selected earlier were also provided with Farm inputs during this season also The new selected five groups were provided with one power sprayer and brush cutter each under proctivity maximization programme in cashew.



*Paniyur-1 established Taleshir IFS model plot*

### Demonstration, capacity building and seed distribution in improved variety of vegetables crops for livelihood security

Under Tribal Sub Plan (TSP) programme, seeds of high yielding  $F_1$  hybrid in okra and variety in vegetable cowpea were distributed in Salcette and Canacona taluka for tribal farmers. Simultaneously, inputs like fertilizers, plant protection chemicals, irrigation pumps and fishing nets were also distributed with periodic visits for implementation.



## Intellectual Property Rights (IPR) Cell

### Activities

- A local Pig breed “Agonda Goan Pig”, was registered with NBAGR, Karnal, Haryana, with registration no. INDIA\_PIG\_3500\_AGONDAGOAN\_09003 on 6<sup>th</sup> January, 2015.  
Scientist Associated: Dr. E.B. Chakurkar, Principal Scientist (Animal Reproduction)
- Goa Cowpea-3, a grain cowpea variety for Goa has been released by the Institute.  
Scientists Associated: Dr. B.L. Manjunath, Principal Scientist (Agronomy), Dr. Narendra Pratap Singh, Director, Dr. Manohara K.K. Scientist (Plant Breeding), Dr. R. Ramesh, Senior Scientist (Plant Pathology) and Dr. Maruthadurai R, Scientist (Agricultural Entomology)
- Korgut, a traditional landrace of rice from Goa, having promising character of salinity stress tolerance at seedling stage, was registered with National Bureau of Plant Genetic Resources, New Delhi and assigned with the Registration No. INGR 14055 and National Identity No. IC0599689 on 4<sup>th</sup> September, 2014.  
Scientist Associated: Dr. Manohara, K.K., Scientist (Plant Breeding)
- Two *Ralstonia solanacearum* strains viz. Rs-09-161 (MTCC No.12263) and Rs-10-224 were deposited with Microbial Type Culture Collection & Gene Bank, of CSIR -Institute of Microbial Technology, Chandigarh.  
Scientist Associated: Dr. R. Ramesh, Senior Scientist (Plant Pathology).
- Nineteen *Ralstonia solanacearum* cultures were deposited with microbial culture collection of National Bureau of Agriculturally important microorganisms (NBAIM) on 2<sup>nd</sup> July, 2014, and assigned the Accession Numbers from: NAIMCC-B-01613 to NAIMCC-B-01631.  
Scientist Associated: Dr. R. Ramesh, Senior Scientist (Plant Pathology)
- Application was submitted to NBPGR, New Delhi on 11<sup>th</sup> June, 2014 to obtain IC numbers for nine Amaranth and two Chilli accessions.  
Scientist Associated: Dr. V. Arunachalam, Principal Scientist, (Spices, Plantation and Medicinal & Aromatic Crops).
- Process for filing of application for patent for technology entitled “Extender for Preservation of Boar Semen the invention” is initiated and is under process with Inventillect Consultancy Services Pvt. Ltd., Pune.
- Final patent application for invention entitled “Process for fermentation of cashew apple juice using microbial consortium” was submitted to the patent attorney Inventillect Consultancy Services Pvt. Ltd., Pune and is under process.
- An application for copyrights protection of the software entitled “Soil test based fertilizer recommendation-Goa i.e. STFR-Goa” is submitted to the patent attorney Inventillect Consultancy Services Pvt. Ltd., Pune and is under process.

### Registration of Agonda Goan Pig

The identification and conservation of locally adaptable pigs with superior phenotypic traits (ability to sustain with minimum quantity of feeds and locally available feed stuffs and to resist diseases) is very important for economic pig production. In this context, local pigs were collected from Goa and selectively bred. After continuous breeding experiments, Agonda Goan pig has identified as a breed for the coastal areas. Recently, ICAR breed recognition committee has accepted and recommended it as breed with id: INDIA\_PIG\_3500\_AGONDA GOAN\_09003.



### Goa Cowpea - 3: A Grain Cowpea variety for Goa

It is an indeterminate type of local cowpea selection with bold pods and high yield. Under ideal conditions, it grows to a height of about a feet with profuse dense foliage (up to 40 trifoliate leaves/plant) with vine growth up to one metre having 4-5 primary branches. The selection takes 68-70 days for flowering with total crop duration of 100-105 days. Each plant produces 14-20 smooth greenish white pods in clusters measuring 23- 25cm. Each pod will have 13 to 17 light brownish seeds having a test weight of 25 g for 100 seeds. The selection has a potential seed yield up to 2000 kg/ha and a haulm yield of 4.30 t/ha. The variety is highly tolerant to pest and diseases. It is fairly tolerant to drought situations and suits for residual moisture condition in rice fallows. This local cowpea is preferred in many of the culinary preparations owing to its unique taste, bold size and better cooking quality. As such, it fetches a premium price in the market. The variety Goa Cowpea-3 was released during Group Meet on Moongbean and Urdbean for Spring/Summer and Rice fallow Cultivation.



### KORGUT: a rice landrace from Goa, registered as Unique Germplasm, for tolerance to salinity stress at seedling stage

Korgut, a traditional rice landrace from the State of Goa, has been registered as unique germplasm, for tolerance to salinity stress at seedling stage, with the National Bureau of Plant Genetic Resources (NBPGR), New Delhi. Plant Germplasm Registration Committee of Indian Council of Agricultural Research in its 30<sup>th</sup> meeting held on September 4, 2014 has approved <Korgut> for registration and assigned with registration number INGR14055. It was collected during *Kharif* 2010 in farmers' field at Chorao Island of North Goa district and being maintained at the institute farm. Phenotyping for salt stress tolerance at seedling stage under hydroponics culture with  $EC = 12 \text{ dSm}^{-1}$ , showed its tolerance (SES score 3) to salinity stress at seedling stage. The tolerance of Korgut was associated with low ratio of  $\text{Na}^+/\text{K}^+$  (0.18) in shoot as compared to susceptible check variety IR-29 (0.68). In addition, evaluation of Korgut under natural coastal salinity conditions in farmers' field at Chorao Island (North Goa), for past four years confirmed its adaptability to coastal saline soils.



## Meetings held

- Total Eight (8) meetings of Institute Technology Management Unit (ITMU) were conducted during the year 2014-15 to discuss various IPR related issues in the Institute.

## Programmes conducted

In order to create awareness among the farming community of Goa regarding Protection of Plant Varieties and Farmers' Right Act - 2001, IPR Cell facilitated a "Progressive farmers meet on Protection of Plant Varieties and Farmers' Right Act 2001" conducted by KVK, North Goa, at this Institute on 16<sup>th</sup> August, 2014. As chief guest of the programme, Dr. RR. Hanchinal, Chairman, PPV FRA, New Delhi, Govt. of India made an elaborative presentation on how to protect farmer's varieties by registering them with PPV & FR Authority. He also informed the scientists of ICAR-CCARI and Krishi Vigyan Kendra to help the farmers in registration of their varieties. Forty Progressive farmers from pillar, Veling, Neura, Aldona, Pernemand other parts of Goa participated in the meeting and took part in the discussion besides, scientists ICAR-CCARI, Ela, Old Goa and staff of Krishi Vigyan Kendra.



*Inaugral session of progressive farmers meet*

Member Secretary, Dr. A.R. Desai, Sr. scientist (Hort.) / IPR Cell Co-ordinator, made a presentation on "Protection of Plant Varieties and Farmers' Right Act, 2001" at One day Awareness Training programme on "Protection of Plant Varieties and Farmers' Right Act, 2001" organized by ICAR-CCARI, Ela, Old Goa on 31<sup>st</sup> January, 2015.



*Lectures during training programme*

## Applications for PPV&FRA Awards

- Applications from two progressive Farmers of Goa *Viz.* Shri Prabhakar M. Keny and Shri Rajaram Yashwant Mavlankar were sent to Protection of Plant Varieties & Farmers' Rights Authority, New Delhi, for consideration under 'Plant Genome Savior Farmer Reward/ Recognition " for year 2014-15.
- An application on behalf of "Khola/ Canacona Chilli Cultivators Groups" was prepared and sent to Protection of Plant Varieties & Farmers' Rights Authority, New Delhi, for consideration under "PLANT GENOME SAVIOR COMMUNITY AWARD" from Goa, for year 2014-15.

## Revenue generation through IPR

Year	Details	Amount in ₹
2014-2015	Contract research work under Consultancy: Amount received from M/s Cazcar Heritage Distiller, Mapusa, Goa for conducting basic research trials for technology entitled "Process For Fermentation of Cashew Apple Juice Using Microbial Consortium".	75,000.00

## Education and Training

### Education

#### **R. Ramesh**

- Guided one student for the award of Ph.D. in Microbiology by Goa University.

#### **G. R. Mahajan**

- Guided a student of Institute of Rural Management, Jodhpur for a short project during May to July, 2014.

### Lectures delivered by the Scientist

Date	Lecture Topic/Programme	Participants	Venue
<b>V. Arunachalam</b>			
15-12-2014	Maturity indices in harvesting of fruit crops	Students	Goa University Dona Paula
<b>A. R. Desai</b>			
22-04-2014	Cashew production technology	Trainees	ICAR-CCARI, Old Goa
24-11-2014	Prospects of cultivating fruit crops in Goa	Trainees	Directorate of Agriculture, Tonca, Goa.
28-01-2015	Value addition of nutmeg pericarp	Delegates	ICAR-CCARI, Old Goa
31-01-2015	Provisions of protection of plant varieties & farmers' rights Act, 2001.	Trainees	KVK , North Goa, Old Goa
13-03-2015	Global Vs Indian scenario: crop improvement in cashew	Trainees	Briganza Hall, Panaji, Goa.
19-03-2015	Principles and methods of fruit preservation	Students	Goa University, Goa
<b>M. Thangam</b>			
29-05-2014	Protected cultivation of high value crops	Farmers	KVK, North Goa, Old Goa
18-06-2014	Nursery management in vegetable crops	Trainees	Malkarne, Quepem
18-06-2014	Protected cultivation of vegetable crops	Trainees	Malkarne, Quepem
22-08-2014	An introduction to horticulture	Students	ICAR-CCARI, Old Goa
11-09-2014	Cucumber cultivation under polyhouse	Trainees	Directorate of Agriculture, Panjim
26-09-2014	Cultivation of orchids, anthurium and chrysanthemum under protected structures	Trainees	Directorate of Agriculture, Panjim
24-11-2014	Prospects of floriculture in Goa	Trainees	Directorate of Agriculture, Panjim

30-01-2015	Application of best practices in agriculture in Goa	Farmers	NABARD, Panjim
31-01-2015	Genetic wealth of vegetables in Goa	Farmers	KVK, North Goa, Old Goa
27-02-2015	Improved methods for cultivation of Gladiolus under agro climatic conditions of Goa	Trainees	Cotigao, Canacona
17-03-2015	Overview on protected cultivation of high value crops in Goa	Farmers	ICAR-CCARI, Old Goa
17-03-2015	Cultivation of flower crops in polyhouse	Farmers	ICAR-CCARI, Old Goa
18-03-2015	Cultivation of vegetable crops in polyhouse	Farmers	ICAR-CCARI, Old Goa
<b>R. Ramesh</b>			
23-04-2014	Status of cashew diseases and their management	Trainees	ICAR-CCARI, Old Goa
25-04-2014	Diagnosis of diseases of plantation and spice crops of Goa	Trainees	ICAR-CCARI, Old Goa
21-01-2015	Diversity analysis of <i>Ralstonia solanacearum</i> causing bacterial wilt of brinjal	Assistant professors and Scientists from NARS system	IARI, New Delhi
28-01-2015	Diseases of spice crops in Goa and their management	Trainee farmers	ICAR-CCARI, Old Goa
23-03-2015	Post harvest diseases of fruits and their management	Students	Goa University, Bambolim Goa
24-03-2015	Disease management in protected structures	Farmers and Trainees	KVK, North Goa, Old Goa
<b>S. Priya Devi</b>			
28-03-2015	A potential native medicinal tree species–Kokum ( <i>Garcinia indica</i> Choisy)	Farmers	Kala Academy, Panaji Goa
<b>Safeena S. A.</b>			
18-06-2014	Livelihood opportunities for small and marginal tribal farmers through flower nursery and floriculture	Trainees	Malkarne, Quepem Goa
22-08-2014	Methods of propagation	Students	ICAR- CCARI, Old Goa
27-02-2015	Improved methods for cultivation of tuberose for livelihood enhancement	Trainees	Cotigao Panchayat Hall, Canacona, Goa
28-02-2015	Scope and prospects of floriculture in Goa	Students	St. Xaviers College of Arts, Science and Commerce, Mapusa, Goa.
17-03-2015	Cultivation of Gladiolus, Tuberose and Rose under open field in Goa	Trainees	ICAR- CCARI, Old Goa

24-03-2015	Protected cultivation of flowers (Gerbera, Orchids, Anthurium)	Trainees	KVK, North Goa, Old Goa
<b>R. Maruthadurai</b>			
23-04-2014	Biological control in cashew	Trainees	ICAR- CCARI, Old Goa
17-03-2015	Plant protection in protected structures	Trainees	ICAR- CCARI, Old Goa
24-03-2015	Pest management in protected structures	Trainees	KVK, North Goa, Old Goa
<b>G. R. Mahajan</b>			
22.08.2014	Some aspects of ecology: Different techniques and equipments used to measure ecological parameters	Students	ICAR- CCARI, Old Goa
13.02.2015	Integrated farming systems	Students	ICAR- CCARI, Old Goa
16.03.2015	Vermicomposting and organic farming	Students	Parvatibai Chowgule College, Madgaon, Goa
<b>Srrekanth G. B.</b>			
21-03-2015	Importance of fresh water ornamental fish resources of Goa	Trainees	ICAR- CCARI, Old Goa
<b>Manju Lekshmi N.</b>			
30-05-2014	Integrated fisheries systems in India	Trainees	KVK, North Goa, Old Goa
25-09-2014	Value addition in seafood	Trainees	Training Center, Dhauji
21-03-2015	Aquarium fabrication and its management	Trainees	ICAR- CCARI, Old Goa

### Training programmes organized by the Institute

Sl No	Name of the Training	Venue	Period
1	Diagnosis of insect pests and diseases of plantation and spice crops of Goa	ICAR- CCARI, Old Goa	April 25, 2014
2	Ornamental fish farming and aquarium fabrication	Sangolda Village	May 08, 2014
3	Jack fruit: value addition as an enterprise for farm women	ICAR-CCARI, Old Goa	June 25-27, 2014
4	Mariculture technologies	ICAR- CCARI, Old Goa	August 6, 2014
5	Management of stem and root borer and tea mosquito bug in cashew	Sanquelim Goa	August 16, 2014
6	Fundamentals of horticulture	ICAR- CCARI, Old Goa	August 22, 2014
7	Adoption of improved technologies in cultivation of bulbous flower crops for livelihood enhancement	Cotigao Panchayat Hall, Canacona, Goa	February 27, 2015
8	ISO 9001 2008 Surveillance audit training	ICAR-CCARI, Old Goa	September 9, 2014
9	Stakeholders meeting of practising Agro Eco Tourism entrepreneurs of Goa	ICAR-CCARI, Old Goa	November 10, .2014



10	Workshop on climate change and coastal aquaculture – impacts, adaptations and mitigations for resilience	ICAR- CCARI, Old Goa	March 11, 2015
11	Hands on training on protected cultivation of high value crops	ICAR-CCARI, Old Goa	March 17-18, 2015
12	Secondary livelihood opportunities through fishery resources	ICAR-CCARI, Old Goa	March 19-21, 2015
13	Use of online web portal soil test based fertilizer recommendations - Goa to make soil test based fertilizer recommendations to Goan crops”	ICAR- CCARI, Old Goa	March 20, 2015

#### Awareness programmes organized by the Institute

SI No	Name of the Programme	Venue	Period
1.	Brainstorming meeting on scope and potential of pulses in coastal regions of India	ICAR-CCARI, Old Goa	November 23, 2014
2.	Awareness programme on community based fisheries management and installation of artificial fish habitats	Curca, Near Goa University, Tiswadi, Goa	December 20, 2014

## Awards and Recognition

### *Dr. Narendra Pratap Singh*

- ISA Gold medal 2011 by Indian Society of Agronomy, Indian Agricultural Research Institute, New Delhi for outstanding contributions in Agronomy



### *Dr. S. K. Das*

- Awarded National Fellow of Animal Production and Management (FNAPM) for the significant contribution in research, extension and developmental work in the field of livestock production and Management received from President, ISAPM on 28 January, 2015.



### *Dr. V. Arunachalam*

- Recognized for the Marker express –DNA marker discovery software as one of top 45 innovations under the India Innovation Growth Program 2014 of the DST-Lockheed Martin Corporation-IndoUS Science and Technology Forum-IC2 Institute at University of Texas at Austin-TiE-Stanford Business School.



### *Dr. G. R. Mahajan*

- Awarded ICAR Jawaharlal Nehru Award for P.G. Outstanding Doctoral Thesis Research in Agricultural and Allied Sciences 2013 by Indian Council of Agricultural Research, New Delhi.
- Awarded– Fifth award in the Photo contest symptoms of nutrient deficiencies and excess in agricultural crops 2014 in BC Fertilis Nutrient Deficiency Photo contest 2014.



- Pragma - Annual Hindi Magazine (2013-14) of the Institute was awarded Ganesh Sankar Vidhyarthi Hindi Krishi Patrika Puraskar for the year 2013-14.



## Ongoing Research Projects

Sr. No.	Project Title	PI	Co - PI	Duration
<b><i>Natural Resource Management</i></b>				
1.	Development and evaluation of soil and water conservation measures for sustainable production of major horticultural crops in Goa.	GR Mahajan		2008 - 16
<b><i>Crop Science</i></b>				
2.	Breeding high yielding salt tolerant rice varieties for coastal saline soils	Manohara KK		2010 - 15
3.	Studies on major insect pests of cashew and their management	Maruthadurai R		2012 -16
4.	Plant disease management by bacterial, fungal agents and other non- conventional methods under coastal ecosystem	R Ramesh		2011 –15
<b><i>Horticultural Science</i></b>				
5.	Allele mining of banana genome sequences for genetic improvement	V Arunachalam		2014 -17
6.	Collection, evaluation and management of fruit and spices	AR Desai	S Priya Devi	2011 – 16
7.	Survey, collection, evaluation and management of under utilized fruits of coastal region	S Priya Devi		2013 -18
8.	Standardization and validation of Precision Farming Technologies (PFT) for major vegetable crops under climatic conditions of Goa	M Thangam	SA Safeena	2013 - 17
9.	Germplasm collection, conservation, evaluation and standardization of production and post harvest techniques of commercially important flower and foliage crops	Safeena SA	M Thangam	2010 - 16
10.	Design of protected cultivation structures for year round utilization in Western region	MJ Gupta	V Arunachalam	2011-15
<b><i>Animal Science</i></b>				
11.	Economic milk production under climate change scenario	SK Das		2013-16
12.	Preparation / formulation of boar semen extender and pre insemination fluid for artificial insemination in pigs	EB Chakurkar	Binsila B Krishnan	2014 - 17

13.	Nutritional interventions for optimization of economical milk production in Goa	PK Naik		2010 - 17
14.	Studies on seminal attributes in relation to fertility in boars	Binsila B Krishnana	EB Chakurkar	2014 - 17
15.	Evaluation of Srinidhi chicken performance under different rearing systems in Goa	K Muniswamy		2014 - 17
<b>Fisheries Sciences</b>				
16.	Augmentation of fishery and fish biodiversity in the near shore marine areas of Goa through artificial fish habitats	Sreekanth GB	Manju Lekshmi N	2013 - 16
17.	Development of coastal mariculture in brackish water areas of Goa	Manju Lekshmi N	Sreekanth GB	2013 - 16

### AICRP Main Centres

Sr. No	Project Title	PI
1.	All India Co-ordinated Project on Cashew	AR Desai
2.	All India Co-ordinated Research Project on Integrated farming System	NP Singh
3.	All India Co-ordinated Project on Pigs	EB Chakurkar

### AICRP Voluntary Centres

Sr. No	Project Title	PI
1.	All India Co-ordinated Rice Improvement Project	Manohara KK
2.	All India Co-ordinated Research Project on Arid Legumes	KK Manohara
3.	All India Co-ordinated Project on Vegetables	M Thangam
4.	All India Co-ordinated Project on Palms	V Arunachalam

### Externally funded projects

Sr. No	Project Title	PI	Co-PI (s)
<b>Foreign Aided</b>			
1.	Stress Tolerant Rice for Africa and South Asia: Salinity Tolerant Breeding Network Trial	NP Singh	Manohara KK
<b>DBT</b>			
1.	Approaches towards combating zoonotic and food borne infections through community participation	EB Chakurkar	

4.	Augmentation of rural pig production for socio economic upliftment of rural poor in Goa through artificial insemination	EB Chakurkar	
<b>ICAR</b>			
5.	Outreach project on <i>Phytophthora</i> , <i>Fusarium</i> and <i>Ralstonia</i> diseases of horticultural and field crops	R Ramesh	
6.	Production and formulation technology refinement of bacterial bio- agents for soil borne plant disease management under coastal ecosystem	R Ramesh	
7.	Seed production in agricultural crops and fisheries	Manohara KK	
8.	Poultry seed project	K Muniswamy	
<b>Noni Foundation</b>			
12.	Genetic diversity of noni in konkan coast of India	V Arunachalam	
<b>DST and E, Goa</b>			
13.	Amelioration and management of coastal saline soils of Goa	GR Mahajan	
14.	Agro - morphological characterization and DNA fingerprinting of rice land races of Goa	Manohara KK	
<b>NFDB</b>			
15.	Technology demonstration on mariculture for improving the livelihood status of youth and women in Goa	Manju Lexshmi N	
<b>RKVY</b>			
16.	Establishment of protected structures for high value flower and vegetable crops for training and demonstration	M Thangam	
17.	Conservation of traditional varieties of vegetable crops and entrepreneurship development for its seed production	M Thangam	
18.	Development of comprehensive e-agriculture portal for information and knowledge sharing in Goa	M Thangam	
19.	Demonstration of Precision Farming Technologies (PFT) in banana, pineapple and papaya in farmers' fields of Goa	S Priya Devi	M Thangam
20.	Empowering farmers of Goa for sustainable adoption of low-cost protected cultivation structures through training and demonstration	MJ Gupta	
21.	Production and supplementation of bypass fat to dairy animals for enhancement of milk production and livelihood security of dairy farmers of Goa	EB Chakurkar	
22.	Feed blocks for dairy animals for effective utilization of locally available feed resources and higher productivity	EB Chakurkar	
23.	Training, demonstration and research on hydroponics green fodder production	EB Chakurkar	

## Human Resource Development

### Participation in Conference / Seminar/ Symposia/ Workshops

Date	Name	Programme	Venue
April 5-8, 2014	Manohara K K	49 <sup>th</sup> Annual Rice Workers Group Meeting	Directorate of Rice Research, Hyderabad,
April 20-22, 2014	Narendra Pratap Singh P K Naik	Global Animal Nutrition Conference (GLANCE-2014) on 'Climate Resilient Livestock Feeding Systems for Global Food Security'	Bengaluru, India.
May 15-16, 2014	S Priya Devi	International Symposium on Jack Fruit and Bread Fruit of the Tropics: Genetic Diversity, Management, Value Addition and Marketing Strategies	UAS, Bangalore
May 19, 2014	Narendra Pratap Singh	Brainstorming session on substitution of NPK requirement using organic sources	Directorate of Cashew Research, Puttur
May 20 – 23, 2014	Manohara K K	Review workshop and launching of STRASA phase III of BMGF funded project 'Stress Tolerant Rice for Africa and South Asia	NASC Complex, New Delhi.
May 21-22, 2014	Sreekanth G B Manju Lekshmi N	National Workshop on Marine Biodiversity and Climate Change	Research Centre of CMFRI, Karwar
May 22-31, 2014	Mathala J Gupta	Participatory Research form mainstreaming Gender Concerns in Agriculture	Directorate of Research on Women in Agriculture, Bhubaneswar, Odisha
May 26-28, 2014	R Ramesh	National Symposium: Plant Pathology in Genomic Era.	IGKV, Raipur
May 27, 2014	P K Naik	Workshop on Priority Setting, Monitoring and Evaluation in National Agricultural Research System: Status, Experiences and Way Forward	NASC Complex, Pusa, New Delhi
	Narendra Pratap Singh	ICAR Directors Conference	NASC Complex, New Delhi
June 6-7, 2014	Narendra Pratap Singh	NAIP-IFPRI two day Workshop on Impact of Capacity Building Programme	NASC Complex, New Delhi



# ANNUAL REPORT 2014 - 2015



June 7-8, 2014	Narendra Pratap Singh Manohara K K	30 <sup>th</sup> Annual Group Meet on Arid Legumes	Rajmata Vijayraje Scindia Krishi Vishwa Vidyalaya, Gwalior
June 14-16, 2014	Narendra Pratap Singh	2 <sup>nd</sup> UP Agricultural Science Congress	IISR, Lucknow
June 24-27, 2014	M Thangam	32 <sup>nd</sup> Group Meeting of AICRP on Vegetable Crops	IGKV, Raipur
July 1-3, 2014	V Arunachalam	XXIII Group Meeting of AICRP on Palms	Directorate of Oilseed Research, Hyderabad
July 05, 2014	P K Naik	Brain Storming Session on Hydroponics Fodder Production in India	NASC Complex, Pusa, New Delhi
July 7, 2014	Narendra Pratap Singh	Meeting for Exploring Possibility of Spreading Out the Insurance Coverage to Horticulture Crops	New Delhi
July 25-28, 2014	Narendra Pratap Singh	Annual Group Meeting of All India Coordinated Research Project on Palms	DOR, Hyderabad
July 29, 2014	Narendra Pratap Singh	86 <sup>th</sup> Foundation day ceremony of ICAR	New Delhi
July 30, 2014	Narendra Pratap Singh	Vice Chancellors and Director's Conference	NASC Complex, New Delhi
July 6, 2014	Narendra Pratap Singh	National Consultation Meet on Oil Palm	DOR Hyderabad
July 28, 2014	Mathala J Gupta	National workshop on New Dimensions in Agricultural Engineering Research and Development in the Changing Environment of the Nation	Central Institute for Agricultural Engineering, Bhopal
August 6, 2014	Manohara K K	Review meeting of half yearly progress of foreign aided project	Krishi Anusandhan Bhavan, New Delhi.
August 22-23, 2014	K Muniswamy	Annual Review Meeting of Poultry Seed Project	Directorate of Poultry Research, Hyderabad
August 28-29, 2014	Narendra Pratap Singh G R Mahajan	Strengthening Partnerships and Refined Methodology for on- station Experiments of AICRP on IFS	Sardar Krushinagar Dantiwada Agricultural University, Sardarkrushinagar
September 22-23, 2014	Manohara K K	9 <sup>th</sup> Annual Review Meeting of ICAR Seed Project "Seed Production in Agricultural Crops"	ANGRAU, Hyderabad

September 27-28, 2014	Narendra Pratap Singh V Arunachalam A R Desai M Thangam R Ramesh Safeena S A	9 <sup>th</sup> National Symposium on Noni for Everyone	International Center, Goa
October 17-18, 2014	Narendra Pratap Singh	23 <sup>rd</sup> meeting of ICAR Regional Committee no. VII	IGKV Raipur, Chattisgarh
October 28, 2014	M Thangam	Mid year Review of RFD-2014-15	NASC Complex, Pusa, New Delhi
October 29-30, 2014	E B Chakurkar	Workshop on Open Access to Agricultural Knowledge for Inclusive Growth and Development	NAARM Hyderabad
October 28- November 4, 2014	Narendra Pratap Singh	4 <sup>th</sup> International Rice Research Congress	Bangkok
November 2-5, 2014	Narendra Pratap Singh	Overview of the Rice Breeding and Agronomic Activities	International Rice Research Institute (IRRI), Phillipines
November 6-9, 2014.	Safeena S A	6 <sup>th</sup> Indian Horticulture Congress	Codissia Trade Fair Complex, Coimbatore, Tamil Nadu
November 11-15, 2014	Sreekanth G B Manju Lekshmi N	Indian Fisheries and Aquaculture Forum	NBFGR, Lucknow
November 17, 2014	Narendra Pratap Singh	Fodder Meet	IGFRI, Jhansi
November 18-21, 2014	Narendra Pratap Singh	National Symposium on Agricultural Diversification for Sustainable Livelihood and Environmental Security	PAU, Ludhiana
November 20-22, 2014	E B Chakurkar	National Symposium on Research and Innovations to Improve Animal Fertility and Fecundity	Veterinary College, Mathura
November 22, 2014	M Thangam	AICRP Group Meet on Mungbean, Urdbean, Lentil, Lathyrus, Rajmash and Pea (MULLaRAP)	ICAR-CCARI, Old Goa
December 1-3, 2014	S Priya Devi	National Seminar on Strategies for Conservation, Improvement and Utilization of Underutilized Fruits	CHES, Chettalli, Madikeri

December 2014	5-7,	Narendra Pratap Singh	National Seminar-cum Exhibition on Pomegranate for Nutrition Livelihood Security and Entrepreneurship Development	NRC for Pomegranate, Solapur
December 2015	10-12,	Maruthadurai R	National symposium on plantation crops	Kozhikode
December 2014.	11-12,	Narendra Pratap Singh A R Desai R Ramesh S Priya Devi Safeena S A Maruthadurai R	National Conference on Innovation in Traditional Practices for Cultivation of Fruit, Vegetable and Plantation crops	ICAR – ICAR-CCARI, Old Goa
December 2014	11-12,	Manohara K K	QRT review meeting of Mega Seed Project on field crops	GKVK, University of Agricultural Sciences, Bengaluru
December 2014	12-14,	V Arunachalam	XXI Placrosym International Plantation Crops Symposium	Kozhikode
December 2014	18-20,	A R Desai	Annual Group Meeting of AICRP on Cashew	Dr. Y.S.R. Horticultural University, Bapatla, Andhra Pradesh
December 2014	18-20,	R Solomon Rajkumar	XXXI Annual Conference of Indian Poultry Science Association and National Symposium on Poultry Production for Global Trade	Veterinary College and Research Centre, TANUVAS, Namakkal, Tamil Nadu.
December 2014	22-24,	Narendra Pratap Singh G R Mahajan	31st Biennial Workshop of AICRP on IFS	Tamil Nadu Agricultural University, Coimbatore
January 2015	22-23,	R Ramesh	Workshop of annual review meeting of AMAAS project	NASC complex, New Delhi
January 2015.	28-29,	Safeena S A	District Level Seminar on Spices Production in Goa	ICAR – ICAR-CCARI, Old Goa
January 29-30, 2015		Narendra Pratap Singh V. Arunachalam R. Ramesh	National Seminar on New Frontiers in Plant Science and Biotechnology	Goa University Taleigao
February 2015	3-6,	Narendra Pratap Singh	XII Agricultural Science Congress	NDRI, Karnal
February 2015	5-8,	E B Chakurkar	4th Bhartiya Vigyan Samelan 2015	Kala Academy Panaji
February 2015	23-25,	Mathala J Gupta	49th Annual ISAE Convention and Symposium on Engineering Solutions for Sustainable Agriculture and Food Processing	College of Agricultural Engineering, PAU, Ludhiana

February 26-28, 2015	Narendra Pratap Singh	National Seminar on Sustainable Horticulture vis-à-vis Changing Environment	Nagaland University, Medziphema, Dimapur Nagaland
March 9-10, 2015	V Arunachalam	National Seminar on Recent Developments in Biotechnology	St. Xavier College Mapusa
March 13-14, 2015	Narendra Pratap Singh A R Desai	National Seminar on The Cashew: Prospective Crop of Future	Panaji, Goa.
March 18, 2015	R. Ramesh	Annual Review Meeting of PhytoFuRa Project	Indian Institute of Spices Research, Calicut

### Training /Summer/ Winter school attended

Date	Name	Programme	Venue
April 20-25, 2014	V. Arunachalam	<i>Technology Commercialization and Entrepreneurship Workshop</i>	Hotel Marriott, Miramar Goa
May 16-18, 2014	Safeena S A	Training cum workshop on essential oils, perfumery and aromatherapy	Pritam Hotels, Dadar, Mumbai
July 22-26, 2014	Manju Lekshmi N	Training programme on isolation, identification and culture of microalgae and live feeds for aquaculture	CMFRI, Kochi
October 23-26, 2014	Sreekanth G B	Open water diving course	DIVEGOA, Donapaula, Goa
November 19, 2014	Safeena S A	Training and Capacity building programme on preserving indigenous flora & fauna, local varieties and breeds	The International Center, Dona-Paula, Goa
January 15-17, 2015	V. Arunachalam	Training programme on basic R for life sciences	CSIR-NCL Innovation Park Pune
February 16 - March 8, 2015	Sreekanth G B	Summer School on “Recent Advances in Marine Biodiversity Conservation and Management”	CMFRI, Kochi, Kerala



## List of Publications

### Research Articles

- Achari GA and Ramesh R (2014). Diversity, biocontrol, and plant growth promoting abilities of xylem residing bacteria from solanaceous crops. *International Journal of Microbiology*, doi:10.1155/2014/296521.
- Achari GA and Ramesh R (2015). Characterization of bacteria degrading 3-hydroxy palmitic acid methyl ester (3OH-PAME), a quorum sensing molecule of *Ralstonia solanacearum*. *Letters in Applied Microbiology*, doi: 10.1111/lam.12389.
- Arunachalam, V (2014) Computational genomics of plants. *CAB Reviews*, 9: 036.
- Chakurkar EB, Naik PK, Swain, BK and Singh NP (2014). Performance of crossbred pigs reared under traditional and scientific feeding practices in Goa. *Animal Nutrition & Feed Technology*, 14 : 405-409.
- Chakurkar EB, Naik Sajan S, Barbuddhe SB, Karunakaran S, Naik PK and Singh NP (2015). Seminal attributes and sperm morphology of Agonda Goan pigs. *Journal of Applied Animal Research*, doi.org/10.1080/09712119.2015.1021807.
- Das Anup, Munda GC, Azad Thakur NS, Yadav RK, Ghosh PK, Nachan SV, Bujarbaruah KM, Lal B, Das SK, Mahapatra BK, Islam M and Dutta KK (2014). Rainwater harvesting and integrated development of agri-horti-livestock cum –pisciculture in high altitudes for livelihood of tribal farmers. *Indian Journal of Agricultural Sciences*, 84 (5): 643 – 649.
- Das SK and Singh NP (2014). Adaptation of dairy cattle towards climate change by improved housing and management. *Indian Journal Animal Science*, 84 (9): 1027- 1028.
- Das SK (2015). Effect of post partum mating time on the reproductive performance of broiler rabbits in Eastern Himalayan region of India. *The Indian Journal Small Ruminant*, 21 (1): 115 - 117.
- Gaitonde S and Ramesh R (2014). Genetic characterization of *Ralstonia solanacearum* infecting eggplant *Solanum melongena* L. from Goa and Western region of India. *International Journal of Current Science*, 12: E128-139.
- Jeetendra Kumar, Geetanjali Deshmukhe, Alkesh Dwivedi, Surya S, Sreekanth GB and Satyendra Kumar Singh. (2015). Seasonal and spatial variation of microalgal abundance and chlorophyll *a* concentration in intertidal rocky pools along Mumbai coast, India, *Indian Journal of Geo Marine Science*, 44 (4):3-7.
- Jerard BA, Niral V, Dhanapal R, Damodaran V, Arunachalam V, Rajesh MK, Devakumar K Samsudeen K, Nair RV, Kumaran PM, Thomas GV (2014) IND 221–Andaman Horned Cocos (IC0598221; INGR13063), a coconut (*Cocos nucifera*) germplasm with distinct character of Horny nuts. *Indian Journal of Plant Genetic Resources*, 27(1): 76-77.
- Jerard BA, Niral V, Dhanapal R, Damodaran V, Rizal SK, Arunachalam V, Sankaran M, Nair RV, Ratnambal MJ, Rao EVVB, Koshy PK, Thomas GV (2014) IND 099–Niu Leka Green Dwarf (EC0415218; INGR13065), a coconut (*Cocos nucifera*) germplasm of short statured palm but possessing the advantageous characters of tall. *Indian Journal of Plant Genetic Resources*, 27(1): 78.

- Maruthadurai R and Singh NP (2015). First report of invasive mealybug *Phenacoccus solenopsis* Tinsley infesting cashew from Goa, India. *Phytoparasitica* 43:121–124.
- Mahajan GR, Pandey RN, Dinesh Kumar, Datta SC, Sahoo RN, Rajender Parsad (2014) Development of critical values for the leaf color chart, SPAD and Fieldscout CM 1000 for fixed time adjustable nitrogen management in aromatic hybrid rice (*Oryza sativa* L.). *Communications in Soil Science and Plant Analysis*, 45 (14), 1877-1893.
- Manju Lekshmi N, Ratheesh Kumar R, Purushothaman CS, Sandeep KP, Pandey PK, Sreekanth GB and Singh NP (2014). Development of lignocellulolytic microbial consortium for the production of organic manures from agricultural wastes. *Journal of Aquatic Biology and Fisheries*, 2: 324-328.
- Muthulakshmi M, Muthukumar M, Rajkumar RS, Girish PS and Mooventhan P (2015). Shelf life of samosa utilizing spent hen meat emulsion. *International Journal of Science, Environment and Technology*, 4(1): 33 –39.
- Naik PK, Swain BK, Chakurkar EB and Singh NP (2014). Feed intake and nutrient digestibility in dairy cows fed rations containing soybean meal or cotton seed meal based concentrate mixtures. *Indian Journal of Animal Nutrition*, 31 (4) : 393-395.
- Naik PK, Dhuri RB, Karunakaran M, Swain BK and Singh NP (2014). Effect of feeding hydroponics maize fodder on digestibility of nutrients and milk production in lactating cows. *Indian Journal of Animal Sciences*, 84 (8): 880-883.
- Naik PK, Swain BK. and Singh NP (2015). Review: production and utilization of hydroponics fodder. *Indian Journal of Animal Nutrition*, 32 (1): 1-9.
- Ramesh R, Gaitonde S, Achari G, Asolkar T, Singh NP, Carrere S, Genin S and Peeters N (2014). Genome sequencing of *Ralstonia solanacearum* biovar 3, phylotype I strains Rs-09-161 and Rs-10-244, isolated from eggplant and chilli in India. *Genome Announcement*, doi:10.1128/genomeA.00323-14.
- Ramesh R, Achari, GA and Gaitonde S (2014). Genetic diversity of *Ralstonia solanacearum* infecting solanaceous vegetables from India reveals the existence of unknown or newer sequevars of Phylotype I strains. *European Journal of Plant Pathology*, 140 (3): 543-562. doi:10.1007/s10658-014-0487-5.
- Remya R, Vivekanandan E, Sreekanth GB, Ambrose TV, Saiby, Nair Preetha G and Mohammed KS (2014). Stock structure analysis of Indian mackerel from south east and south west coasts of India using truss network system. *Indian Journal of Fisheries*, 61 (3): 16-19.
- Safeena SA, Jayanthi R, Raju B, Jaganath S, Ramakrishna BM and Ramakrishna Parama VR (2014). Effect of pulsing on postharvest longevity of cut leaves of lace fern/bridal fern (*Asparagus setaceus* syn. plumosus). *Proceedings of the National Academy of Sciences, India Section B: Biological Sciences*, 84(3):735–742.
- Safeena SA. and Patil VS (2014). Studies on the effect of microwave oven drying on flower quality of dried dutch rose flowers. *National Academy Science Letters*, 37(1):19–24.



- Sandeep KP, Shukla SP, Manju Lekshmi N, Vennila A and Purushothaman CS (2015). Cultivation of *Spirulina (Arthrospira) platensis* in low cost seawater based medium for extraction of value added pigments. *Indian Journal of Geo Marine Science*, 44 (3).
- Sreekanth GB, Chakraborty SK, Jaiswar AK, Renjith RK, Mishal P, Sunil S Ail and Vaisakh G (2014). Comparison of length-weight progression for Japanese threadfin bream, *Nemipterus japonicus* (Bloch, 1791) from different regions along Indian coast using selected regression models. *Indian Journal of Geo Marine Science*, 43 (8).
- Sunkara, S, Arunachalam, V. Bhatnagar-Mathur, P. and Sharma, K.K. (2014) Isolation, cloning and characterization of 5' upstream region of galactose binding seed lectin gene of chickpea (*Cicer arietinum* L.). *Journal of SAT Agricultural Research*, 04/2014; 12.
- Tarkeshwar Kumar, Chakraborty SK, Jaiswar AK, Sandhya KM., Shah Tasaduq Hussain, Panda Debabrata, Sawant Bhawesh T, Sreekanth GB and Akhade Roshan R (2014). Gonadal maturation profile and fecundity of the *Johnieops sina* (Cuvier 1830) from Ratnagiri coast of India. *Indian Journal. Geo Marine Science*, Vol. 43 (9).
- Thangam M, Safeena SA, Priya Devi S and Singh NP (2014). Performance of Heliconia – An exotic cut flower crop as intercrop in coconut under coastal climatic conditions of Goa, *Journal of Indian Society of Coastal Agricultural Research*, 32 (2) : 37-41.

#### Paper Presented/ Conference / Abstracts

- Arunachalam V. (2015) Genetic and genomic resources for horticultural crops. National Seminar on Recent developments in Biotechnology, St Xavier College Mapusa Goa. 9 March 2015.
- Arunachalam V. (2015) Computational genomics of horticultural crops. Symposium on mathematical and computational biology. Invited talk at IIT Gandhinagar 22 March 2015.
- Arunachalam, V Jerard BA, Manju, KP and Niral, V (2014) Alternate genetics and genomics of coconut. In: George V. Thomas, V. Krishnakumar and B. Augustine Jerard International Conference on Coconut Biodiversity for Prosperity, 2010, Central Plantation Crops Research Institute, Kasaragod, Kerala, 97-101.
- Arunachalam V and Ashwita N. (2014). Grafting for propagation of noni. Ninth National Symposium on Noni for Everyone, International Centre Goa, 27-28, September 2014.
- Arunachalam V (2014) Goa Benaulim pani- a coconut selection for tendernut. Poster presented at XXI Placrosym International Plantation Crops Symposium, Hotel Gateway Kozhikode Kerala, 12-14 December 2014.
- Arunachalam V, Premkrishnan BV, Deepika K, Gayathri S. and Mugilisai M (2015) DNA sequence mining for molecular marker discovery in plants. National Seminar on New Frontiers in Plant Science and Biotechnology, Goa University Taleigao, 29-30 January 2015.

- Atish MM, Dube R Kiran, Roy Dam, Singh Kohli MP, Jayasiri HB, Manju Lekshmi N and Sreekanth GB (2014). Standardization of stocking density for Indian Major Carp fry for raising fingerlings under cage culture in an Indian reservoir, Indian Fisheries and Aquaculture Forum, Lucknow, 11-15 November, 2014.
- Basheer VS, Kumar Rahul G, Swaminathan TR, Sreekanth GB, Shanis C.P, Divya PR and Jena JK (2014). Fish diversity studies of Rivers of Goa, A Biodiversity Hotspot within the Western Ghats Region, Indian Fisheries and Aquaculture Forum, Lucknow, 11-15 November, 2014.
- Chakurkar EB (2014). Role of Advance Reproductive Techniques in Pig Production, National Symposium on Research and Innovations to Improve Animal Fertility and Fecundity ISSAR convention at Veterinary College Mathura, 20-22 November, 2014.
- Dani Thomas, Chandra Prakash, Sreekanth GB and Gopakumar G (2015). The environmental influence on reproductive performance of *Amphiprion Sebae* (Bleeker, 1853), with special reference to photoperiod and temperature. 2nd International Conference on Fisheries, Aquaculture and Environment in the Indian Ocean, Sultan Qaboos University, Muscat, Sultanate of Oman 24-26 February, 2015.
- Dani Thomas, Chandra Prakash, Sreekanth GB and Gopakumar G (2014) Influence of elevated temperatures on the period of embryonic development in *Amphiprion sebae* (Bleeker, 1853) under in-vitro check, Indian Fisheries and Aquaculture Forum, Lucknow, 11-15 November, 2014.
- Das SK, Karunakaran M and Barbudde SB (2014). Effect of orientation, ventilation, floor space allowance and cooling arrangement of cattle shed on the microclimate of shed and milk yield of dairy cattle of Goa, 2<sup>nd</sup> International Conference on Animal and Dairy Sciences, at HICC, Hyderabad 15-17 September, 2014.
- Das SK, Karunakaran M, Barbudde SB and Singh NP (2014). Dairy Production System in Goa, 7<sup>th</sup> National Extension Education Congress -2014, ICAR Research Complex for NEH Region, Barapani, Meghalaya, 8 -11 November, 2014.
- Das SK, Chakurkar EB, Kumar D and Singh NP (2015). Performances of Murrah cross buffaloes under the coastal climate of Goa, National Seminar and 22<sup>nd</sup> Annual Convention of ISAPM, CVsc & AH, CAU, Aizwal, Mizoram, 28 – 30<sup>th</sup>, January.
- Gupta MJ, Thangam M, Arunachalam V and Pitre AM (2015). Performance of a single-span naturally ventilated greenhouse for cucumber production in Goa, 49<sup>th</sup> Annual Convention of Indian Society of Agricultural Engineers (ISAE) & Symposium on Engineering Solutions for Sustainable Agriculture and Food Processing, Ludhiana, Punjab, 23-25 February 2015.
- Heena, D. and Arunachalam, V. (2014). Leaf and fruit production in noni germplasm of Konkan coast of Goa and Maharashtra. Proceedings of Ninth National Symposium on Noni for Everyone, International Centre Goa Sep 27-28, 2014.
- Karunakaran M, Chakurkar EB, Ratnakaran U, Naik PK and Babu MD (2014). Evaluation of boar semen quality in relation to lipid peroxidation status and in vitro sperm character, National Symposium on Research and Innovations to Improve Animal Fertility and Fecundity ISSAR convention at Veterinary College Mathura, 20-22 November, 2014.



- Manju Lekshmi N, Sreekanth GB, Ratheesh Kumar R and Singh NP (2014). Species diversity and relative abundance of fisheries resources found in traditional fishery along Siridao coast off Goa, National Workshop on Marine Biodiversity and Climate Change at Karwar Research Centre of CMFRI, 21-22 May 2014.
- Manju Lekshmi N, Sreekanth GB, Ratheesh Kumar R, Pandey PK, Vennila A, Anuraj A, Philipose KK and Singh NP (2014). Comparison of growth and length-weight relationships of green mussel, *Perna viridis* in two different coastal culture systems along Goa, Indian Fisheries and Aquaculture Forum, Lucknow, 11-15 November, 2014.
- Maruthadurai R and Singh NP (2014). Biology of invasive mealybug *Phenacoccus solenopsis* on cashew and record of its parasitoid, XXI Placrosym International Plantation Crops Symposium, Hotel Gateway Kozhikode Kerala, 12-14 December 2014.
- Maruthadurai R and Singh NP (2014). Red ant *Oecophylla smaragdina* for managing tea mosquito bugs in cashew. National Conference on Innovation in traditional practices for cultivation of fruit, vegetable and plantation crops, ICAR-CCARI, Old Goa, Goa, 11-12 December 2014.
- Naik PK, Gaikwad SP, Gupta MJ, Dhumal GM and Singh NP (2014). Low cost devices for hydroponics fodder production : case studies of farmers of Satara district, Maharashtra, Global Animal Nutrition Conference, GLANCE 2014 on Climate Resilient Livestock feeding Systems for Global Security, Bengaluru, 20-22 April 2014.
- Naik PK, Swain BK and Singh NP (2015). Hydroponics: its feasibility as an alternative to cultivated forages, 9<sup>th</sup> Biennial animal nutrition association conference on Eco-responsive feeding and nutrition: linking livestock and livelihood, Guwahati, 22-24 January 2015.
- Priya Devi S (2014). Kokum - A native, potential, nutraceutical crop of Goa, Extended summaries, national conference on innovation in traditional practices for cultivation of fruit, vegetable and plantation crops, ICAR-CCARI, Old Goa, 11-12 December, 2014.
- Priya Devi S, Gupta MJ, Thangam M and Singh NP (2014). Upscaling homestead value addition of jackfruit to an organised cottage industry through mechanisation and human resource development in Goa. In Compendium of International Symposium on Jack fruit (*Artocarpus heterophyllus* Lam.) and Bread fruit (*Artocarpus altilis* Fosberg) of the Tropics: Genetic diversity, Management, Value Addition and Marketing Strategies, at UAS, Bangalore, 15-16 May, 2014.
- Priya Devi S, Talaulikar S, Thangam M, Porob S, Mhalshi R and Singh NP (2014). Rose apple-wax jambo jam – A potential value added product for commercialization, National seminar on strategies for conservation, improvement and utilization of underutilized fruits, CHES, Chettalli, Madikeri, Kodagu, Karnataka, 1-3 December 2014.
- Priya Devi S, Thangam M, Porob S and Singh NP (2014). Morphological and biochemical changes during fruit development in kokum (*Garcinia indica* Choisy (Thouars)). National seminar on strategies for conservation, improvement and utilization of underutilized fruits, CHES, Chettalli, Madikeri, Kodagu, Karnataka, 1-3 December 2014.
- Priya Devi S, Thangam M and Singh NP (2014). Growth performance of pomegranate varieties in hot and humid climatic conditions of Goa. National seminar-cum-exhibition, pomegranate for nutrition, livelihood security and entrepreneurship development, ICAR-National Research Centre on Pomegranate, Solapur, Maharashtra, 05-07 December 2014.



- Ramesh R, Achari G, Gaitonde S and Thangam M. (2014). Screening of eggplant germplasm for bacterial wilt resistance and identification of resistant donor for resistant breeding. National symposium on plant pathology in genomic era, IGKV, Raipur, 26-28 May 2014.
- Ramesh R. Asolkar T and Singh NP (2014). Management of bacterial wilt in brinjal by grafting on wild type and soil application of lime. National Conference on Innovation in traditional practices for cultivation of fruit, vegetable and plantation crops, ICAR-CCARI, Old Goa, Goa, 11-12 December 2014.
- Ramesh R and Singh NP (2014). Management of major soil borne plant diseases in Goa using *Trichoderma* spp. National Seminar on New frontiers in plant sciences and biotechnology, Goa University, Goa, 29-30<sup>th</sup> January 2015.
- Ramesh R (2015). Bacterial wilt of solanaceous vegetables: Pathogen diversity and management options. National Symposium on Understanding host-pathogen interaction through science of omics, ICAR-Indian Institute of Spices Research, Kozhikode, Kerala, 16-17 March 2015.
- Safeena SA, Jayanthi R, Raju B and Singh NP (2014). Effect of pulsing on postharvest longevity of cut leaves of sprengeri fern (*Asparagus densiflorus* 'Sprengeri'). 6<sup>th</sup> Indian Horticulture Congress, Codissia Trade Fair Complex, Coimbatore, Tamil Nadu, 6-9 November, 2014.
- Safeena SA, Thangam M and Singh NP (2014), Effect of planting density on growth, flowering and yield of China aster (*Callistephus chinensis*. L. Nees) under agroclimatic conditions of Goa. 6<sup>th</sup> Indian Horticulture Congress, Codissia Trade Fair Complex, Coimbatore, Tamil Nadu, 6-9 November, 2014.
- Safeena SA, Thangam M, Priya Devi S and Singh NP (2014), Traditional wisdom in utilization of orchids for ethno botanical applications. National Conference on Innovation in traditional practices for cultivation of fruit, vegetable and plantation crops, ICAR-CCARI, Old Goa, Goa, 11-12 December 2014.
- Safeena SA, Anabel Rita Alphonso, Thangam M, Priya Devi S and Singh NP (2014). Innovations in traditional utilities of marigold. National Conference on Innovation in traditional practices for cultivation of fruit, vegetable and plantation crops, ICAR-CCARI, Old Goa, Goa, 11-12 December 2014.
- Singh NP and Desai AR (2014). "Kulaagars" of Goa: A unique Horticulture based Traditional land Use Pattern for Sustainable Production and livelihood security. National Conference on Innovation in traditional practices for cultivation of fruit, vegetable and plantation crops, ICAR-CCARI, Old Goa, Goa, 11-12 December 2014.
- Singh NP and Manjunath BL (2014). Integrated Farming Systems for livelihood security of small and marginal farmers. National symposium on agricultural diversification for sustainable livelihood and environmental security, PAU Ludhiana, 18-20 November, 2014.
- Singh NP, Desai AR and Priyadevi S (2014). Status and prospects of underutilized fruits of Goa. In souvenir: National seminar on Strategies for Conservation, Improvement and Utilization of Underutilized Fruitsheld. National seminar on strategies for conservation, improvement and utilization of underutilized fruits, CHES, Chettalli, Madikeri, Kodagu, Karnataka, 1-3 December 2014.



Singh NP, Manjunath BL, Mahajan Gopal, Priyadevi S, Desai AR, Das SK, Chakurkar EB and Swain BK (2014). Development of integrated farming system models for west coast region, National symposium on agricultural diversification for sustainable livelihood and environmental security, PAU Ludhiana, 18-20 November, 2014.

Singh NP, Sreekanth GB and Manju Lekshmi N (2014). Integrating Fisheries into Coastal Agricultural System: Way Forward, 10<sup>th</sup> Indian Fisheries and Aquaculture Forum (10 IFAF), Lucknow, 12-15 November, 2014.

Sreekanth GB, Manju Lekshmi N, Ratheesh Kumar R and Singh NP (2014). Exploring new Initiatives and platforms in fish biodiversity analysis. National workshop on marine biodiversity and climate change at Karwar research centre of CMFRI, 21-22 May 2014.

Sreekanth GB, Manju Lekshmi N, Chakraborty SK, Jaiswar AK, Zacharia PU, Renjith Vishnu Radhan, Sreenath R, Divu D and Singh NP (2014). Approximation of temporal variation of species abundance in a coastal ecosystem using fishermen assisted gillnets fishing experiments along Goa, Indian Fisheries and Aquaculture Forum, Lucknow, 11-15 November, 2014.

Thangam M, Safeena SA, Priya Devi S and Singh NP (2014). Traditional Vegetable Varieties of Goa for Conservation and Sustainable Utilization, National conference on innovation in traditional practices for cultivation of fruit, vegetable and plantation crops, ICAR RC, Old Goa, 21-22 December, 2014

Thangam M, Sawant T, Safeena SA, Priya Devi S and Singh NP (2015). Genetic diversity in *Heliconia*-a tropical flower and related genera using DNA markers, International Symposium on New Perspectives in Modern Biotechnology, Puducherry, 23-25 March, 2015.

### Popular / Technical Articles

Maruthadurai R and Karuppaiah V (2014). Managing Menace of Insect Pests on Custard Apple. *Kheti* 2(3): 108-111.

Naik PK and Singh NP (2014). Production and feeding of hydroponics green fodder. *Indian Farming*, 64 (6): 42-44.

Naik PK, Faterpekar DD, Dhawaskar BD and Singh NP (2014). Nutritional interventions for profitable dairy farming in Goa. *Goa Vet*, III (IV): 1.

Sandeep KP, Shukla SP, Manju Lekshmi N (2014). Potential application of cyanobacterium spirulina. *Aqua International*, 52-54.

Sreekanth GB, Manju Lekshmi N, Singh NP (2014). Marine fisheries sector of Goa, Marine fisheries sector of Goa, Challenges and options- A critical analysis. *Fishing Chimes*, 34(1): 53-57.

Sreekanth GB, Tincy Varghese, Mishal P, Sandeep KP and Praveen KV (2015). Food security in India: Is aquaculture a solution in the offing?. *International Journal of Science and Research*, 4(3): 553-560.

### Institute as Publisher

Publications	Authors/ Editors
<b>Reports</b>	
Annual Report (2013-2014) pp.1-173	Narendra Pratap Singh, PK Naik, R Ramesh, Safeena SA, GR Mahajan and Sreekanth GB
Pragya - Annual Hindi Magazine - 2013-14	Mathala J Gupta and Shashi Vishwakarma
<b>Technical Bulletins</b>	
Important Zoonotic Diseases: Prevention & Control Technical Bulletin No 39, pp. 1-38	ZB Dubal, SB Barduddhe and Narendra Pratap Singh
A manual on the use of Potential Fishing Zone (PFZ) Forecast Technical Bulletin No 40, pp. 1-27	S Subramanian, Sreekanth GB., Manju Lekshmi N, Narendra Pratap Singh, Janhavi Kolwalkar, Tejaswini Patil and Pastta Fernandes
A guide on Jack Fruit Cultivation and Value Addition Technical Bulletin No 41, pp. 1-56	S Priya Devi, Suntera Talaulikar, MJ Gupta, M Thangam and Narendra Pratap Singh
Three Decades (1981-2010) of Research on Fish Nutrition at ICAR-CCARI Technical Bulletin No 42, pp. 1-34	PK Naik, BK Swain and Narendra Pratap Singh
Ready Reckoner on Cultivation of Gladiolus Technical Bulletin No 43, pp. 1-20	Safeena SA, M Thangam, S Priya Devi, AR Desai, V Arunachalam, MJ Gupta and Narendra Pratap Singh
Goat Farming for the Farmers of Goa Technical Bulletin No 44, pp. 1-32	SK Das, ZB Dubal and Narendra Pratap Singh
Rabbit as an Alternative Source of Meat Production Technical Bulletin No 45, pp. 1-42	SK Das, EB Chakurkar and Narendra Pratap Singh
Agro- Eco- Tourism: A New Dimension to Agriculture Technical Bulletin No 46, pp. 1-37	SB Barbuddhe and Narendra Pratap Singh
Unconventional Feed Resources for Efficient Poultry Production Technical Bulletin No 47, pp. 1-55	BK Swain, PK Naik and Narendra Pratap Singh
Two Decades (1999 – 2010) of Agricultural Entomology Research at ICAR-CCARI – A Scientific Review Technical Bulletin No 48, pp. 1-66	Maruthadurai R, R Ramesh and Narendra Pratap Singh



Catch Trends in Major Marine Fisheries Resources of Goa Technical Bulletin No 49, pp. 1-42	Sreekanth GB, Manju Lekshmi N and Narendra Pratap Singh
<b>Extension Folders</b>	
Heliconia - a profitable intercrop in Coconut Extension Folder No.71	M Thangam, Safeena SA, S Priya Devi and Narendra Pratap Singh
Freshwater ornamental aquarium fabrication and management Extension Folder No.72	Manju Lekshmi N, Sreekanth GB and Narendra Pratap Singh
News Letter	
Vol. XVI. No.1 January – April, 2014 pp1-14	GR Mahajan, Sreekanth GB and Manju Lekshmi N
Vol. XVI. No.2 May – August, 2014 pp1-16	GR Mahajan, Sreekanth GB and Manju Lekshmi N
Vol. XVI. No.3 September – December, 2014 pp1-10	GR Mahajan, Sreekanth GB and Manju Lekshmi N

## Workshops, Seminars and Other Events

### Visit of DG, ICAR and Brainstorming session on coastal agricultural research

Dr. S. Ayyappan, Secretary (DARE) and Director General (ICAR), New Delhi and Dr. A. K. Sikka, DDG (NRM) visited the Institute on 9th April, 2014. The Honourable DG inaugurated the newly constructed Zuari Guest House and the Renovated Lab-Cum Administrative Building. A brainstorming session on ‘Coastal Agricultural Research’ was conducted in the Institute which was presided by Dr. S. Ayyappan. The objective of the brain storming session was to expand the mandate of this Institute and rename it into ICAR-CCARI (CCARI). DG, DDG and other dignitaries deliberated and discussed on the subject. Three technical bulletins viz. “Agricultural Technology Options”, “Genetic diversity of Kokum (*Garcinia indica*) in Goa-Tree and fruit characters” and “Manual on Diagnosis of insect pests and diseases of plantation and spice crops of Goa” were released by Director General.



*Dr. S. Ayyappan, DG ICAR, during inauguration of Zuari guest house*

### National Level Training Programme on Cashew Production and Processing Technologies

A National Level Training Programme on Cashew Production and Processing Technologies” was jointly organized by ICAR-CCARI in collaboration with Directorate of Cashewnut and Cocoa Development, Kochi, Kerala from 22nd to 24th April, 2014. The programme was inaugurated by Shri Bharat

Vir Wanchoo, the Honourable Governor of Goa, who emphasized the role of agriculture in food security. Dr S. K. Malhotra, Horticulture Commissioner, Government of India pointed the availability of more than forty varieties of cashews for different regions of India. Dr. Narendra Pratap Singh, Director of ICAR institute briefed about the institute especially the cashew production in the State. Shri Hubballi, Director, DCCD, Kochi told about the trade related issues of cashew. In this programme, 50 officers from different departments, corporations, Universities and NGOs representing the cashew growing states across the country participated in the training.



*Hon'ble Governor releasing the publication*

### Training programme on “Diagnosis of insect pests and diseases of plantation and spice crops of Goa”

A training programme on “Diagnosis of insect pests and diseases of plantation and spice crops of Goa” was conducted by ICAR-CCARI, Old Goa on 25th April, 2014. Over fifty people participated in the programme. The participants include Zonal Agricultural Officers, Agricultural Officers from Directorate of Agriculture, extension personnel from NGOs, Private companies and progressive farmers from Goa. The training was inaugurated by Shri. P. Tufani, Director, Directorate of Agriculture, Govt. of Goa. Shri. Tufani highlighted the important insect pests and diseases of plantation and spice crops of Goa and the associated practical problems in the control of pests and diseases. Dr. Narendra



*Inaugural session of the training programme*

Pratap Singh, Director, ICAR-CCARI stressed the need for early detection and proper diagnosis of the insect pests and diseases. Detailed presentation and deliberations were conducted during the training by Dr. R. Ramesh, Senior Scientist (Plant Pathology) and Dr. R. Maruthadurai, Scientist (Agricultural Entomology), the course coordinators.

### वार्षिक हिन्दी पत्रिका प्रज्ञा को गणेश शंकर विद्यार्थी हिन्दी कृषि पत्रिका पुरस्कार

हमारे संस्थान द्वारा प्रकाशित गृह पत्रिका प्रज्ञा को भारतीय कृषि अनुसंधान परिषद द्वारा वर्ष २०१२-१३ के गणेश शंकर विद्यार्थी हिन्दी कृषि पत्रिका पुरस्कार के अंतर्गत प्रथम पुरस्कार से सम्मानित किया गया है। नई दिल्ली में दिनांक २८-०४-२०१४ को संपन्न निदेशको की बैठक में इस पुरस्कार को प्रदान करते हुए परिषद के मुख्यालय से इस पत्रिका के कार्य के लिए संस्थान के निदेशक डॉ. नरेन्द्र प्रताप सिंह व पत्रिका की प्रमुख संपादक डॉ. मतला जूलियट गुप्ता की मुक्त कंज से प्रशंसा की। ज्ञात हो कि 'प्रज्ञा' संस्थान द्वारा प्रकाशित हिन्दी गृह पत्रिका का



आदरणीय महानिदेशक डॉ. एस. अय्यप्पन जी से पुरस्कार स्वीकार करते हुए डॉ. एन.पी.सिंह और श्री. सौरभ मुनी

प्रथम अंक है। इसमें कृषि क्षेत्र पर समर्पित लेख सम्मिलित किए गए हैं। प्रज्ञा के सफल प्रकाशन हेतु संपादक मंडल के सभी सदस्य व लेखक विशेष सराहना एवं बधाई के पात्र हैं।

### Training programme on ornamental fish farming and aquarium fabrication

A training programme on ornamental fish farming and aquarium fabrication for women and children was organized on 8th May, 2014 at village Sangolda, adopted by Krishi Vigyan Kendra, ICAR-CCARI, Old Goa. There is a huge untapped potential for ornamental fish farming. The training programme emphasized on breeding and feeding of fishes, aquarium fabrication and its maintenance. As a part of the training programme practical demonstrations on aquarium fabrication, settings etc. were given. Dr. Narendra Pratap Singh, Director ICAR-CCARI highlighted the development of ornamental fisheries sector and explained that under the National mega seed project many activities like breeding and sales of ornamental fishes, live feed development etc. are going on in the Institute. He further explained that ornamental fisheries sector can be managed without any large investment or intensive labour.



*Hands on training to women and school children*

### Participation in the Goa Mango Festival 2014

The Institute participated actively in the Goa Mango Festival-2014 organised by the Directorate of Agriculture was inaugurated on 13th May, 2014. The programme experienced the presence of Honourable Governor of Goa, Shri. Bharat Vir Wanchoo, Mathew Samuel, Secretary of Agriculture, Govt. of Goa, Dr. Narendra Pratap Singh, Director, ICAR-CCARI and Shri. P. Tufani, Director, Directorate of Agriculture,

Govt. of Goa. The festival has been organized with an objective to verify the different varieties of mangoes in Goa. During the festival around sixty varieties of mangoes were displayed. The KVK, ICAR-CCARI, Old Goa exhibited 35 local and introduced mango varieties. Samples of important pest and diseases and value added products of mango are also displayed. Practical demonstrations on mango grafting were given to interested farmers during the festival.



*Hon'ble Governor Shri. Bharat Vir Wanchoo visiting the stall*

### Training and demonstration programme on bypass fat

A training and demonstration programme for dairy farmers of Goa was held at ICAR-CCARI, Old Goa on 23rd May, 2014 under the Rashtriya Krishi Vikas Yojana (RKVY) funded project 'Production and supplementation of bypass fat to dairy animals for enhancement of milk production and livelihood security of dairy farmers of Goa'. About 50 delegates including dairy farmers from different Talukas, officials from Directorate of Agriculture, Directorate of Animal Husbandry and Veterinary Services and Goa State Co-operative Milk Producers' Union Limited (Goa Dairy) of the state participated in the above training and demonstration programme. Shri P. Tufani, Director of Agriculture and Nodal Officer, RKVY, Govt. of Goa was the chief guest; while Shri Vithoba D. Dessai, Chairman, Goa Dairy and Dr. S. K. Singh, Director, NBSS & LUP, Nagpur were the Guests of Honour. The delegates were trained for 'production and supplementation of bypass fat to dairy animals for enhancement of milk production and livelihood security of dairy

farmers of Goa' through technical presentations and practical demonstrations. Indigenously produced bypass fat at the Institute was provided to the dairy farmers at a fixed rate for feeding their dairy animals and were requested to give their feedback.



*Release of indigenously prepared bypass fat and publication*

### Training on Jack fruit: Value Addition as an enterprise for farm women

ICAR-CCARI organised a training on jack fruit: Value Addition as an enterprise for farm women, during 25th to 27th June, 2014. The Institute has trained and ensured capacity building to tribal self help groups by providing processing machinery to the groups. During the training, demonstration on preparing different products (twelve) of Jack fruit was given. They were also given hands on training for operation of the processing machinery, bulk production, packaging and labelling. Besides, Mrs. Iva Fernandes, resource person from Department of Food and Drugs, Panjim has given a lecture on "Significance, modalities and advantages of FSSAI license for value added products".



*Practical demonstration on value addition of jackfruit*

### **Technology demonstration on mussel culture**

ICAR-CCARI initiated demonstration on mussel (green mussel, *Perna viridis*) culture on about 500 sq. m. semi enclosed water body of Mr. Antonio Bosco Menezes, an entrepreneur in Goavelha on 29th November 2013. The rack culture method was followed by constructing a structure with dimension 5×5 m made of bamboo poles. Regular monitoring and advisories through scientific biweekly sampling procedure was followed. The physico-chemical and biological parameters of water and sediment were monitored regularly. Moreover, growth, length-weight progression and meat quality of mussels were monitored. The culture operation has revealed enterprising results for the coastal mariculture in Goa. This method is found to be eco-friendly as there is no involvement of additional nutrient inputs to the culture system. The mussels will thrive on the plankton which enters through the tidal forcing by filter feeding.



*Technology demonstration on mussel culture*

### **Training programme on Improved methods for nursery production and cultivation of vegetables, flower and fruit crops**

A training program on “Improved Methods for nursery production and cultivation of vegetable, flower and fruit crops cultivation” under Tribal Sub plan project on “Naturally ventilated greenhouse for seedling production and crop cultivation for providing livelihood opportunities for Tribal of Goa” was conducted on 18th June, 2014 at temple hall of Malcoaponwado, Malkarne, Quepem Taluka Goa. A total of 29 farmers of various Self Help Groups (SHGs) of Macopon and Malkarne attended the

same. There were deliberations on different themes like improved methods of vegetable cultivation, protected cultivation, improved methods for fruit tree propagation and nursery production, flower nursery management and floriculture and structures for protected cultivation of horticultural crops by scientists from the institute. Hybrid seeds and inputs were distributed to the members of the SHGs.



*Training on nursery production and vegetable production*

### **Training programme on power tiller operation and maintenance**

A training program on “Power tiller operation and maintenance” under Tribal Sub plan project on “Agricultural Mechanization Program for Small and Marginal Tribal Farmers of Goa” was conducted on 21st June, 2014 at research farm of ICAR-CCARI, Ela, Old Goa by Dr. Mathala Juliet Gupta, Principal Investigator of the project. A total of 42 farmers (29 men and 13 women) who were from 18 Farmers /Self Help Groups from 18 wado belonging to Cotigaon, Gaodongrim, Karvem and Barddem of Canacona taluka and



*Demonstration of power tiller operation and maintenance*

Morpirla, Dabem, and Karvem of Quepem Taluka participated in the same. On the occasion, Mr. Talbert Frank of Ms. Goa Tractors Tillers Agencies gave a lecture on Power tiller and its various attachments, applications, servicing, common mistakes made by farmers during use and its servicing. The farmers were then individually taught to use the power tiller and mini rotary tillers in the wetlands at the research farm of the ICAR-CCARI.

### **Distribution of machinery to beneficiaries under Tribal Sub Plan, Govt. of India**

A program was arranged on 5<sup>th</sup> July, 2014 for distribution of farm machinery viz. 12 Power tillers (13 Hp), 6 Power tillers (9 Hp) with all accessories including Mould board plough, cage wheels, rotavator, cultivator etc. and 6 mini rotary tillers to 225 farmers of 18 wards belonging to Gaodongrim, Morpirla, Cotigaon and Cola under Agricultural Mechanization Programme for Small and Marginal Farmers of Goa. Similarly, five sets of processing equipment viz., Jackfruit cutting machine, jackfruit Chips cutter, kokum cutting Machine, Electric Cabinet dryer, Mini mill, sealing machine, wetgrinder and utensils and cutlery worth were distributed to about 100 farmers of Gaodongrim, Poinguinim, Morpirla, Mardol, Priol and Karmali under the project “Empowering Tribes of Goa with Post-Harvest Machinery for Processing and Value Addition in Minor Fruits”. Dr. Narendra Pratap Singh, Director, ICAR RC for Goa and Shri. Narendra Sawaikar, Hon’ble MP, South Goa appreciated the efforts of scientists and enthusiasm of the

farmers and urged them to focus on the strategic development of agriculture in the state through mechanisation

### **Foundation Day Celebration**

ICAR-CCARI, Old Goa, celebrated the ICAR Foundation Day on 16<sup>th</sup> July, 2014 at KVK Old Goa. On this occasion “Small and Marginal Farmers Meet on Integrated Farming System” was organized. The event was attended by 110 farmers from different adopted villages of KVK – North Goa. The event was chaired by Shri Deepak Dhavalikar, Hon. Minister for Cooperation, Govt. of Goa. He appreciated the role of Scientists and KVK officials in developing new agricultural technologies and transferring them to the farmers over last few decades. Further, he urged the farmers to take up agriculture as an enterprise for the development of the state. Shri Pandurang Madkaikar, Hon. MLA, Kumbharjua, requested the farmers/youth to take up agriculture in the state which has the highest subsidy component in comparison with the national status. Dr. Narendra Pratap Singh, Director, ICAR-CCARI presented the highlights of ICAR system in India and the role played by the organization in securing food security. He advised the farmers to take up the advantage of the ICAR Institute and KVK to enhance the growth of agriculture in Goa. Shri Prakash Amonkar, Sarpanch, Old Goa and Smt Sandra Fernandes, Director, Green Growth Institute, Sangolda, also addressed the gathering. Farm machinery and implements were distributed during the occasion to the tribal farmers of Veling village.



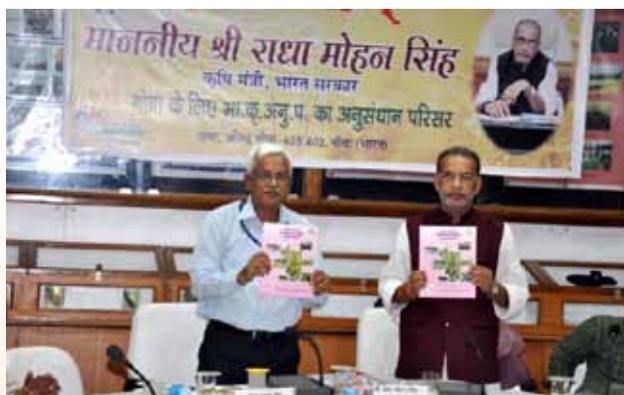
*Distribution of machinery to beneficiaries under Tribal Sub Plan, Govt. of India*



*Foundation day celebration*

### Visit of Union Minister of Agriculture to the Institute

Honourable Shri. Radha Mohan Singh, Union Minister of Agriculture, Govt. of India visited ICAR-CCARI on 3rd August 2014. During the visit, he was appraised about the Institutional activities through exhibition of various technologies developed at the Institute. He visited the laboratories of the Institute and was explained about the ongoing research work. On the occasion, Dr. Narendra Pratap Singh, Director, ICAR-CCARI welcomed the Hon. Minister which was followed by a brief presentation on research and extension activities of the Institute. The Union Minister launched 'Soil Health Management-Goa' website on this occasion. He stressed upon dissemination of technologies as 'Lab to Land' for improving livelihood of the farmers. The programme was also attended by Shri. Narendra Sawaikar, MP, South Goa, Scientists, Technical and Administrative Staff of the Institute and KVK staff of North & South Goa, State Government Officials, representatives of press and media, etc. The Hon. Minister released two publications – 1. Annual Report of ICAR RC for Goa – 2013-14 and 2. Handbook on Freshwater Aquaculture during the programme. The Hon. Minister visited experimental farms, units and demonstration plots of the Institute and Krishi Vigyan Kendra. The Union Minister appreciated the research work and extension activities being carried out by the Institute. Further the minister suggested that personal involvement in the day-to-day research is very crucial for the success of various programmes.



*Shri. Radha Mohan Singh Hon'ble Union Minister of Agriculture releasing the publication*

### Training programme on mariculture technologies

A training programme on mariculture technologies was conducted at ICAR-CCARI under the National Fisheries Development Board funded project on August 6, 2014. Around 15 participants from Madkai and Canacona areas attended the training programme. The programme highlighted the importance of mariculture in Goa with particular reference to mussel and oyster culture. Dr. Narendra Pratap Singh, Director, ICAR-CCARI welcomed the participants and sensitized them about the importance of mariculture in Goa.

### Progressive farmers meet on Protection of Plant Varieties and Farmers Right Act

In order to create awareness among the farming community of Goa regarding protection of plant varieties and farmers right act 2001, one meeting with progressive farmers of Goa and scientists of ICAR-CCARI, Ela, Old Goa and staff of Krishi Vigyan Kendra was held on 16th August, 2014 at ICAR-CCARI.

Dr. R. R. Hanchinal, Chairman, PPV FRA, New Delhi gave the detail presentation on how to protect farmers varieties by doing registration of their varieties. He explained in detail the Farmer Right Act 2001. He further said that if farmers and scientist do not register their varieties in time then some other persons will register and take the benefit. He said that there is no any kind of fees for farmers for registration of varieties.

He requested the scientist of ICAR-CCARI and Krishi Vigyan Kendra to help the farmers in registration of their varieties. Dr. Narandra Pratap Singh, Director, ICAR-CCARI, Ela, Old Goa in his introductory remark assured full help to farmers from his side in getting their varieties registered. Dr. Priya Devi, Sr. Scientist (Horticulture) presented the work done in collection and evaluation of Kokum, Flowers and vegetables varieties from Goa. Forty Progressive farmers from Pilar, Veling, Neura, Aldona and other parts of Goa participated in the meeting and took part in the discussion.



*Awareness on Protection of Plant Varieties and Farmers Right Act*



*Inaugural function of Noni Search 2014*

### संस्थान द्वारा इस वर्ष मनाए गए हिन्दी सप्ताह का संक्षिप्त विवरण

इस वर्ष संस्थान द्वारा दिनांक ११ सेप्टेम्बर २०१४ से १९ सेप्टेम्बर २०१४ तक हिन्दी सप्ताह का आयोजन किया जा गया। हिन्दी सप्ताह कार्यक्रम का उद्घाटन माननीय निदेशक महोदय जी के करकमलों से हुआ, इस अवसर पर उन्होंने हिन्दी के गौरवपूर्ण इतिहास का वर्णन किया, साथ ही संस्थान के सभी कर्मचारियों को हिन्दी में काम करने हेतु प्रेरित किया। संस्थान में मनाए गए हिन्दी सप्ताह के दौरान कर्मचारियों के लिए अनेक प्रकार की प्रतियोगिताएं जैसे की निबंध लेखन, टिप्पणी लेखन, पत्र लेखन, गायन, सस्वर कविता पाठन आदि प्रतियोगिताओं का आयोजन किया गया, जिसमें संस्थान के अधिकांश कर्मचारियों ने उत्साह के साथ भाग लिया। इस अवसर पर संस्थान के कर्मचारियों के बच्चों के लिए भी अनेक प्रतियोगिताओं का आयोजित की गयी। मासिक स्टाफ मीटिंग में हिन्दी सप्ताह कार्यक्रम में आयोजित विभिन्न प्रतियोगिताओं के विजेता प्रतिभागियों को पुरस्कार से सम्मानित किया गया।

### Ninth National Symposium “Noni for Everyone”

The Ninth National Symposium on Noni Research “Noni Search-2014” was held at the International centre, Goa during 27th to 28th September, 2014. The symposium was organised by World Noni Research Foundation, International Society for Noni Science (Chennai), ICAR-CCARI and Dr. BSKKV, Dapoli. The symposium was inaugurated by Mrs. Mridula Sinha, Hon. Governor of Goa and presided over by Dr. K. E. Lawande (Vice Chancellor, Dr.BSKKV, Dapoli) and Dr. R. R. Hanchinal, (Chairman, Protection of

Plant Variety and Farmers Right Authority, New Delhi). Symposium had 20 oral presentations by scientists from 15 research organisations. Dr. Kirti Singh (Chairperson, WNRF and President, ISNS), Prof. P. I. Peter (Chairman, Noni Biotech, Chennai) and members of RAB briefed about the outcome of the symposium. The two days National Symposium had seven technical sessions including a special session on success stories after using divine Noni. Honourable Governor of Goa released two technical bulletins and Annual Report 2013-14. The symposium stressed for intensifying clinical studies on Noni to manage new life style diseases like cancer, cardio-vascular disorders, diabetes, obesity and arthritis. The Research Advisory Board (RAB) of WNRF was held on 29th September 2014 at ICAR-CCARI, Old Goa reviewed all the ongoing projects funded by WNRF, Chennai.

### “Swachh Bharat Mission” set in motion

Owing to the importance of “Swachh Bharat Abhiyan” or Clean India Mission” led by the Government of India, the ICAR-ICAR-CCARI has actively organised various activities between 25th September and 2nd October, 2014. The main objective was to propagate a cleanliness drive in and around the Institute and the surroundings of Old Goa. All the staff of the Institute and Krishi Vigyan Kendra (KVK) undertook a cleanliness drive. The Institute has carried out the following activities under the “Clean India Mission”. On this occasion, all the Institute staffs took pledge to keep and maintain cleanliness. A silent procession was also organised to create awareness and motivate



*Awareness rally on 'Swachh Bharat'*

the people of Old Goa for maintaining individual hygiene and cleanliness of the surroundings.

### **Group Meet on Moongbean and Urdbean for Spring/Summer and Rice fallow Cultivation**

A group meet for Spring, Summer and Rice fallow cultivation of Moongbean and Urdbean under All India Co-ordinated Research Project on "MULLaRP" was held at ICAR-ICAR-CCARI, Old Goa on 22nd November, 2014. Dr. B. B. Singh, Assistant Director General (Oilseeds and Pulses), ICAR, New Delhi was the Chief Guest of the programme. He released Goa Cowpea-3, a newly developed cowpea variety. Dr. Narendra Pratap Singh, Director, ICAR-ICAR-CCARI in his welcome address emphasised the need and scope for pulse research in the coastal region. Dr. N. P. Singh, Director, ICAR-Indian Institute of Pulses Research (ICAR-IIPR), Kanpur delivered the introductory remarks, while Dr. Sanjeev Gupta, Project Co-ordinator (MULLaRP) delivered the exhaustive report on research achievements and future programmes.



*Group discussion during the group meet on pulses*

### **Brainstorming Session on prospects and potential of pulses for coastal region**

A Brainstorming Session on prospects and potential of pulses for coastal region was held on 23rd November, 2014 at ICAR-ICAR-CCARI, Old Goa. Dr. Narendra Pratap Singh, Director, requested the expert group to suggest research plan for the pulses production in the coastal areas. Dr. B. B. Singh, Assistant Director General (Oilseeds and Pulses), ICAR, New Delhi, highlighted the scope of pulses especially mungbean, urdbean and cowpea in the coastal areas and cautioned for designing approaches east and west coast differently. Suitable crops, varieties, production practices and crop protection measures were discussed. Priorities of introducing pulses in coastal areas were identified through discussions and it is proposed to prepare a strategic plan.

### **National conference on Innovation in Traditional Practices for the Cultivation of Fruits, Vegetables and Plantation crops**

National conference on "Innovation in Traditional Practices for the Cultivation of Fruits, Vegetables and Plantation crops" was organized by Asian Agri-History Foundation (AAHF) in collaboration with ICAR-ICAR Research complex for Goa during 11th to 12th December, 2014. The conference was inaugurated by Dr. Y.L. Nene, a well known plant protection scientist in the country and Retd. Justice V.S. Dave was the guest of honour. The conference was organised to promote and popularize traditional practices in the agricultural field. The conference had discussions on region-wise



*Inauguration session of the National Conference*

information on traditional agricultural practices, yagic agriculture, conservation of agricultural biodiversity, indigenous technical knowledge in various aspects like general agricultural practices, biological disease management, local germplasm conservation, traditional processing methods in agriculture and preservation of indigenous technical knowledge. The conference was concluded with suggestions and recommendations for maintaining and improving the knowledge on these traditional practices for the cultivation of agricultural crops and modernizing and fine tuning ancient traditional techniques for sustainable and eco-friendly agriculture.

### District level seminar on Spices Production in Goa

A District Level Seminar on Spices production in Goa was organized at ICAR-CCARI, Ela, Old Goa in collaboration with Spices Board, Kochi, Kerala, from 28th to 29th January, 2015. Shri. DP Dwivedi, Secretary (Agriculture), Govt. of Goa, Dr. Narendra Pratap Singh, Director, ICAR-CCARI, Shri. Orlando Rodrigues, Director (Agriculture), Govt. of Goa, Shri. Siddaramappa, Director (Dev.), Spices Board, Kochi and Dr. AR Desai, Senior Scientist (Horticulture section, ICAR-CCARI) were present during the function. During the technical Session, scientists from IISR, Calicut; Agricultural Research Station (MPKV, Rahuri, Maharashtra); Spices Board and ICAR-CCARI gave detailed account of promising varieties, improved production technologies, plant protection practices and value addition of spice crops. Officers from Spice Board briefed the gathering about various Schemes of Spice



*Inaugural session of seminar on spices production*

Board to support the spice production and marketing. The deliberations of the seminar and open discussion during the interactive session led to the formulation of resolutions to boost the spice industry in Goa.

### Participation in Aqua Goa Mega Fish Festival-2015

ICAR-CCARI has participated with a scientific exhibition stall in the Second Aqua Goa Fish Festival-2015 organised by Directorate of Fisheries, Govt. of Goa with National Fisheries Development Board, Hyderabad from 29th January to 1st February (Navelim) and 6th to 9th February (Mapusa). Shri. Laxmikant Parsekar, Chief Minister of Goa inaugurated the event. The Section, Fisheries Science, ICAR-CCARI, displayed posters representing their research and extension activities in the stall. Moreover, the sale and display of fresh water ornamental fishes were also done.



*Hon'ble Chief Minister of Goa visiting ICAR-CCARI stall*

### Participation in Exhibition organized by Vigyan Bharati at Kala Academy

The Institute participated in the exhibition organized by Vigyan Bharati at Kala Academy from 5th to 8th February, 2015. The exhibition was inaugurated by Hon'ble Governor of Goa, Mrs. Mridula Sinha. About 1.5 lakh visitors, including school children and farmers visited our exhibition stall. Different technologies developed by the Institute were showcased in the form of posters, models, samples, etc. during the occasion. Team of scientists/officials headed by the Director, Dr. Narendra Pratap Singh guided the visitors and explained the activities of the Institute.



*ICAR-CCARI stall in exhibition organised by Vigyan Bharati*

### **NICRA Focus Group Workshop on “Climate Change and Coastal Aquaculture – Impacts, Adaptations and Mitigations for Resilience”**

National Initiative on Climate Resilient Agriculture Focus Group Workshop on “Climate Change and Coastal Aquaculture – Impacts, Adaptations and Mitigations for Resilience” was organised by ICAR-Central Institute of Brackishwater Aquaculture (ICAR-CIBA) in collaboration with ICAR-CCARI on 11th March, 2015. There were about forty participants representing the fishermen, and fish farmers of Goa. Scientists from ICAR-CIBA gave an introduction about the NICRA project, importance of awareness on climate change and various coastal and brackishwater fish culture techniques. Dr. Narendra Pratap Singh, Director, ICAR-CCARI emphasized on climate change and its impacts on the agriculture and fisheries sector of Goa. Dr. Shamila Monteiro, Director, Dept. of Fisheries, Govt. of Goa urged for new initiatives



*Inaugural session workshop on climate change and coastal aquaculture*

in the fisheries sector to combat the climate change. The participants gave their feedback on their perceptions and auto-adaptations of climate change in Goa.

### **Hands on training programme on Protected cultivation of high value crops in Goa**

A RKVY sponsored training programme on protected cultivation of high value crops in Goa was organised from 17th to 18th March, 2015. The deliberations by scientists of ICAR-CCARI included protected cultivation of high value crops in Goa, cultivation of flower crops in polyhouse, cultivation of gladiolus and tuberose under open field in Goa, suitable protected structures for high value crops in Goa and plant protection in protected structures. Dr. Narendra Pratap Singh, Director emphasized the scope of protected cultivation and need to develop marketing strategies for large scale cultivation in Goa.



*Demonstration on protected cultivation of high valued crops*

### **Secondary livelihood opportunities through fishery resources**

A training programme on “Secondary livelihood opportunities through fishery resources” sponsored by National Fisheries Development Board was organised by ICAR-CCARI from 19<sup>th</sup> to 21<sup>st</sup> March, 2015. It covered technical sessions from scientific experts of ICAR-Central Marine Fisheries Research Institute (ICAR-CMFRI) and ICAR-CCARI. A total of twenty eight farmers and entrepreneurs from different parts of North and South Goa have participated in the programme. Dr.



*Trainee group of the training programme*

Narendra Pratap Singh, Director, ICAR-CCARI pin pointed the importance of mariculture and ornamental fish culture in Goa. The training emphasized on mussel culture, ornamental fish culture, fish health management, aquarium construction and management, live feed culture, feed formulation techniques and indigenous freshwater ornamental fishes of Goa and practical sessions on aquarium fabrication and hatchery management.

### Training on “Use of online web portal Soil Test Based Fertilizer recommendations in Goa”

The Institute conducted one day training on “Use of online web portal Soil Test Based Fertilizer Recommendations - Goa to make soil test based fertilizer recommendations to Goan crops” on 20th March, 2015. The Institute has launched an online web portal to make the fertilizer recommendations to important crops of the State of Goa. Dr. Narendra Pratap Singh, Director, ICAR-CCARI, enlightened the trainees about importance of making the soil test based fertilizer application and urged them to make use of the utility developed by the Institute. The group



*Trainee group of the training programme*

of trainees consisted of the officials of soil testing laboratories in Goa, Department of Agriculture, Government of Goa, farmers and participants from the Institute. The importance of the web portal was also conveyed through technical presentation on development of the web portal and soil test based fertilizer recommendations from farmer, fertilizer manufacturer and distributor point of view.

### Awareness Programme on Sexual Harassment Act (Prevention, Prohibition and Redressal) 2013

An Awareness Programme on Sexual Harassment Act (Prevention, Prohibition and Redressal) 2013 was conducted on 24<sup>th</sup> March 2015, 3.30 to 5.00 pm, at the institute by the Internal Complaints Committee members of the institute viz., Dr (Mrs.)S.Priya Devi, Ms. Manju Lekshmi, Ms. Sandra Fernandes (External member), Mrs. Lizette Noronha, Mrs. Rita D Silva and Mrs. Pranjali Wadekar. All women employees of the institute were called for the programme. A general awareness was created on the history of this Act, the various harassment acts that are covered under this, and the mode of redressal for the same. The details were deliberated in both English and Konkani, so that all staff would understand. Ms Fernandes presented about the importance of women in all walks of life, and the attitude with which one has to face any problem.

In order to know about the level of awareness, a questionnaire was circulated among all the staff. All women staff was asked to answer it on the spot.



*Awareness on Sexual Harrasement Act 2013*

## Committees and Meetings

### Research Advisory Committee

The VII Research Advisory Committee (RAC) for ICAR-CCARI was constituted for a period of three years from 30/01/2014 to 29/01/2017. The composition of RAC is given below.

**Dr. R. B. Deshmukh,** **Chairman**  
Ex-Vice Chancellor,  
MPKV, Rahuri

**Dr. D. P. Waskar** **Member**  
Director of Research (Horticulture)  
Vasantao Naik Marathwada Krishi Vidyapeeth,  
Parbhani – 431402 – Maharashtra

**Prof. Satya P. Bhardwaj,** **Member**  
Ex- Head, CS&WCR&TI,  
63 B, Rajpur Road, Dehradun Uttarakhand

**Dr. N. Sarangi** **Member**  
Ex. Director, CIFA,  
510, Nilchakra Apartment, Cuttack Road,  
Bhubaneswar – 751006, Odhisha

**Dr. P. Indira Devi** **Member**  
Professor (Ag. Eco.) & Director (CEEE),  
College of Horticulture, Kerala Agricultural  
University, Trichur – 680656, Kerala

**Dr. I. D. Tyagi** **Member**  
Ex-Prof and Head,  
Dept of Crop Improvement,  
CS. Azad UAT,  
T – 206, Vasundhara Valley Apartments,  
Sector – 6, Ghaziabad – 201012 – U.P

**Dr. B. Mohan Kumar** **Member**  
Assistant Director General (A, AF&CC)  
NRM, ICAR, KAB-II, Pusa, New Delhi

**Dr. Narendra Pratap Singh,** **Member**  
Director, ICAR-CCARI, Old Goa

**Dr. M. Thangam** **Member Secretary**  
Senior Scientist, ICAR-CCARI, Old Goa

The first meeting of the VII RAC was held on 18 and 19 July, 2014 at ICAR-CCARI. The meeting was chaired by Dr. R. B. Deshmukh, Chairman, RAC and attended by following members Dr. D. P. Waskar, Dr. P. Indira Devi, Dr. N. Sarangi and Dr. I. D. Tyagi, Dr. Narendra Pratap Singh and Dr. M. Thangam, Member - Secretary.

At the outset Dr. Narendra Pratap Singh, Director of the Institute gave welcome address and highlighted the research carried out at this Institute. Then Chairman of RAC, Dr. R. B. Deshmukh addressed the gathering. A presentation of action taken report on recommendations of last RAC meeting was made by Dr. M. Thangam, Member – Secretary.

Presentations were made by all the Scientists and Programme Co-ordinator, KVK on transfer of technology highlighting the research work done by them during the last year.

The approved RAC recommendations are as



*Research Advisory Committee Meeting*

follows

1. RAC recommended that the posts of a scientists particularly in Social Sciences viz. Agricultural Economics, Extension may be filled up on priority. For time being economic analysis may be carried out by hiring services of an economist from an external organization
2. While standardizing integrated farming

systems, studies may be conducted in participatory mode with prevailing resources at farmers farms. Similarly, effort should be made to develop viable integrated farming system models for workers displaced from mining sector. Looking into vast scope of *Glyricidia*, studies on variability in *Glyricidia* may be initiated and identification of superior type with vigorous growth and better content of Nitrogen and other nutrients done for green manure purpose.

3. Varietal wealth of local germplasm of important field and horticultural crops of the state may be documented and conserved and should be registered with PPV & FRA. Similarly, information available on indigenous technological knowledge (ITK) may be collected and documented. Studies on organic farming with environmental friendly technologies may be initiated looking into the market demand.
4. Research findings should be published in referred journals and in the form of technical bulletins, extension bulletins/ leaflets/ etc. The major findings in the form or technology package should be developed in Hindi and other local languages. Similarly, latest technologies should be disseminated through electronic media like TV, radio, newspaper, SMS services, etc. Awareness programmes may also be carried out to showcase the best local varieties and indigenous technologies (explore the financial assistance from PPV & FRA).
5. A Coastal Bio Research Centre (CBRC) comprising of all components like crops, animals & fishery may be established to generate a suitable system for conservation of bio- resources including creating livelihood options in sustainable manner.

### Institute Research Council

The 25<sup>th</sup> Annual Institute Research Committee meeting of the Institute was held during 12-13 August, 2014 in the conference hall of the Institute. The meeting was chaired by Dr. Narendra Pratap Singh, Director of the institute. He welcomed

all the scientists and highlighted the suggestions from DG, DDG and Secretary, ICAR during the Director's conference for research and extension activities in the institute.

The scientists made their deliberations on the actions taken on recommendations of last IRC meeting and research activities carried out during the last one year. Scientists also presented their new research project proposals.

The IRC reviewed the progress made under various research projects for the year 2013-14 and finalized the technical programmes of the ongoing research projects for the year 2014-15. The Committee of the IRC is as follows

**Dr. N. P. Singh** - Chairman  
Director,  
ICAR-CCARI,  
Ela, Old Goa

All Project Leaders - Members

**Dr. S. K. Das** - Member Secretary  
Principal Scientist  
ICAR-CCARI  
Ela, Old Goa



*Institute Research Council Meeting*

### Institute Management Committee

The Institute Management Committee is constituted for financial and administrative guidance of Institute by the council for a period of three years from 14/09/2013 to 13/09/2016. Following is the composition of IMC.

**Dr. N. P. Singh** - Chairman  
Director,  
ICAR-CCARI,  
Ela, Old Goa

**Shri Ulhas B. Kakode** - Member  
Deputy Director,  
Directorate of Agriculture,  
Tonca, Caranzalem-Goa.

**Dr. B.R. Salvi,** - Member  
Associate Director of Research,  
Regional Fruit Research Station,  
Vengurla.

**Dr. U.V. Mahadkar** - Member  
Director of Research,  
Dr. Balasaheb Sawant Konkan Krishi  
Vidyapeeth,  
Dapoli, Distt. Ratnagiri-

**Dr. R. Venkataramanan** - Member  
Joint Director,  
Indian Veterinary Research Institute,  
Hebbal, Bangalore

**Dr. M. Thangam,** - Member  
Senior Scientist (Horticulture),  
ICAR-CCARI,  
Old Goa.

**Dr. K.K. Phillipose** - Member  
Principal Scientist & Scientist-in-Charge,  
Karwar Research Centre of  
Central Marine Fisheries Research Institute,  
Karwar, Karnataka.

**Dr. Naveen P Singh** - Member  
Principal Scientist (Agril. Economics),  
National Institute of Abiotic Stress  
Management  
Baramati. Maharashtra

**ADG (A,AF & CC),** - Member  
ICAR, KAB-II, New Delhi -12

**The Finance & Accounts Officer** - Member  
National Institute of Abiotic Stress  
Management  
Baramati, Maharashtra

**Administrative Officer** - Member Secretary  
ICAR-CCARI  
Ela, Old Goa

The meeting of the IMC was held on 10<sup>th</sup> July, 2014 and 10<sup>th</sup> March, 2015.

### Interface meeting

The interface meeting with various developmental departments was held on 20<sup>th</sup> June, 2014 at ICAR-CCARI, Old Goa. The meeting was chaired by Prof. Narendra Pratap Singh, Director, ICAR-CCARI, where in Shri. P. Tufani, Director, Directorate of Agriculture, Govt. of Goa was the chief guest and Dr. U. V. T. Pednekar, Assistant Director, Directorate of Animal Husbandry and Veterinary Services, Govt. of Goa and Shri. Hrishikesh Pawar, Superintendent, Directorate of Fisheries were guests of Honour. The meeting was attended by all the scientists of ICAR RC, Old Goa and Officers from directorate of Agriculture, Animal Husbandry & Veterinary Services and Fisheries along with representatives from Goa Dairy and TERI etc. Dr. N. P. Singh, in his introductory remarks informed the participants that due to prediction of irregular monsoon forecast, the meeting assumes greater importance for finalizing contingency plans for Goa. He also laid emphasis on developing Goa as an educational hub including starting an agriculture college or



Interface meeting with development departments

university in the state of Goa. Shri. P. Tufani in his address elaborated the problem faced for farming of important crops/areas of agriculture in Goa *viz.*, Mango, Kokum, spices, Nutmeg and protected cultivation and requested the ICAR-CCARI for scientific solutions. Dr. U. V. T. Pednekar in his inaugural address enlisted the constraints in the Animal Husbandry sector like Mastitis, Infertility in dairy cattle and shortage of feed and fodder for the animals. He also requested the scientists to develop technologies for boosting milk production in Goa. Shri. H. Pawar, representing Fisheries department narrated the problems faced by fishermen like seed availability for Indian Major Carps, Cobia and Seabass and improving the potential for ornamental fish production in the state.

Based on the presentation and discussions, the following decisions were taken:

- Soil deposition in field from mines may be analyzed for toxic metals *etc.* in Bicholim taluk for reclamation and further management (Action: ICAR-CCARI)
- Short duration paddy varieties *viz.*, Hrswa from KAU, Kerala may be evaluated to recommend during contingency plan (Action: ICAR-CCARI)
- Good Agricultural Practices (GAP) for important crops of Goa *viz.*, Cashew, Coconut, Arecanut, Banana, Cowpea, Paddy, Ground nut *etc.* may be compiled in booklet form for the stakeholders (Action: ICAR-CCARI)
- Information on suitable crops and varieties/hybrids in vegetable and flower crops under protected structures may be compiled and submitted to Department (Action: ICAR-CCARI)
- Modified design for naturally ventilated poly house suitable for Goa condition may be recommended for new poly house construction (Action: ICAR-CCARI)
- Information on traps for banana Pseudo stem weevil may be obtained from NRC for Banana, Trichy, Tamil Nadu and forwarded for testing and demonstration (Action: ICAR-CCARI)
- Taluka level meeting may be organized with progressive farmers by concerned ZAO with ICAR Scientists for technology dissemination (Action: Directorate of Agriculture)
- Technology/Recommendation on use of Brewers Spent Grain as animal feed may be shared with Directorate of Animal Husbandry and Veterinary Services (Action: ICAR-CCARI)
- Massive field level awareness cum detection programme on mastitis, infertility in dairy animals and nutritional aspects may be convened at every sub division for awareness and technology dissemination (Action: Directorate of AH & VS and ICAR-CCARI)
- Training on ornamental fish breeding, poultry farming etc maybe combined with training organized by FTC, Ela Farm (Action: Directorate of Agriculture and ICAR-CCARI)
- Water and soil quality analysis for water bodies, creeks and rivers may be undertaken to identify the cause of mass mortality of clam in River Sal *etc.* (Action: ICAR-CCARI, Goa and Directorate of Fisheries)
- Ornamental fish breeding units of ICAR RC may be used as demonstration model for training and capacity building (Action: ICAR-CCARI and Directorate of Fisheries)

The meeting ended with vote of thanks to the Chair and all the participants.



## Distinguished Visitors

Date	Name of Visitor	Designation/ Institute/ Place
22-04-2014	Shri. Bharat Vir Wanchoo	Honourable Governor, Goa
03-08-2014	Shri. Radha Mohan Singh	Honourable Union Minister of Agriculture, Govt. of India, New Delhi
03-08-2014	Shri. Narendra Sawaikar	Member of Parliament, South Goa
16-07-2014	Shri. Deepak Dhavalikar	Minister for Cooperation, Govt. Of Goa
16-07-2014	Shri. Pandurang Madkaikar	Member of Legislative Assembly, Kumbharjua Constituency
09-04-2014	Dr. S Ayyappan	Secretary (DARE) and DG (ICAR), New Delhi
09-04-2014	Dr. Alok Kumar Sikka	Deputy Director General (NRM), ICAR New Delhi
10-03-2015	Prof. RB Singh	Chancellor CAU and Past President NAAS
22-11-2014	Dr. BB Singh	Assistant Director General (Oilseeds and Pulses), ICAR, New Delhi
22.04.2014	Dr. SK Malhotra	Horticulture Commissioner, Government of India, New Delhi
26-09-2014	Dr. Kirti Singh	Chairperson, WNRF, Chennai
16-08-2014	Dr. RR Hanchinal	Chairman, PPV FRA, New Delhi
26-09-2014	Dr. P Rethinam	Member WNRF, Chennai
28-01-2015	Shri. DP Dwivedi	Secretary (Agriculture), Government of Goa
09-04-2014	Dr. George V Thomas	Director, CPCRI, Kasargod, Kerala
09-04-2014	Dr. M Anand Raj	Director, IISR, Calicut
23-05-2014	Dr. SK Singh	Director, NBSS and LUP, Nagpur
22-11-2014	Dr. NP Singh	Director, IIPR, Kanpur
09-04-2014	Dr. PL Saroj	Director, Directorate of Cashew Research, Puttur
11-12-2014	Justice VS Dave	Retd. Justice
11-12-2014	Dr. YL Nene	Plant Protection Scientist
26-09-2014	Prof. PI Peter	Chairman, Noni Biotech, Chennai

## Personnel

### Institute

Sr. No.	Name	Designation	Additional Charge
<i>Research Management</i>			
1.	Dr. Narendra Pratap Singh	Director	
<i>Scientific Staff</i>			
1.	Dr. SK Das	Principal Scientist (Livestock Production & Management)	IRC Secretary
2.	Dr. EB Chakurkar	Principal Scientist (Animal Reproduction & Gynecology)	Animal Science and Estate
3.	Dr. V Arunachalam	Principal Scientist (Horticulture)	Horticulture Science
4.	Dr. AR Desai	Senior Scientist (Horticulture)	PME and IPR Cell
5.	Dr. R Ramesh	Senior Scientist (Plant Pathology)	CIP, AKMU Cell, PIMS
6.	Dr. M Thangam	Senior Scientist (Horticulture - Vegetable Science)	RFD and RAC, Secretary
7.	Dr. (Ms.) S Priya Devi	Scientist (Horticulture - Fruit Science)	RKVY
8.	Dr. (Ms.) Mathala Juliet Gupta	Scientist (Agricultural Structures and Environmental Management)	
9.	Dr. Manohara KK	Scientist (Plant Breeding)	
10.	Dr. (Ms.) SA Safeena	Scientist (Horticulture - Floriculture & Landscaping)	HRD
11.	Dr. K Muniswamy	Scientist (Bio-technology – Animal Science)	
12.	Dr. R Solomon Rajkumar	Scientist (Livestock Products Technology)	
13.	Dr. (Ms.) Susitha Rajkumar	Scientist (Veterinary Pathology)	
14.	Dr. Maruthadurai R	Scientist (Agricultural Entomology)	TSP
15.	Dr. GR Mahajan	Scientist (Soil Science)	
16.	Shri. Sreekanth GB	Scientist (Fisheries Resource Management)	Library
17.	Ms. Manju Lekshmi N	Scientist (Fisheries Resource Management)	



**Technical Staff**

1.	Shri VD Kulkarni	Assistant Chief Technical Officer	
2.	Ms. MadinaSollapuri	Senior Technical Officer (Civil Engineering)	
3.	Shri Raghurama Kukkude	Senior Technical Officer. (Library)	
4.	Shri Vinod Ubharhande	Farm Superintendent	
5.	Shri Edward Crasto	Technical Officer (Stockman)	
6.	Shri Sidharth K Marathe	Technical Officer (PME Cell)	
7.	Shri Rahul Kulkarni	Technical Officer (Agronomy)	
8.	Ms. Pranjali Wadekar	Technical Officer (Computers)	
9.	Shri. Yoganand Gaude	Technical Officer. (Electrical)	
10.	Shri. Suresh M Gomes	Technical Assistant (Tractor Driver)	
11.	Shri. Omar Illroy Francisco De Ursula De Souza	Technical Assistant	
12.	Shri. Upendra Kumar	Technician	
13.	Shri. Sanjeev Kumar Singh	Technician	
14.	Shri. Prakash Parwar	Technician	
15.	Shri. Gokuldas Gawas	Technician	
16.	Shri. Data Velip	Technician	
17.	Shri. Laxman Naik	Technician	

**Administrative & Accounts Staff**

1.	Shri P Rajendran	Administrative Officer	
2.	Shri Saurabh Muni	Finance & Accounts Officer	
3.	Ms. Maria Teresa Nilgli	Assistant Administrative Officer	Works
4.	Ms. Lizette Maria Carmel Noronha	Private Secretary	
5.	Ms. Montia Rita D'Silva	Assistant Administrative Officer	Estt./ Bills
6.	Shri Agostinho Fernandes	Assistant Administrative Officer	Store/ DDO/ Vehicle
7.	Ms. Sneha Arlekar	Assistant	
8.	Ms. Pratibha Sawant	Assistant	
9.	Ms. Sohni Sawant	Assistant	
10.	Ms. Tarika Maoulignkar	Personal Assistant	
11.	Shri Vinod Pagi	Upper Division Clerk	
12.	Ms. Bushra Ansari	Stenographer Grade.III	

13.	Ms. Chitra Madkaikar	Lower Division Clerk	
14.	Shri Tushar Mangaraj	Lower Division Clerk	
15.	Shri Vyas Hiren Kumar	Lower Division Clerk	
16.	Mr. Vikrant Gupta	Lower Division Clerk	
17.	Ms. Sujatha S. Kamble	Lower Division Clerk	
<i>Skilled Supporting Staff</i>			
1.	Shri Subhash Melekar		
2.	Ms. Rukma R Naik		
3.	Shri Dhaku Kankonkar		
4.	Shri Dugu Khandeparkar		
5.	Shri Ashok Gadekar		
6.	Ms. Farida Jabbar Khan		
7.	Shri Ravi S Kadam		
8.	Shri Chimmnu Tivrekar		
9.	Shri Umakant Haldankar		
10.	Shri Anil Khandeparkar		
11.	Ms. Maria S Varella		
12.	Shri Giri Madkaikar		
13.	Shri Gokuldas Kasker		
14.	Shri Umesh Marcelkar		
15.	Shri Vittal Porwar		
16.	Ms. Prafulla Khandeparkar		
17.	Ms. Rekha V Naik,		
18.	Ms. Lalitha Naik		
19.	Ms. Partibha Folkar		
20.	Shri Vilas P Gaonkar		
21.	Shri Prabhakar Goankar		
22.	Shri Sitaram Kuncolikar		
23.	Ms. Janika S Shirodkar		
24.	Shri Shanu G Velip		
25.	Shri Nitin J Naik		

26.	Shri Mayur. N Mandrekar		
27.	Ms. Swati R Khandeparkar		
28.	Shri Prallhad H Zambaulikar		

### KVK

Sr. No.	Name	Designation	Additional Charge
<i>Technical Staff</i>			
1.	Shri Vishram Gaonkar	Subject Matter Specialist T-9 (Horticulture)	Programme Co-ordinator
2.	Shri H.R. C Prabhu	Subject Matter Specialist T-9 (Plant Protection)	
3.	Ms. Sunetra Talaulikar	Subject Matter Specialist T-9 (Home Science)	
4.	Dr. Vilas Sakharkar	Subject Matter Specialist T-6 (Extension)	
5.	Dr. Sanjay Kumar Udharwar	Subject Matter Specialist T-6 (Animal Science)	
6.	Shri Shashi Vishwakarma	T-4 (Lab Technician)	
7.	Shri Prajapati V.S	T-4 (Computer)	
8.	Shri Deep Kumar	Farm Manager T-4	
9.	Shri Irappa M Chawadi	Driver-cum-Mechanic T-4	
10.	Shri. Dilkush Velip	Driver T-1	
<i>Administrative Staff</i>			
1.	Shri Vishwas Sharma	Assistant	
2.	Ms. Shreya C. Barve	Stenographer Grade. III	
<i>Skilled Supporting Staff</i>			
1.	Shri Payak J Padkar		
2.	Ms. Sarita Tuko Zaro		

### Staff activities

#### Foreign Deputation

- Dr. Narendra Pratap Singh, Director was deputed for the poster presentation of his abstract entitled "Evaluation and promotion of new rice (*Oryza Sativa* L) varieties for stress prone environment of Goa, India" at the 4th International Rice Congress held at Bangkok International Trade and Exhibition Centre, Thailand during 27th October – 1st November, 2014.
- Dr. Narendra Pratap Singh, Director was deputed to visit the International Rice Research Institute (IRRI), headquarters at Phillipines during 2-5 November, 2014 to have an overview of the rice breeding and agronomic activities.

### Appointments / Joining

Name	Post	Date of Joining
Dr. R. Solomon Rajkumar	Scientist (Livestock Products Technology)	03-11-2014
Dr. Susitha Rajkumar	Scientist (Veterinary Pathology)	17-11-2014
Dr. Sanjay Kumar Udharwar	Subject Matter Specialist (Animal Science)	02-09-2014
Shri Vinod Ananda Ubharhande	Farm Superintendent	24-11-2014

### Promotions

Name & Designation	Post held	Promoted Post	Date of promotion
Shri Raghurama Kukkude	Technical Officer (Library)	Senior Technical Officer (Library)	22-12-2013

### Retirement

Name	Post held	Date of Retirement
Shri H. R. Prabhudesai	Subject Matter Specialist (Agronomy)	31-12-2014
Shri Ankush Kambli	Technical Assistant	31-05-2014

### Transfer

Name & Designation	Post held	Transfer to	Date of transfer
Dr. B. L. Manjunath	Principal Scientist (Agronomy)	IIHR, Bangalore	31-05-2014
Dr. Prafulla Kumar Naik	Senior Scientist (Animal Nutrition)	CARI Regional Station Bhubaneswar, Odisha	25-10-2014
Dr. Z. B. Dubal	Scientist (Veterinary Public Health)	IVRI Izatnagar, UP as Senior Scientist	09-05-2014
Dr. Binsila B. Krishnan	Scientist (Animal Reproduction & Gynaecology)	NIAP, Bangalore	25-10-2014
Shri Deep Kumar	Farm Manager	IISR, Lucknow	31-03-2015
Shri Raghav Kiran Kumar G	Stenographer Grade III	DOR, Hyderabad	31-12-2014
Shri Sanjeev Kumar Singh	Technician	CIARI, Port Blair as Technical Assistant	10-12-2014









*Implementation of Tribal Sub Plan by Member of Parliament, South Goa*



*Swachh Bharat Abhiyan*



हर कदम, हर डगर  
किसानों का हमसाफर  
भारतीय कृषि अनुसंधान परिषद

*AgriSearch with a human touch*



Agro-eco tourism



## **ICAR-Central Coastal Agricultural Research Institute**

(Formerly ICAR Research Complex for Goa)

**भा.कृ.अनु.प.-केंद्रीय तटीय कृषि अनुसंधान संस्थान**

(भारतीय कृषि अनुसंधान परिषद)

ओल्ड गोवा ४०३ ४०२, गोवा, भारत

(INDIAN COUNCIL OF AGRICULTURAL RESEARCH)

Old Goa - 403 402, Goa, India