

ICAR-CCARI

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वार्षिक प्रतिवेदन

Annual Report

2015-2016



ICAR-Central Coastal Agricultural Research Institute

भाकृअनुप-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 Governor of Goa



Visit of Hon'ble Union Minister of State for Agriculture and Farmers Welfare



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

ICAR-CCARI, Goa

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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 Institute is mandated to carry out the research and extension work on field and horticultural crops, livestock, and fisheries relevant to natural resource base for sustainable productivity, to develop climate resilient land use and farming systems and agro-ecotourism. Research activities are executed through five functional sections *viz* Natural Resource Management, Crop Science, Horticulture Science, Animal Sciences and Fisheries Science. The annual report of the ICAR - Central Coastal Agricultural research Institute documents the progress made in research and extension during the year 2015-16.

Amongst many important achievements, identification of promising crop varieties/accessions of field and horticultural crops, identification of salt tolerant microbe for plant growth promotion, selection of salt tolerant rice varieties, development of rice and plantation crop based farming system models for improved livelihood, development of eco-friendly management practices of major insect pests and diseases in major crops, development of low cost protected structures for vegetable and flower crop production, development of boar semen extender, low cost hydroponics fodder production technology, standardization of package of practices for goat and poultry, exploration of fish diversity of Goa *etc.*, are significant. Scientists of the Institute published many research articles in peer reviewed journals and similar information is disseminated by means of publication of technical bulletins, extension folders, posters, *etc.* The staff of the Institute received recognitions for their research, administrative and extra-curricular excellence.

The Institute is a regular centre for AICRPs on cashew, integrated farming system, vegetable crops, palms, pig and animal disease monitoring & surveillance and voluntary centre for rice and arid legumes. In addition to Institute projects, research projects are also funded by ICAR through various network platforms and collaborations, Department of Science, Technology & Environment and Department of Biotechnology, *etc.* Extension and development projects are channelled through various development programmes like Tribal Sub Plan, National Horticultural Mission, Rashtriya Krishi Vikas Yojana, NFDB and also through other developmental agencies.

Number of programmes for human resource development and capacity building were organized during the year on important technologies developed by the Institute. Various trainings, workshops, group meetings, field days, *etc* on different topics were organized to disseminate the technologies to the farming community and other stakeholders.

I place on record my gratitude to Dr. Trilochan Mohapatra, Secretary, DARE and DG, ICAR and Dr. S Ayyappan, Former Secretary, DARE and Former DG, ICAR, New Delhi, Dr. AK Sikka, DDG (NRM), ICAR New Delhi, Dr. B Mohan Kumar, ADG (A,AF&CC) and Dr. SK Choudhary, ADG (SW & M) for the support, encouragement and guidance extended. I appreciate all the scientists and staff members of the Institute who contributed to the significant development of the Institute. I sincerely acknowledge the efforts made by the editorial committee of the Annual Report for compilation and publication.

As a Director of the Institute, it gives me immense pleasure to present the Institute's Annual Report 2015-16 and I hope the report will be useful for researchers, policy makers, planners and extension personnel. I strongly believe that the information contained in the annual report would not only update the readers about the Institute activities but also it would be quite useful to them. While our esteemed readers take a note of our achievements, any feedback, suggestion or comment is welcome so that it can be incorporated in future publications.

Place : Old Goa
Date : 03-07-2016


(Narendra Pratap Singh)
DIRECTOR

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Executive Summary

ICAR- Central Coastal Agricultural Research Institute conducts strategic and applied research under five functional sections *viz.* Natural Resource Management, Crop Science, Horticulture Science, Animal Science and Fishery Science. The highlights of the research achievements of this Institute for the year 2015-2016 are presented below.

Natural Resource Management

A rice based Integrated Farming System (IFS) model (crop-livestock) on 0.5 ha area was evaluated for typical lowland situations of Goa. The model recorded net returns of ₹ 1.00 Lakh with the highest contribution from crops (89%) followed by dairy (11%). The benefit cost ratio for the system was 0.93. After four years of IFS, the rice-groundnut-dairy and rice-groundnut-fish-poultry could store significantly highest stock of 28 Mg Carbon/ha. The IFS has potential to sequester more Carbon in soil. Rice-cowpea-dairy, rice-groundnut-dairy and rice-cowpea-fish-poultry makes the soil more biologically active and this was indicated by significantly higher values of microbial biomass carbon and dehydrogenase activity over the other farming system models.

Among different soil and water conservation measures, continuous contour trench + *Vetiveria zizanioides* in mango and circular trenching in coconut were found most efficient in arresting soil and runoff loss and improved the soil moisture content and plant growth parameters. Adoption of continuous contour trench + *Stylosanthes scabra* + *Vetiveria zizanioides* for continuous thirteen year in cashew could sequester 6.59 Mg carbon ha⁻¹. This indicates a huge potential of using the soil and water conservation measures to capture the atmospheric carbon into soil. Two salinity tolerant microorganisms as alone and consortia were tested for plant growth promoting activity in rice crop. Application of, *Bacillus methylotrophicus* Strain STC-4, either as alone or in combination with farmyard manure caused significant improvement in plant growth parameter, microbial and enzyme activity.

Socio economic assessment of the two sample village (crop and livestock farming based) revealed that farming is becoming unprofitable and both man and woman are jointly involved in the farming activity and decision making related to it. The assessment suggested that, based on resources and gender participation, there is a need to provide small scale interventions to augment the income of the farmers.

Crop Sciences

Under the project on breeding high yielding salt tolerant rice varieties for coastal saline soils, two lines *viz.*, GRS-1 (IRRI line: IR87848-301-2-1-3-B) and KS-12 (pure line derivative from Korgut) were promoted to Advance Variety Trial of All India Co-ordinated testing during the current year. About 236 Recombinant Inbred Lines derived from the cross Jyothi X Korgut were phenotyped for yield and its contributing characters under coastal salinity conditions at farmers field. Six lines which were derived from Korgut through pure-line selection were tested along with the check variety Korgut under coastal salinity conditions. KS-19-2, recorded highest grain yield (2804.49 kg/ha) among the tall types followed by KS-17 (2672.49 kg/ha). KS-12 recorded highest grain yield among the semi-tall type (1884.19 kg/ha).

Crosses were attempted involving high yielding salinity sensitive and tolerant donors, for developing mapping populations. The crosses were initiated in 2014 *kharif* and during the current year about 10 different cross combinations were advanced to F₂ (*kharif*) and F₃ (*Rabi*) generation. Further, 60 germplasm comprising 20 landraces, 23 wild rice, 9 advanced breeding lines, 6 improved cultivars and 2 check varieties (Tolerant Pokkali, Sensitive IR-29) were screened for tolerance to salinity stress at seedling stage under micro plot during *rabi* season. Genotypes Korgut, KS-17 and WR-18 were found to be highly tolerant with SES score of 1 and KS-4, KS-12, KS-16-1, KS-19-2 and Kagga were found to be tolerant with SES score of 3.



Eighteen landraces of rice were characterized for 27 different agro-morphological and 12 yield and its contributing characters at four phases. Characters *viz.*, length of awns and lemma pubescence of leaf blade showed wide variation (four classes) among the genotypes followed by basal leaf sheath colour, lemma and palea colour, panicle exertion, spikelet density pubescence of lemma and secondary branching showed three distinct classes. 11 characters showed two distinct classes and eight of them have shown no variation among the studied landraces.

Under STRASA project, 30 rice cultures were evaluated under coastal salinity situation in farmers' field. With regard to grain yield, none of the entries recorded significantly higher grain yield compared to the three check varieties. However, entries *viz.*, IR 87938-1-1-2-1-3-B (3113.33 kg/ha), IR 87831-3-1-1-2-2-BAY B (2971.67 kg/ha), IR87848-301-2-1-3-B (2958.33kg/ha) and RYT – 3207 (2941.67 kg/ha) recorded significantly higher grain yield compared to the local check variety Korgut (1780 kg/ha).

In AICRIP programme on rice, two trials IVT and AVT-I comprising 64 and 16 entries respectively, were evaluated under coastal saline conditions. Among the test entries in IVT, the top 5 ranking entries are DRR H 106 (Hybrid) (3632.13.13 kg/ha), GNV 11-14 (IR 78806-B-B-16-1-2-2-AJY 1) (3466 kg/ha), KAU CUL 27-2 (3085.42 kg/ha), NVSR-6137 (2858.34 kg/ha) and KAU-CUL 51-5 (2684.38 kg/ha). Among the test entries in AVT, none of the entries recorded significantly higher grain yield compared to the check.

In AICRP programme on Cowpea, 11 lines of Cowpea were evaluated during rabi season of 2015-16 in rice fallow. The line CP – 29 recorded highest seed yield (1801.85 kg/ha) followed by CP – 21 (1098.14 kg/ha) and CP – 24 (1042.14 kg/ha).

Seed production in rice and cowpea was taken up under the mega seed project during kharif and rabi season, respectively. About 18 Q of seeds were produced in rice and 2.5 Q of seeds were produced in Cowpea.

Study on stem borer association in cashew ecosystem revealed that, already known species of stem and root borers *viz.*, *Plocaederus ferrugineus*, *P. obesus* and *Batocera rufomaculata* of cerambycids were found in all the locations. Besides these four species of cerambycidae, one species each of bostrichidae, buprestidae, platypodidae and curculionidae were recorded on borer affected cashew trees from different locations.

Studies on infestation and seasonal occurrence of aphid *A. odinae* and its predators on cashew revealed that maximum population of 132.6 aphids/leaf/nuts was recorded during second week of March whereas minimum population of 33.60 aphids/leaf/ nut was recorded during second week of January, 2016. The recorded predators include *Scymnus castaneus* Sicard, *Cheilomenes sexmaculata* (Fabricius) and *Paragus serratus* (Fabricius).

Population of cashew mealy bug *Phenacoccus solenopsis* varied from 12-51 with a mean of 31.4 on fruiting bodies. In case of nuts, the population of nymphs varied from 10-73 with a mean of 23.80. Natural parasitization of *P. solenopsis* by *Aenasius bambawalei* was recorded. Percentage parasitization varied from 13.33 to 60% with a mean of 33.9%.

Experiments on the management of *Aphis craccivora* in cowpea indicated that the least number of aphids (12.6/leaf/shoot) was recorded in imidacloprid seed treatment followed by (24.08) in STC -4 *Bacillus* biocontrol formulation whereas highest number of aphids (52.5/leaf/shoot) was recorded in control. Maximum damage incidence of *Maruca vitrata* (3.7 larvae/pod/bud) was recorded on 86 days after sowing (DAS), whereas minimum damage incidence of (0.53 larvae/pod/bud) was recorded on 100 DAS.

Studies on effect of roasting crops and food baits on management of cucurbit fruit fly *Bactrocera cucurbitae* revealed that, the least percentage of fruit fly infestation (20.6) was recorded in castor + food baits spray followed by maize + food baits spray treatment.



Experiment on integrated management of black pepper foot rot in farmers' field over a period of three years indicated that treatment with bio-agents protected the black pepper plants from foot rot. Better protection was recorded in treatments where nematicide or anti-fungal and anti-nematode bio-agent is used. The plants treated with bio-agents were healthy, vigorous and produced fruiting spikes early. Further, bio-agents viz. talc formulation of *Trichoderma* and *Bacillus* spp (RCh6-2b) protected the black pepper plants from foot rot when they were used in a field where there was no water stagnation. These disease management strategies could be recommended for cultivation of black pepper in this region.

Study on the etiology of mortality of cashew plants (Root rot/ collar rot) indicated the presence of *Pythium* sp.

LAMP PCR was validated to detect *R. solanacearum* directly from field soil. Results of two seasons indicated that LAMP PCR in isothermal water bath detected *R. solanacearum* from 98.85% soil samples. Further, it was observed that *R. solanacearum* was detected even from the samples collected from apparently healthy plants indicating the presence of pathogen in the asymptomatic plants. Results of the experiments conducted to find out seed transmission of the *R. solanacearum*, indicated that the pathogen is not carried to seeds from the diseased brinjal plant.

Forty six lines of F₅ and 222 lines of F₆ brinjal varying in fruit colour, fruit shape, fruit size, and bearing habit were evaluated and seeds were collected. Grafting of susceptible cultivated types of brinjal and tomato on wild brinjal and other resistant root stocks reduced the incidence of bacterial wilt and hence this technology could be used in bacterial wilt management.

Two bacterial strains (RCh6-2b and STC-4) were characterized and submitted to national repository ICAR-NBAIM, Mau.

Bacillus methylotrophicus Strain RCh6-2b has been identified as one of the promising bio-agent in suppression of various plant pathogens.

Being a good rhizosphere colonizer, broad spectrum pathogen inhibition ability and secretor of antimicrobial compounds with longer shelf life in the formulation, the strain is a promising biological agent in plant health management under coastal ecosystems.

B. methylotrophicus Strain STC-4 has been identified as a plant growth promoter and is salt tolerant. Application of this strain to paddy crop recorded highest soil biological activity and improvement in plant growth parameters.

Growth media for mass multiplication of promising bacterial bio-agents (STC-4, RCh23-b and RSH-9) was standardized. Further, synthetic medium for the multiplication of RCh6-2b was standardized. Population in the synthetic medium was at par with the control medium and hence this medium could be used for mass multiplication.

Carrier based and liquid formulation of RCh6-2b was standardized. Population in the talc formulation is over 8.0 Log CFU g⁻¹ and in the liquid formulation is over 7.0 Log CFU mL⁻¹ after 16 months. Population of RCh6-2b in sodium alginate formulation was above 9.0 Log CFU mL⁻¹ till 345 days.

In planta evaluation of talc, liquid and sodium alginate formulations of RCh6-2b improved plant growth in brinjal, tomato and other crops. Soil application of talc formulation was found to be superior to other application methods.

Horticulture Sciences

A potential betacyanin pigment rich (416.26±19 mg/g fresh weight) amaranth genetic stock (IC-598190) was identified. About 450 progenies of 19 mother palms of four varieties of coconut were scored for eight DUS traits to identify best mother palms. *In silico* SCAR markers were designed based on priming sites on published whole genome sequences of banana. Simple sequence repeats were identified in repetitive region genomes of *Musa* species and *Ensete*.

In mango, mean fruit yield/tree of Mankurad variants varied from 1.8 kg (MKD-3/3-12) to 5.6 kg (MKD-1/1-1). Accessions MKD1/4- and MKD-



6/4- had attractive fruit skin colour and orange coloured pulp with mean fruit weight of 278.6 g and 288 g respectively.

Among the different germplasm of nutmeg, female dominated bisexual trees (NMD1, NMD2, NMD5, NME4 and NMF6) gave higher yield (525 to 908 fruits/tree). Genotypes NME3, NMF5 and NMG8 had equal proportions of male and female flowers and appeared as medium yielders.

A coconut based multispecies cropping system (0.5 ha) gave gross returns of ₹ 1.9 lakhs for which the coconut component contributed highest with 31.9% of the gross returns.

Studies on characterisation of cashew genotypes revealed that Valpoi-2 had vigorous growth with maximum tree height (4.68 m) and collar girth (61 cm) and it was followed by Valpoi-3. Valpoi-1 and Tiswadi-3 had medium vigorous growth habit. Highest nut yield (2.73 kg/tree) was recorded in Tiswadi-3. Tiswadi-3, Bardez-9 and Valpoi-2 recorded more than 10 g nut weight.

In jack fruit, wide variation was recorded for traits *viz.*, stalk length (2.6 to 25.4 cm), stalk girth (5.6 to 11.5 cm), fruit weight (3.62 to 19.36 kg), fruit length (31.2 to 54.1cm), fruit girth (52.2 to 94.2 cm) rachis length (11.9 to 42.3 cm), rachis diameter (5.1 to 11.0 cm), number of bulbs per fruit (48 to 130), bulb weight without seeds (0.51 to 5.57 kg), weight of seeds (0.2 to 1.38), weight of inedible waste (2.05 to 8.2 kg) *etc.*

Seven year old aonla (var. Krishna), recorded maximum fruit yield of 150 kg per year inclusive of both the seasons, whereas it was 45 kg for var. Kanchan.

In chilli, four varieties *viz.*, Nisha, Preeti, Aluva (F₁ hybrid) and G-4 (OP) were evaluated under PFT and the earliest flowering was observed in Nisha (26.50 days) followed by Preeti (28.50 days). Days to first harvest (for green chilli) was earliest in Nisha (38.88 days) followed by Preeti (45.25 days). In brinjal (Surya), the individual fruit weight was highest under fertigation (82.56g) when compared to conventional (70.25g). In okra,

mulched beds with fertigation recorded a yield of 16.56 kg per bed compared to 10.87 kg per bed under unmulched treatment.

Among the gladiolus cultivars studied Red ginger gave tallest plant with longest, broadest and maximum number of leaves, spikes and corms, higher spike weight and longer vase life. Evaluation of different cultivars of tuberose (*Polianthes tuberosa* L.) indicated that cv. Mexican Single, Suvasini and Pearl Double could be recommended for commercial cultivation in Goa. Among different rose varieties studied, Babe, Suntan and Rubecon were judged as most ideal variety for using as loose flower under open field conditions.

Studies were carried out on value addition in floral products through production of potpourri and its blending with different scents was standardized.

Based on five years research the major limitation/problems associated with the commonly used greenhouse designs in Goa were studied and two technologies *viz.*, a) recommended set of modifications for existing designs to improve the microclimate for successful crop cultivation and b) a new design of greenhouse suitable for regions of high rainfall, high humidity, moderate to high temperature conditions like Goa have been developed. Successful cultivation of crops under the existing design of greenhouses with recommended modifications has also been demonstrated.

A CFD model for greenhouse environment has been developed as a tool for study of the greenhouse microclimate as affected by external factors like ambient temperature, humidity, air flow and direction, structural factors such as vent size and location, shape and internal factors like crop type, geometry and microclimate.

A sustainable design of cost-effective evaporative-cooled hydroponic fodder production structure has been designed and its operation standardized for fodder production. The structure could produce 3 kg of hydroponic fodder per kg of yellow maize and maintained at temperature of 20^o-34^oC and relative humidity 64.5-99.5 %.



Animal Sciences

Scientific management practices *viz.* breeding, nutritional, reproduction and health practices were standardized in institute livestock farms for optimal production. Gir cattle, Konkan kanyal goat and kuttanad ducks were introduced to evaluate their production performance under coastal climatic conditions. Advanced reproductive technologies such as AI, Ultrasonography and freezing of pig semen were carried out. Vaccination and deworming health calendar for dairy cows, goats, pigs and poultry were standardized.

Boar semen extender was formulated for preservation of boar semen and evaluated in the institute pig farm and also in pig farms of Veterinary college Tirupati, Trisur, Hyderabad and NRC pig, Guwahati. A patent was filed for Boar semen extender (serial number is 3037/MUM/2015).

Scientific goat farming practices of Konkan kanyal goats were standardised and disseminated for coastal region. Average body weight of adult male and female goats was 38 and 34 kg respectively under stall fed conditions. PCR based diagnostic assays for rapid detection and characterization of goat pathogens such as zoonotic ORF virus and *E. coli* O157:H7 were standardised. Health calendar for vaccination and deworming in goats under coastal region was standardised.

Isolation and characterization of major pathogens causing mastitis in dairy cattle was carried out. *Streptococci*, *Staphylococci* and *Candida* spp from acute and chronic mastitis have been characterized. CMT test and clean milk production measures were demonstrated at various Goshalas and organised dairy farms. Pathogenic strains of *E. coli* from diarrheic calves were isolated and characterised. Antibiotic sensitivity screening of vaginal swabs revealed resistant bacteria and *Candida* sp. as a major cause of endometritis in dairy cows.

Diagnostic assays to detect the zoonotic pig parasites from faecal samples were standardised. *Trichuris*, *Balantidium coli* and *Coccidian* parasites were found in pig faecal samples. PCR to

detect *Cryptosporidium* from faeces has also been optimised.

Evaluation of egg quality (internal as well as external) of improved varieties of rural backyard chicken (Gramapriya) in comparison with free-range local (Desi) and commercial chicken (White Leghorn) revealed that the Gramapriya eggs are superior in egg weight, shell thickness, albumen height and Haugh Unit in comparison to Desi and Commercial eggs. However, the shape index and Yolk colour are superior in Desi in comparison to Gramapiya and Commercial eggs.

Fisheries Science

As a result of the pre-deployment surveys for artificial fish habitats through gillnet fishing experiments, a total of 213 aquatic species comprising 156 finfish species and 57 shellfish species are documented from Zuari estuary. This is the highest record of fish biodiversity from Zuari estuary. Comparative studies for AFHs on the natural reef patches, artificial fish habitats and rocky reefs have resulted in a total count of 115 finfish species from natural reef patches and shipwrecks of Grande Island using a non-destructive underwater visual census (UVC). Both the species richness and diversity were comparatively high and it indicated that these habitats hold rich and diversified fish assemblages.

A trophic model was constructed for Zuari estuary employing the Ecopath with Ecosim model. The results suggest that the estuary is immature but a developing ecosystem with adequate strength in reserve to adjust perturbations. The simulation of incremental fishing effort in GN and AS fleet suggests that there are possible chances of collapses for major fishery groups with marginal increase in GN fleet. In this context, techno-economic data were collected from a representative sample of fishermen of covering both these fleets from Zuari estuary. The comparison of economic indicators showed that both GN and AS fleets contributed significantly to the socio-economics of the fisherfolk in Zuari. Both the fleets were found to be economically profitable though GN showed comparatively higher profitability.



To rejuvenate and replenish the fish stocks in Zuari, site specific nine rectangular Artificial Fish Habitats (AFHs) were constructed and deployed with the participation of fishermen community. Diving surveys counted total of 21 species on the AFHs and the maximum abundance of *Heniochus acuminatus*, *Halichoeres nigrescens*, *Lutjanus russelli*, *Lutjanus fulvus*, *Pomadasys furcatus*, *Acanthurus blochii*, *Chaetodon collare*, *Chromis chromis*, *Lutjanus lutjanus* were observed at the AFHs.

A continuous stocking and harvesting system including finfishes like red snapper (*Lutjanus argentimaculatus*) and pearlspot (*Etroplus suratensis*) were cultured in combination with a shellfish species, Green mussel, *Perna viridis* for a period of eight months. These types of culture techniques are suitable for the coastal khazan areas called Manas (sluice gate operating areas). Finfish seeds obtained as a by-catch during the fishing operations were separately stocked in nylon hapas (2m x 1.5m x 2m) positioned using bamboo poles. Mussel seeds collected from the wild were stocked in cotton mosquito net bags. The total cost and returns from the culture system including three hapas were ₹ 0.14 lakh and ₹ 0.54 lakh respectively. Thus, this system can function as a source of alternate livelihood for youth.

Mine rejected pits hold rich freshwater resources which can be utilized for aquaculture. It is estimated that the state of Goa has about 200 ha of mine reject pits and quarries, which offers reasonable scope for developing freshwater aquaculture. In this context, ICAR-CCARI, Goa has initiated demonstrations of fish culture in small floating cages (2 x 1.5 x 2m and 4 x 3 x 4m) and these cages can hold a capacity of 70-100 kg of fish biomass. Pearlspot and Indian Major Carps (IMC) (Catla and Rohu) are used for stocking in these cages.

A study was conducted to utilise rose petals as natural dietary carotenoid source for pigmentation of Cyprinidae fishes. The results revealed that colouration and growth in goldfish could be successfully enhanced by using natural carotenoid in fish feed.

Rashtriya Krishi Vikas Yojana (RKVY)

There are nine RKVY funded projects running in the Institute, with total funding of rupees six crores. Under these projects, infrastructures like Polyhouses, shadenet houses, low cost shade chambers, Hydroponic unit *etc* have been created. 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. The modifications needed in the existing polyhouses of Goa have been recommended through project on protected cultivation structures. Seed production has been done in various local types on vegetables like bhendi, red amaranthus, gourds *etc.*

Tribal Sub Plan

Under Tribal Sub Plan (TSP) programme, tribal farmers groups were identified. The farmers groups were provided with farm machinery, sewing machines, 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. Awareness training programmes on post harvest machinery and Pusa STFR meter have been organised.



Introduction

The Indian Council of Agricultural Research, New Delhi, established the ICAR research Complex for Goa in April, 1976. After a short spell under the ICAR Research Complex for North East Hill Region, the complex was brought under the administrative and technical control of the Central Plantation Crops Research Institute, Kasaragod, Kerala. After functioning at different Government agricultural farm sites in Goa, the location was finally shifted to Ela, Old Goa in 1982. In order to intensify the transfer of technology and to impart grass-root level vocational training, a Krishi Vigyan Kendra was also established at the Research Complex in 1983. The Institute was upgraded to a full-fledged Institute in April, 1989 to cater to the growing needs of agricultural research, education and extension in the state of Goa.

It is noted that in India, the coastal ecosystem covers an area of 10.78 million ha along 8129 km long coastline. All the above districts together cover about 3.99 lakh square km of the area to form the coastal ecosystem of the Country with an estimated population of about 20.13 crores accounting for about 17% of the total population of the country. The major activities in the coastal region include agriculture and allied sectors, tourism, mining, industries, shipping transport, *etc.* The institute has been further upgraded to ICAR- Central Coastal Agricultural Research Institute to address the sustainable agricultural and allied activities in fragile coastal ecosystem of the country. The Institute is poised to carry out the research and extension work on field and horticultural crops, livestock, and fisheries relevant to natural resource base for sustainable productivity, to develop climate resilient land use and farming systems and agro-ecotourism.

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.

The important areas of research of the Institute are 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 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 staff of the Institute has also received several awards and recognitions in research, technical, administration, sports, *etc.*

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

- Researches on field and horticultural crops, livestock, and fisheries relevant to natural resource base of coastal India for sustainable productivity.
- Develop climate resilient land use and farming systems for improved and sustainable livelihood through coastal agriculture.
- Act as a centre of agro-eco-tourism.



Staff Position as on March 31, 2016

| Category | Sanctioned post | Posts filled | posts vacant |
|-----------------------|-------------------|--------------|--------------|
| RMP | 01 | 01 | - |
| Scientific | 20 | 21 | - |
| Technical | 18 | 15 | 3 |
| Administrative | 21 | 16 | 5 |
| Skilled Support Staff | 32-4* = 28 | 26 | 2 |
| Total | 92-4* = 88 | 79 | 10 |

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

Financial Achievement for 2015-16 ICAR-CCARI

(₹ In lakhs)

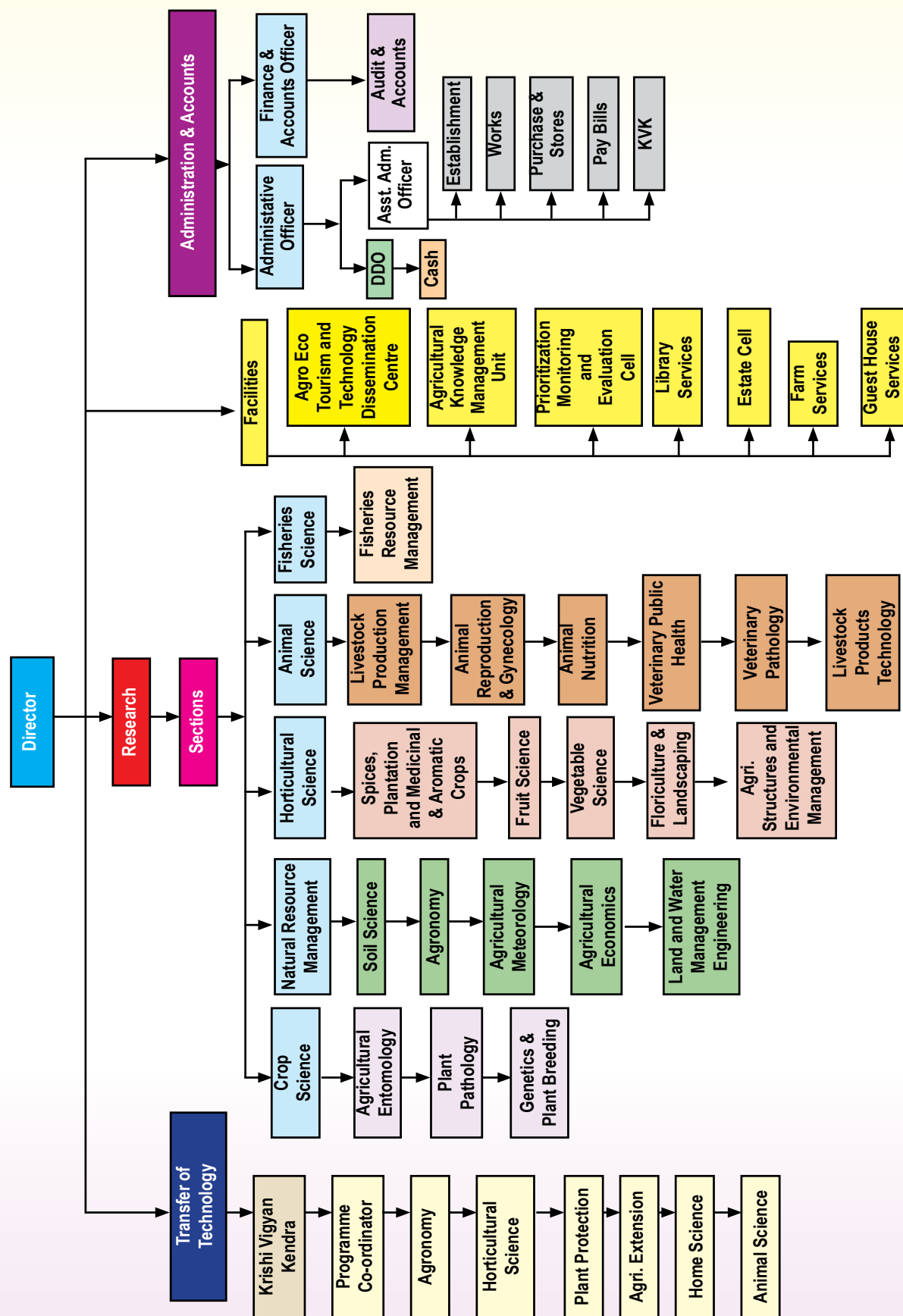
| Sl. No. | Budget Head | Revised estimate | Actual expenditure | Revised estimate | Actual expenditure |
|---------|-------------------------------------|------------------|--------------------|------------------|--------------------|
| | Grant-in-Aid Capital | | | | |
| i | Equipments | 8.90 | 8.90 | 66.00 | 65.97 |
| ii | IT..Equipments | | | 5.00 | 4.98 |
| iii | Livestock | | | 2.00 | 1.98 |
| iv | Furniture | 3.10 | 3.09 | 3.00 | 3.00 |
| v | Library | 1.00 | 1.00 | 20.00 | 20.00 |
| vi | Works | | | 127.00 | 127.00 |
| | Total | 13.00 | 12.99 | 223.00 | 222.93 |
| i | Establishment Charges | 565.00 | 561.21 | | |
| ii | OTA | 0.10 | 0.09 | | |
| | Total | 565.10 | 561.30 | 0.00 | 0.00 |
| | Grant-in-Aid Salary | | | | |
| i | Pension | 90.00 | 83.70 | | |
| ii | TA | 6.00 | 6.00 | 16.00 | 15.94 |
| iii | Research / Operational Expenses | 100.00 | 99.99 | 51.95 | 51.89 |
| iv | Administrative Expenses | 177.90 | 101.85 | 76.05 | 76.02 |
| v | Other Misc. Expenses | 8.00 | 1.99 | 3.00 | 2.97 |
| | Total | 381.90 | 293.53 | 147.00 | 146.82 |
| | Tribal Special rogramme(TSP) | | | | |
| i | Contingencies | | | 20.00 | 19.99 |
| ii | Equipments/works | | | 5.00 | 5.00 |
| | Total | 0.00 | 0.00 | 25.00 | 24.99 |
| i | P- Loans & Advances | 5.00 | 4.98 | 0.00 | 0.00 |
| | Total | 965.00 | 872.80 | 395.00 | 394.74 |

| Attributes | Remittance | Expenditure |
|------------------------|------------|-------------|
| Plan Schemes | 274.74 | 253.72 |
| External Aided Project | 15.58 | 165.22 |

| Attributes | Target | Actual |
|--------------------------------|--------|--------|
| Revenue Receipt | 83.76 | 94.28 |
| Interest on short term Deposit | | 41.08 |
| Recovery of Loans & Advances | 5.00 | 6.19 |



Organisational Set up





Weather Report

Information on weather is of paramount importance for agricultural production. Observation of weather parameters is being continuously recorded by the Institute. Observations made during April, 2015 to March, 2016 are discussed here.

Air temperature

Mean maximum temperature during April 2015 to March 2016 varied from 30.1 °C (August 2015) to 35.3 °C (May 2015), whereas mean minimum temperature varied from 18.5 °C (January 2016) to 25.8 °C (May 2015).

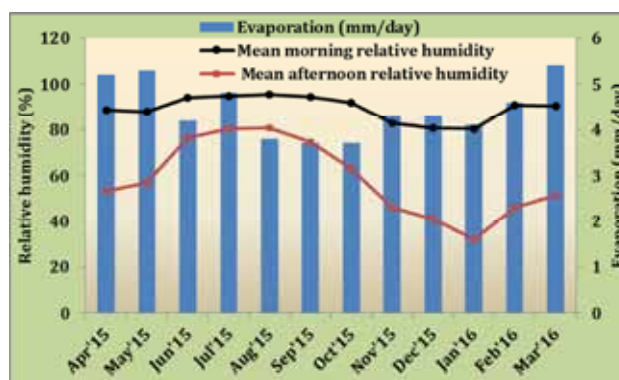


Mean maximum and minimum air temperature

mm). Total number of rainy days observed was 121 and was higher compared to last year (119 days).

Evaporation and relative humidity

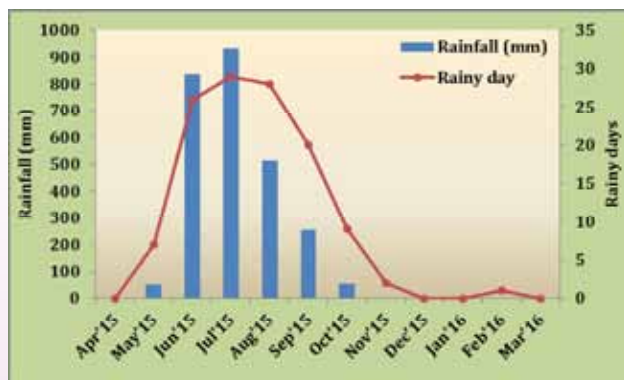
Daily evaporation was measured using USDA-Class A pan evaporimeter. Sum of monthly mean water evaporated from April 2015 to March 2016 was 53.4 mm. The highest morning as well as afternoon relative humidity were observed during June to September, 2015, whereas the corresponding lowest were recorded during January, 2016.



Mean monthly evaporation and morning and afternoon relative humidity

Rainfall and rainy days

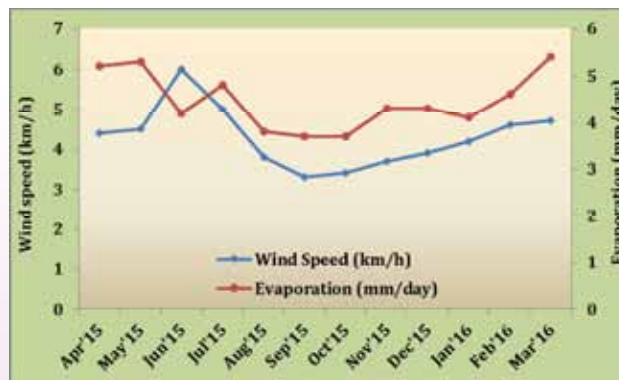
The total rainfall received during April 2015 to March 2016 was 2648.4 mm. Total of 2539.5 mm was received during *kharif* (June 2015 to September 2015). The annual rainfall of this year was 982.4 mm lower than that of 2014-15 (3630.8



Trend of mean monthly rainfall and number of rainy days

Wind speed

Mean monthly wind speed ranged from 3.3 km/h (September 2015) to 6 km/h (June 2015). Mean monthly wind speed started decreasing from June 2015 to September 2015 and it increased thereon till February 2016.



Mean monthly wind speed and evaporation



Sunshine hours

The mean monthly sunshine hours ranged from 3.3 (June, 2015) to 8.5 (February, 2016). As expected, mean monthly sunshine hours were lower during rainy season compared to rest of the months of the year.

Soil temperature

The ranges of mean monthly soil temperature recorded in morning hours at 5, 10 and 20 cm depths were 24.7-30.8 °C, 26.6-34.5 °C and 27.9-35.3 °C, respectively, whereas the corresponding ranges for afternoon observation were 31.3-45.8 °C, 30.7-41.1 °C and 28.1-36.2 °C.

Mean monthly weather parameters recorded at ICAR-CCARI from April, 2015 to March, 2016.

| Parameter | Months | | | | | | | | | | | |
|----------------------------|--------|------|-------|-------|-------|-------|------|------|------|------|------|------|
| | Apr | May | Jun | July | Aug | Sept | Oct | Nov | Dec | Jan | Feb | Mar |
| Mean max temp (°C) | 35.2 | 35.3 | 31.4 | 30.4 | 30.1 | 31.4 | 34.4 | 35.0 | 35.0 | 34.2 | 34.0 | 34.9 |
| Mean min temp (°C) | 24.1 | 25.8 | 23.5 | 23.1 | 23.4 | 23.8 | 23.9 | 22.7 | 22.2 | 18.5 | 20.3 | 23.0 |
| Mean morning R.H. (%) | 89.9 | 88.1 | 94.2 | 95.0 | 95.6 | 94.5 | 92.0 | 82.9 | 80.8 | 80.5 | 90.8 | 90.5 |
| Mean afternoon R.H. (%) | 53.4 | 57.0 | 76.5 | 80.6 | 80.7 | 74.7 | 63.1 | 46.0 | 40.9 | 32.0 | 46.2 | 51.5 |
| Mean wind speed (km/hr) | 4.4 | 4.5 | 6.0 | 5.0 | 3.8 | 3.3 | 3.4 | 3.7 | 3.9 | 4.2 | 4.6 | 4.7 |
| Sunshine (hrs/day) | 7.9 | 7.3 | 3.3 | 3.6 | 3.4 | 5.2 | 6.8 | 7.0 | 8.2 | 8.4 | 8.5 | 7.5 |
| Total rain (mm) | 0.0 | 52.5 | 837.1 | 934.3 | 512.9 | 255.2 | 55.2 | 0.4 | 0.0 | 0.0 | 0.8 | 0.0 |
| Total rainy days | 0 | 7 | 26 | 29 | 28 | 20 | 9 | 2 | 0 | 0 | 1 | 0 |
| Evaporation (mm/day) | 5.2 | 5.3 | 4.2 | 4.8 | 3.8 | 3.7 | 3.7 | 4.3 | 4.3 | 4.1 | 4.6 | 5.4 |
| Cloudiness morning (hrs) | 2.4 | 3.7 | 5.0 | 4.6 | 4.6 | 4.3 | 3.6 | 3.1 | 3.3 | 3.0 | 4.4 | 2.7 |
| Cloudiness afternoon (hrs) | 1.5 | 3.2 | 4.7 | 4.5 | 4.4 | 4.4 | 2.8 | 2.9 | 1.9 | 1.5 | 1.3 | 1.1 |

Important dates of observations during April, 2015 to March, 2016 with highest and lowest values of weather parameter

| Particular of weather parameter | Value | Date |
|---------------------------------|-----------|------------|
| Highest maximum temperature | 38.6 °C | 02/02/2016 |
| Lowest minimum temperature | 16.9 °C | 21/01/2016 |
| Highest rainfall | 180 mm | 25/07/2015 |
| Highest evaporation | 7.8 mm | 19/04/2015 |
| Highest wind speed | 13.2 km/h | 24/06/2015 |
| Maximum sunshine hours | 10.9 h | 11/05/2015 |

ICAR - CCARI, Goa

Annual Report 2015-2016

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.
(GR Mahajan)

Soil and water conservation studies in mango

Soil moisture

Relatively higher soil moisture content of 13.8%, 20% and 0.7% was recorded under continuous contour trenching + vegetative barrier over control during November, January and March, respectively.

Run-off and soil loss

Continuous contour trenching + vegetative barrier (Vb) (*Vetiveria zizanioides*) (CCT+Vb) and staggered contour trenching + vegetative barrier (SCT+Vb) reduced runoff by 47 and 36% over control, respectively. This has resulted in conservation of soil to an extent of 12.9% and 9.6% under CCT+Vb and SCT+Vb over control, respectively. The efficiency of the different SWC measure to conserve soil and water was in the order of CCT+Vb > SCT+Vb > Vb > Control.



Vegetative barrier of *Vetiveria zizanioides* in mango

Soil and water conservation studies in coconut

Soil moisture characteristics

Among different soil and water conservation measures circular trenching followed by circular terraces recorded highest soil moisture content during post monsoon months.

Run-off and soil loss

Two different kinds of soil and water conservation measures could reduce the soil and runoff loss substantially. Runoff from circular trenching and circular terraces were 15.6% and 18.5% that of total rainfall, however it was 23.9% in control treatment. The efficiency of the different SWC measure to conserve soil and water was observed in the order of circular trenching > Circular terraces > Control.

Plant growth parameters

The effect of soil and water conservation measure on plant growth parameters was in order as, circular trenching > Circular terraces > Control (significant at $p < 0.05$)

Carbon sequestration and microbial activity after long term adoption of soil and water conservation measures in high density cashew

Effect of long term adoption (13 year) of soil and water conservation measures on the carbon sequestration and microbial activity in cashew (4×4 m spacing) was studied. The soil and water conservation measure, continuous contour trench + *Stylosanthes scabra* + *Vetiveria zizanioides* (CCT+SC+VB), sequestered 6.59 Mg ha⁻¹ carbon up to 0-0.90 m depth. This indicates a huge potential of using the soil and water conservation measures to capture the atmospheric carbon into soil. Besides carbon sequestration, the CCT+SC+VB also caused highest soil microbial biomass carbon of 39.2 µg g⁻¹ soil compared to other measures. This explains the positive effect of the soil and water conservation measures on the microbial activity.



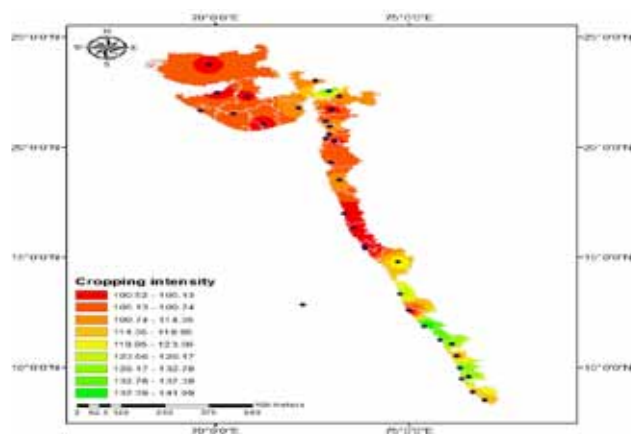
Project: An economic analysis of agricultural sustainability in West Coast of India (Viswanatha Reddy K)

The objective of the study is to develop or map Sustainable Livelihood Security Index (SLSI) for west coast of India. It is a composite index which explains existing set of conditions present or not for sustainable agriculture development in given region. Wide variations with respect to population density, forest cover, cropping intensity and livestock intensity in states and districts of coastal areas were observed. The population density in most of the coastal districts is more than the National average of 382 persons/km². Population density in coastal districts Gujarat, Maharashtra, Goa, Karnataka and Kerala is 459, 465, 398.5, 300 and 1105 persons / km² respectively. The highest population densities (1508 persons/km²) were recorded in Thiruvananthapuram district,

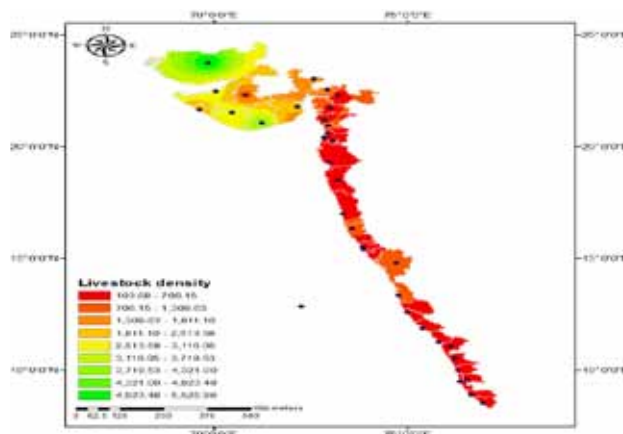
Kerala and lowest (46 persons/km²) in Kutch district Gujarat.

The mean forest cover of coastal districts of Gujarat, Maharashtra, Goa, Karnataka and Kerala is 9, 40, 64.5, 54 and 35 per cent, respectively. The highest (88%) forest cover was in Raigad district of Maharashtra whereas the lowest (1%) was in Rajkot district of Gujarat.

Cropping intensity of most of coastal district was found below the national average of 135 %. The livestock densities of Gujarat, Maharashtra, Goa, Karnataka and Kerala were 1964, 576, 478, 940.5 and 285 per square km respectively.



Crop intensity map of western coast of India



Livestock density map of western coast of India



Crop Science

Project : Breeding high yielding salt tolerant rice varieties for coastal saline soils (Manohara KK)

Phenotyping of Recombinant Inbred Lines (RILs) derived from Jyothi x Korgut under natural stress situation

About 236 lines along with parents and check varieties were evaluated under coastal salinity conditions at farmers' field in Chorao Island of North Goa district. The trial was laid out in alpha-lattice design with two replication. All the 240 lines were phenotyped for 12 yield and its contributing characters.

Analysis of variance revealed significant differences among the entries for all the characters studied. Days to 50% flowering ranged from 80 days to 122.50 days with a mean of 100.45 days, plant height ranging from 50.16 cm to 177.50 cm with a mean of 117.82 cm, productive tillers from 2.66 to 11.16 with a mean of 6.66, panicle length ranging from 18.41 cm to 33.98 cm with a mean

of 23.84 cm, filled grain per panicle ranging from 41.66 to 180.00 with a mean of 107.39, per cent fertility ranged from 50.98 to 95.42 with a mean of 82.13 and straw yield ranging from 2258.33 kg/ha to 11883.30 kg/ha with a mean of 5654.01 kg/ha. Grain yield ranged from 948.69 kg/ha to 4811.97 kg/ha with mean of 2635.28 kg/ha.



Field view of RILs at chorao island

Mean performance of top five entries among the RILs

| Variety | DDF | PHT | NPT | GY |
|-------------------|--------|--------|-------|---------|
| JK-84 | 109 | 130 | 6.00 | 4811.98 |
| JK-95 | 93 | 109 | 7.50 | 4803.43 |
| JK-1 | 102 | 113 | 6.50 | 4661.06 |
| JK-160 | 103 | 177 | 5.50 | 4449.93 |
| JK-46 | 95 | 141 | 7.67 | 4318.90 |
| Pusa - 44 (Check) | 100 | 106 | 5.33 | 2442.72 |
| CSR - 36 (Check) | 101 | 119 | 5.83 | 3152.67 |
| Jyothi (P1) | 89 | 105 | 5.50 | 1571.57 |
| Korgut (P2) | 92 | 146 | 10.00 | 2450.42 |
| Mean | 100.46 | 117.82 | 6.66 | 2635.29 |
| SE | 4.67 | 10.96 | 1.74 | 709.71 |
| CD @ 5% | 9.20 | 21.58 | 3.43 | 1398.09 |
| CV (%) | 4.65 | 9.30 | 26.16 | 26.93 |

DDF- Days to 50% flowering
NPT- No. of productive tillers per hill

PHT- Plant height (cm)
GY- Grain yield (kg/ha)



Phenotyping and selection of RILs

Evaluation of pure-line derivatives of Korgut under coastal salinity conditions

To test the performance of the pure-line derivatives of korgut, station trial was conducted under coastal salinity conditions. Six lines which

were derived through pure-line selection were tested along with the check variety Korgut. KS-19-2, recorded highest grain yield (2804.49 kg/ha) among the tall types followed by KS-17 (2672.49 kg/ha). KS-12 recorded highest grain yield among the semi-tall types (1884.19 kg/ha).

Multiplication of promising salt tolerant rice cultures

Promising rice cultures which were developed under this project for cultivation in coastal saline soils viz., GRS-1 (IRRI line: IR87848-301-2-1-3-B) and KS-12 (pure line derivative from Korgut) were multiplied in the rabi season of 2015-16 for providing them to mini-kit programme of the state department of agriculture.



KS-12



GRS - 1 (IR87848-301-2-1-3-B)

Mean performance of selections from Korgut under stress situation

| Entry | DDF | PHT (cm) | NPT | GY (kg/ha) |
|----------------|------|----------|-------|------------|
| KS - 2 | 115 | 149 | 46.8 | 1478.73 |
| KS - 4 | 109 | 140 | 62.2 | 2410.19 |
| KS - 12 | 108 | 143 | 45.2 | 1884.19 |
| KS - 16 - 1 | 109 | 140 | 65.8 | 2401.27 |
| KS - 17 | 108 | 140 | 63.8 | 2672.20 |
| KS - 19-2 | 107 | 140 | 69.8 | 2804.49 |
| Korgut (Check) | 94 | 126 | 51.0 | 1391.44 |
| Mean | 107 | 139 | 57.8 | 2148.93 |
| SE | 0.72 | 1.43 | 14.90 | 321.92 |
| CD @ 5% | 1.56 | 3.11 | 32.48 | 701.41 |
| CV (%) | 0.81 | 1.25 | 31.56 | 18.34 |

DDF- Days to 50% flowering
NPT- No. of productive tillers per hill

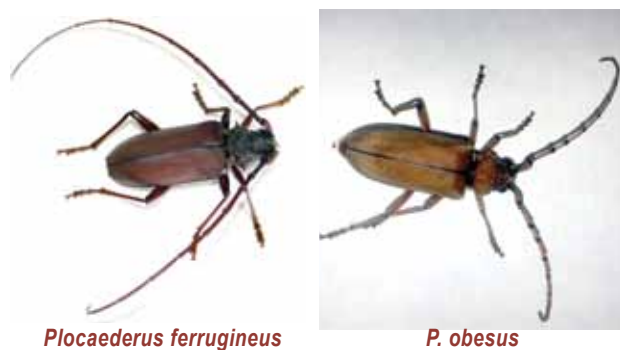
PHT- Plant height (cm)
GY- Grain yield (kg/ha)



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

Stem borer complex in cashew ecosystem

A field study was undertaken to record the stem borers association in cashew ecosystem. Samples were collected from borer affected trees on different location viz., Old goa, Carambolim, Narvae, Shiroda and Netravali. Mechanically extracted grubs, pupae and adults were identified. Already known species of stem and root borers viz., *Plocaederus ferrugineus*, *P. obesus* and *Batocera rufomaculata* of cerambycids were found in all the locations. Beside these, four species of cerambycidae, 1 species of bostrichidae, 1 species of buprestidae, 1 species of platypodidae and 1 species of curculionidae were recorded on borer affected cashew trees from different locations. Field collected grubs were reared on fresh cashew chips and pupae were kept for adult emergence. The field collected buprestid beetle has been introduced in to the fresh cashew logs with predrilled bore holes. The beetles were able to complete the life cycle on the fresh cashew logs.



Plocaederus ferrugineus

P. obesus

Infestation and seasonal occurrence of cashew aphid *Aphis odinae* and its predators

Infestation and seasonal occurrence of aphid *A. odinae* and its predators was studied on cashew plantations. Seasonal occurrence was noticed from first week of January, 2016 to last week of March, 2016. Initially, the aphid population was recorded on young growing shoots and undersides of young leaves and later on migrated to the nuts. The maximum population of (132.6 aphids/leaf/nuts) was recorded during second week of March whereas minimum population of (33.6 aphids/leaf/

nut) was recorded during second week of January, 2016. The recorded predators include *Scymnus castaneus* Sicard, *Cheilomenes sexmaculata* (Fabricius) and *Paragus serratus* (Fabricius) were found predated on aphids. The aphidophagous predators comprising of coccinellids and syrphid were quite effective in managing *A. odinae* in cashew plantations under natural conditions.



Aphid colonies on nut



Cheilomenes sexmaculata predated on aphids

Infestation of *Phenacoccus solenopsis* in cashew and parasitization by *Aenasius bambawalei*

Infestation and population of *P. solenopsis* was recorded on fruiting bodies and nuts of cashew. Population of nymphs varied from 12-51 with a mean of 31.4 on fruiting bodies. In case of nuts, the population of nymphs varied from 10-73 with a mean of 23.8. Mealy bug populations and incidence was observed more on fruiting bodies than the nuts. Natural parasitization of *P. solenopsis* by *Aenasius bambawalei* was



Mealy bugs infestation on nut



Aenasius bambawalei



recorded. Percentage parasitization varied from 13.33 to 60 with a mean of 33.9%. Besides, *A. bambawalei* other predators viz., *Spalgius epius* and *Chelomenes sexmaculata* were found predated on *P. solenopsis*. The citrus mealy bug *P. citri* was also found infesting on fruiting bodies and nuts of cashew along with *P. solenopsis*.

Management of cowpea aphid *Aphis craccivora*

The bean aphid *A. craccivora* is a major insect pest in cowpea. A field trial was undertaken to evaluate seed treatment with liquid formulation of bio-agents followed by spraying. Bio-agents used were RCh6-2b (T1), STC - 4 (T2) and RP7 (T3). Imidacloprid (T4) was used as chemical control. The variety used for the experiment was Goa cowpea-3. The aphid population was recorded after one month of sowing. The least no of aphids (12.6/leaf/shoot) was recorded in T4 (24.08) followed by in T2 whereas highest no of aphids (52.5/leaf/shoot) was recorded in Control (T5). Spraying of the same formulation were taken up after 35 days of sowing. Aphid population recorded after spraying indicated the minimum no of aphids (10.3/leaf/shoot) was recorded in T4 (11.3) followed by in T2 whereas maximum no of aphids (25.8/leaf/shoot) was recorded in T5 (20.75).

Coccinellid predators in cowpea ecosystem

Diversity of coccinellid predators was studied in cowpea ecosystem. Seven species of coccinellid predators were found predated on cowpea aphid *Aphis craccivora*. The recorded species include *Chelomenes sexmaculata*, *Coccinella transversalis*, *Micraspis discolour*, *Brumoides suturalis*, *Hippodamia variegata*, *Scymnus latemaculatus* and *Pseudaspidemerus flaviceps*. Both grubs and adults were found predated on cowpea aphids. During the entire cropping season, the maximum number of grubs and adults of *C. sexmaculata* followed by *C. transversalis* and *M. discolour* were recorded. Among the coccinellids,



C. Sexmaculata *M. discolour* *H. variegata* *C. transversalis*

the maximum relative density of (53.5 %) was recorded in *C. sexmaculata* followed by *C. transversalis* (21.8 %) and *M. discolour* (13.2 %).

Incidence of pod borer *Maruca vitrata* in cowpea

Damage incidence of pod borer *Maruca vitrata* (lepidoptera: crambidae) was recorded in cowpea. Thirty randomly selected cowpea plants were observed for buds, flowers and pods infested with *M. vitrata* at weekly intervals. Maximum damage incidence of (3.7 larvae/pod/bud) was recorded on 86 DAS, whereas minimum damage incidence of (0.53 larvae/pod/bud) was recorded on 100 DAS.

Effect of roasting crops and food baits on management of cucurbit fruit fly *Bactrocera cucurbitae*

A field experiment was conducted to study the effect of roasting 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 roasting crops viz., maize, castor, sorghum and Co-3 fodder grass was sown as border crops two weeks before the main crop. Locally made food baits containing jaggery + 10 ml of nimbizidine was sprayed weekly on the border crops. Results revealed that, the least percentage of fruit fly infestation (20.6) was recorded in treatment castor + food baits spray (24.6) followed by maize + food baits spray.

Management of sweet potato weevil *Cylas formicarius*

Sweet potato is an important crop of the rice based cropping system. The crop 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 major stages of growth viz., (i) at planting, by dipping plant cuttings in insecticides solution for 30 minutes before plantings and spraying at 45 DAP. The field trial is under progress.



Project : Plant disease management by bacterial, fungal agents and other non-conventional methods under coastal ecosystem (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 at Torla, Shiroda during 2013. The application of bio-agents was repeated in the third year. Results indicated that plants treated with talc formulation of biocontrol agent (*Trichoderma* sp) protected the black pepper plants from foot rot for almost over two years. None of plants died due to foot rot in the treatments where chemicals, and talc formulation of bio-agents were applied. When talc formulation of a single bio-agent was used, only three to six per cent plants died. However, non-treated plants in the adjacent plot showed complete mortality.

It was observed that the biocontrol treatments improved plant growth which is evident from plant growth, vigour, number of plants bearing berries (4.75 to 5.50) and number of fruiting spikes per square foot (5.5 to 7.6). Further, it was observed that the fruiting was early in the plants treated with bio-agents. Higher yield was recorded from the plants treated with talc formulation of *Trichoderma*.

Results of the second experiment conducted at Netrawali indicated that there was sharp decline in the number of surviving plants in water logged and poor drainage areas inspite of the bio-agent application. Per cent change in the number of black pepper plants in various treatments indicated negative trend in all the treatments during Feb 15



Application of talc formulation of bio-agent to black pepper

to May 15 and Nov 15 to Mar 16. The reason might be that generally the plants show the decline once the rains stopped. The maximum decline (-30 to -60%) in the number of plants was observed in low lying and water logged areas. Better survival percentage was recorded in *Trichoderma* and *Trichoderma* + carbosulfan treatments.

From this experiment, it is concluded that bio-agents viz. talc formulation of *Trichoderma* and *Bacillus* spp (RCh6-2b) protected the black pepper plants from foot rot when they are used in a field where there is no water stagnation. The survival rate of plants declined in spite of bio-agent application wherever water logging was observed. Proper drainage channels within the field should be provided as an integrated strategy.

Further, talc formulation of *Trichoderma* and *Bacillus* spp. (RCh6-2b) were provided to the farmers (Five Nos.) for demonstration of black pepper foot rot management.



Bio-agent treated plantation



Early fruiting of black pepper in the treated plants



Project : Monitoring and study on the incidence of diseases and insect pests in protected cultivation (R Ramesh)

Survey and selection of polyhouses and periodical monitoring of plant diseases

Visits were made to some polyhouses in North Goa to select the suitable ones for the study. Most of the polyhouses were empty and the farmers told that they would be taking up the crops in May-June. Few polyhouses are grown with flower crops and the farmers were either unable to maintain the basic details or reluctant to share the details. To begin with one polyhouse in farmer's field and one polyhouse in ICAR growing vegetables (cucumber, tomato) were identified. In case of cucumber, no major disease incidence was observed. However in tomato, incidence of bacterial wilt, blossom end rot and sucking pests was recorded.

Other activities

Etiology of mortality of cashew plants (Root rot/ collar rot) and nature of damage

In Canacona taluka, some of the cashew trees started wilt suddenly. The problem started soon after the monsoon (July, 2015) and mortality continued till October, 2015. Around 30-40 % cashew trees were dead due to the problem in that particular field. Some of the mango trees in the field were also affected by the same problem.

Symptoms include, yellowing of leaves and defoliation; drying of entire tree within one to two months; infected tap root appears black from outside; dead and rotten lateral roots; oozing from

rotten bark; brown to black discolouration of the tissue below the bark; dark violet colouration just below the bark tissues and fermented smell. It appears the blackening was only from the collar region and extended down.

Sample analysis in the laboratory and microscopic studies indicated the fungi grew from all the soil samples was *Pythium* sp. Root rot in cashew caused by *Pythium* was reported from Nigeria. However, other than this particular location, death of cashew trees due to root rot was not reported in Goa. The farmers were advised to take up the management practices and no further mortality was reported from farmers. It needs to be investigated if there is further report on the mortality in cashew due to root rot.

Production of talc formulation of biocontrol agents for various experiments and field trials

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, plants in protected cultivation, chilli root rot/ wilt and *etc.* over 120 kg of the talc formulation of *Trichoderma* was produced and used in field experiments, as well as distributed to farmers. Bacterial antagonists (RCh6-2b) was produced and given to farmer's demonstration plots to manage black pepper foot rot.



Symptoms of cashew root rot

Sporangia of *Pythium*



Horticultural Science

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

The objectives of the project are to mine the genome sequence information to develop reliable markers associated with desirable traits and to develop a suitable breeding population/colchiploids for harnessing phenotyping techniques.

In silico mining for microsatellite repeat regions

In case of *Ensete* the whole genome sequence was used. A total of 509,665 SSRs were mined from a pool of 6,896,179 sequences of 1.36 Gb size. These SSRs were classified according to their classes, their repeat motif and its size. *M. beccarii* displayed wide variety of repeat units, while *M. acuminata* displayed few types of SSR Mononucleotide repeats were found most common among all species, in comparison to the other type of nucleotide repeats. An attempt was made to design primers for 41 scaffold sequences of *Ensete ventricosum*, but only 8 primers could be designed.

Genetic enhancement of banana by colchiploidy

Growing shoot tips of banana suckers of cv. Velchi (AB) were treated with colchicine 0.2 % solution to induce polyploidy. Nineteen putative tetraploid plants along with seven untreated diploid check plants of the Velchi variety are planted for characterisation.

True banana seed progenies

A rare banana plant with seedy fruits was located at the farmer's garden of Ms. Rupali at Ponda, Goa. The true banana seeds are extracted from four fruits of the single plant. About 252 sexual seedlings are raised on nursery bags. After transplanting 197 seedlings have survived. Seedlings varied in their size and phenotypic traits. Height and collar girth of the seedlings

varied from 2 to 11.5 cm and 0.7 to 4.5 cm respectively. Weight of the whole seedling ranged from 0.2 to 10 g per plant.



Variation in true seedling progenies of banana

The above population forms an important material to screen using allele mining and phenotyping techniques for desirable traits of dwarf stature, salinity tolerance, resistance to sigatoka disease etc.

Phenotyping for salinity tolerance

A phenotyping method for screening of salinity tolerance in banana was employed using a detached leaf tip assay. A medium of sodium chloride dissolved in deionised water at concentrations at 0, 50, 150, 200, 400, 600 and 800 molar volumes was used. Two banana cultivars differing salt tolerance Sugandhi (ABB) and Grand Naine (AAA) were used as test materials. Change in electric conductivity of the solution, change in leaf such as browning, drying, necrosis, rolling of tip, deposition of salt at the edge, after few days of assay were found useful to discriminate the salinity tolerance. The technique after validation with several varieties has scope in rapid phenotyping for banana breeding for salinity tolerance.



Project: Collection, evaluation and management of fruit and spices (AR Desai)

Conservation of mango Germplasm

Mango Germplasm comprising of the following 123 accessions / varieties of mango and two wild relatives namely, *Mangifera camptosperma* and *M. graphitthi* is maintained in the Institute's field

Germplasm bank

87 : Local varieties, 15 : Introduced hybrids, 12 : Introduced varieties and 9 : variants of local Mankurad varieties. In addition to the above, one new Mankurad variant each from Santa Cruz (MKD-St.Cruz-1), Mapusa (MKD-Mapusa-1) and Cancona (MKD-Gaodongrim-1), and five new types of Mankurad variants from Harmal (MKD-Harmal-1 to 5) were also clonally collected.



Fruits of MKD St. Cruz-1

Mankurad fruits of Santa Cruz variant were of medium size with yellowish orange skin colour and orange pulp having total soluble solids of 20.8°B and total acids of 0.22%. Four varieties (Pusa Arunima, Pusa Lalima, Pusa Peetambar and Pusa Shreshta) from ICAR-IARI, New Delhi, two

varieties (Amika and Arunika) from ICAR-CISH Lucknow and five exotic varieties (Maya, Kent, Tomy Atkins, Lily, Austin) and Konkan Raja variety from RFRS Vengurla (of Dr.B.S.KKV, Dapoli) were collected during the year for adding to the Germplasm.

Evaluation of Mankurad variants

Of the 18 mankurad variants under evaluation, 12 accessions started fruiting during the season. Mean fruit yield per tree varied from 1.8.kg (MKD-3/3-12) to 5.6kg (MKD-1/1-1) with mean fruit weight of 288.6g and 245.5g; TSS of 19.4°B and 20.2°B respectively. The Accessions MKD1/4- and MKD-6/4- have the fruits with attractive skin colour and orange coloured pulp having TSS of 20.6 °B and 22.2 °B with scanty fibre. These accessions yielded 3.4kg and 4.8kg/ tree fruits of mean weight 278.6g and 288.8g respectively. MKD-2/3-7 also had medium sized fruits (258.4g) with attractive skin and pulp colour of excellent fibreless flesh quality (TSS: 20.8 °B).



Mankurad 1/4



Mankurad 6/4



Mankurad-1/1-1 accession with matured fruits ready for harvest





Performance of Mango hybrids

Among the mango hybrids introduced and evaluated under coastal agroclimatic conditions of Goa, Amrapali continued to show prolific yield performance recording the higher mean fruit yield of 78.8kg/tree followed by Neelgoa (62.68kg/tree) with mean fruit weight of 295.6g and 287.6g respectively. Fruit quality of Amrapali variety in terms of total soluble solids (23.4 °B & 0.18% total acids) was far superior compared to fruit quality of Neelgoa (17.2° B & 0.39% total acids). Ratna (280.6g), Amrapali (295.6g) and Arka Puneet (289.5g) had medium sized fruits with TSS in the range of 21.4–23.6 °B and orange coloured pulp contents of about 70 per cent. Ratna recorded a mean fruit yield of 48.6kg/tree whereas the fruit yield of Arka Puneet was 45.6kg/tree. Other hybrid varieties, with bigger sized fruits, namely Arka Aruna, HB-45 and HB-56 had mean fruit weight of 428.5g, 455.8g and 410.2g with more than 70 per cent of pulp contents. Ripe fruits of Arka puneet and Arka Aruna had attractively coloured red blush on the shoulders while Amrapali, HB-87 and K X B had the light yellowish green skin colour. Arka Anmol fruits developed uniformly yellow colour on ripening, but had higher total acids (0.38%) as compared to excellent sugar acid blend in HB-87 and Arka Puneet.



Amrapali - prolific regular bearer under coastal agro-climatic conditions of Goa

Intercropping of elephant foot yam in mango orchard

In well spaced mango orchard, elephant foot yam (Var.Gajendra) showed excellent performance under coastal agro-system in Goa. At a spacing of

2.5m by 2.5 from plant to plant in a line between the mango trees, this crop recorded tuber yield of 18 tonnes/ha. No disease or pest problem was noticed in this intercrop in mango orchard.

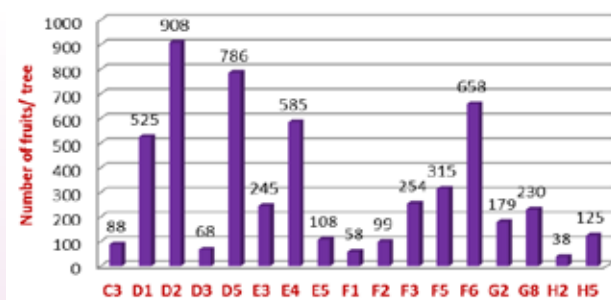


Intercropping of elephant foot yam in mango orchard

Nutmeg genetic resources

A total of 28 germplasm accessions or varieties of nutmeg comprising of 24 local seedling genotypes, one precocious bisexual seedling genotype, two improved varieties viz. Konkan Swad (from Dr BSKKV, Dapoli) and Vishwashri (from ICAR-IISR, Calicut), and one wild species (*Knema orientalis*) are evaluated in Institute's Farm.

In general, the number of fruits per tree varied from 38 – 908 per tree. Female dominated bisexual trees, namely NMD1, NMD2, NMD5, NME4 and NMF6 gave higher yield in the range of 525 – 908 fruits per tree. The genotypes namely, NME3, NMF5, NMG8, etc, having equal proportion of male and female flowers appeared to be medium yielders (NME3, NMF3, NMF5 and NMG8).



Yield trend of nutmeg genotypes - 2015



Cross section of nutmeg genetic variability

In situ performance of promising local nutmeg genotypes viz. Tamsuli-1 to Tamsuli-3, was monitored for confirming their genetic potential. During the current year also, Tamsuli-1, a bold nut selection showed higher yield trend of 189 fruits per tree (at 11th year of age). The mean nut weight and mace weight per seed on dry weight basis were observed to be 6.8g and 2.3 g respectively. While other genotypes namely Tamsuli-2 and Tamsuli-3, which are of more than 20 years of age, yielded 1023 and 989 fruits of medium nut size (4.2 and 4.7g respectively) with dry mace per seed 1.45 and 1.8g respectively.



Tamsuli-1 : A high yielding genotype with bold nut size and higher dry mace recovery

Coconut based multi-species cropping system

Coconut based multi-species cropping system in about 0.5103 ha. comprising of banana, nutmeg, black pepper, betel leaf, elephant foot yam, drum stick, papaya and bee hive is being studied for its feature of sustainable livelihood security from the small holding farmer point of view. Overall gross returns of ₹1,89,915 was realized from above cropping system during the current year. Coconut is the main crop which yielded 4958 nuts from

48 bearing palms with an average of 103 nuts per palm. At the rate of ₹ 5.00 per nut, the income from coconut alone was ₹ 24,790/- from the system. Banana yield of 1680kg (hands) at the rate of ₹ 20/- gave the income of ₹ 33,600/- while the income generated by selling the suckers of banana plants from the system amounted to ₹ 15200/-. A total of 4459 fruits were harvested from yielding trees. High yielding nutmeg tree had the average yield of about 800 fruits per tree. Mace yield and nutmeg seed yield from such high yielding trees from the system would give the gross returns of ₹ 59,100/- besides the scope for processing of the available pericarp biomass into value added products high commercial value. Gajendra variety of elephant foot yam was observed to be the most suitable intercrop for the cropping system under coconut shade which yielded 1150kg of tuber yield. At the rate of ₹ 40/- per kg of tuber, this yield gave income of ₹ 46,000/-, besides the planting material for the next of the improved variety. Black pepper in the system has started yielding resulting in the harvest of 3.5kg dry berries. Yield of Banana, Papaya and Drum stick was available round the year which would fetch continuous income from the system. Drumstick and papaya were planted in the border line. Besides this, Cinnamon, Clove, Birds eye chili, were added to the system. Bee hive colonies introduced had profound benefits on nut set in coconut palms which enhanced the coconut yield also. The system components generate year round income for the farmers with different levels of contribution to the total income. It is revealed that nutmeg takes the utmost advantage of the interspace of coconut garden with the highest contribution of 31.9% to the total income. Its share will further enhance if the pericarp biomass is processed into added products. The next higher contributors were elephant foot yam and banana with 24.22% and 23.69% respectively. Coconut as a base crop rather facilitated the system with share of 13.05% in the gross income. Its share can be enhanced by harvesting the coconuts for tender water and processed for value added products like virgin coconut oil production. Enormous amount of biomass such as Glyricidia leaves, coconut fronds, banana leaves and pseudo stem and nutmeg leaves are re-incorporated back into basins for recycling of nutrients.



Project: Survey, collection and evaluation and management of under utilized fruits of coastal regions (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 and Ponda talukas of Goa for jack fruit during, May-June, 2015. Based on descriptor, fruit characters of the accessions were recorded. There was wide variation recorded in traits like, stalk length (2.6 to 25.4 cm), stalk girth (5.6 to 11.5 cm), fruit weight (3.62 to 19.36 kg), fruit length (31.2 to 54.1cm), fruit girth (52.2 to 94.2 cm) rachis length (11.9 to 42.3 cm), rachis diameter (5.1 to 11.0 cm), number of bulbs per fruit (48 to 130), bulb weight without seeds (0.51 to 5.57 kg), weight of seeds (0.2 to 1.38 kg), weight of inedible waste (2.05 to 8.2 kg) *etc.* The study will be continued and promising accessions will be identified.



Kirlapal-1

Tudal-1

Bread fruit

In order to study the variability in bread fruit, field surveys were conducted in Bicholim, Canacona and Sanguem talukas of Goa for bread fruit during, August, 2015. Observations were recorded and root suckers of promising trees were collected; are being maintained in the nursery and will be planted in main field during June-July, 2016

Papaya

F₁ families of three crosses *viz.*, 27/16 x 24/18,

21/7 x 21/9, 8/4 x 12/4 and of hermaphrodite plant no.15/10 were transplanted in main field and are being maintained. Flowering has started in the plants and observations on sex of plants and PRSV incidence have been recorded.

Aonla

Evaluation of Aonla varieties *viz.* Krishna, Kanchan, NA-7, NA-10 and Chakaiya is being continued. The trees being seven years old (one graft of Krishna), recorded the maximum yield of 150 kg per year inclusive of both the seasons, whereas var Kanchan recorded 45 kg. Varieties Krishna and Kanchan are promising in yield and fruit quality under Goa climatic conditions

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 I, II and III years consequently. There is a remarkable progress in growth in all the varieties. Kasi Pentla recorded the highest plant height of 134.95cm during the third year.

Sapota

The vegetative growth parameters recorded during this year indicated that, DHS-1 recorded better plant height (3.08 m) and canopy spread (2.11 m) whereas, maximum number of branches (2.85) was recorded in Kalipati when compared to other varieties.

Pomegranate

An evaluation trial was laid out in RBD with six varieties of Pomegranate *viz.*, Bhagwa, Mridhula, Ganesh, Jalore Seedless, G-137and P-26 in March, 2013 in order to study growth and yield performance of different pomegranate varieties under Goa conditions. After three years of growth, variety P-26 has recorded the maximum plant height of 210 cm.



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

Precision Farming Technologies (PFT) in horticultural crops are widely practiced 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 has great scope and potential for land scarce state like Goa.

Evaluation of chilli varieties and hybrids under drip and fertigation system

In chilli, four varieties *viz.*, Nisha, Preeti, Aluva (F_1 hybrids) and G-4 (OP) were evaluated under drip and fertigation system for morphological and yield traits. Among the varieties evaluated, the earliest flowering was observed in Nisha (26.50 days) followed by Preeti (28.50 days). Days to first harvest (for green chilli) was early in Nisha (38.88 days) followed by Preeti (45.25 days). The other observations with regard to fruit and yield characters are under progress.



Best performing chilli Hybrid-Nisha

Evaluation of brinjal variety Surya under drip and fertigation system

In brinjal, the bacterial wilt resistant variety Surya (OP) is being evaluated under drip and fertigation system as well as conventional system. In general, flowering and days to first harvest were advanced under drip and fertigation system compared to conventional system of cultivation. The individual fruit weight was highest under fertigation (82.56g) when compared to open field (70.25g).



Brinjal (Surya) under drip system

Evaluation of bhendi hybrid (Jai Kisan-62) under drip and fertigation system

In Bhendi, Jai Kisan-62 (F_1 hybrid) is being evaluated under drip and fertigation system as well as conventional system. In general, plant characters were better under drip system and other observations are under progress. Mulched beds with fertigation recorded a yield of 16.56kg bed compared to 10.87 kg per bed under unmulched treatment.

Evaluation of cluster bean (Ankur-Rani) under drip and fertigation system

In cluster bean, variety-Ankur-Rani is being evaluated under fertigation and conventional system of cultivation. The plant height during first harvest was height under drip system (85.25cm) compared to open field (75.55cm). The earliest flowering was recorded under drip system (65.28 days) followed by 72.57 days under open field condition.



Cluster bean (Ankur-Rani) under drip system



Project: Germplasm collection, conservation, evaluation and standardization of production and post harvest handling techniques of commercially important flower and foliage crops
(Safeena SA)

Collection and evaluation of local accessions of crossandra

Seeds of different types of *Crossandra viz.*, *Crossandra* local (Big dark orange), *Crossandra* local dark red (Ratan aboli), *Crossandra* local (light orange), *Crossandra* local (bright yellow), *Crossandra* local (dark orange) were raised. Significant variation was noticed among local accessions of *crossandra* used for the study for various morphological and flower quality traits.



Local accessions of crossandra

Evaluation of different cultivars of tuberose (*Polyanthes tuberosa* L.)

Six cultivars (Mexican Single, Pearl Double, Suvasini, Bangalore local Double, Calcutta Double and Pune local) were evaluated during the study



Performance of different cultivars of tuberose

period. All cultivars differed in their growth and flowering behaviour. On the basis of observations recorded for growth and floral parameters cv. Mexican Single, Suvasini and Pearl Double could be recommended for commercial cultivation under agro-climatic conditions of Goa.

Studies on the performance of improved cultivars of gladiolus

Among the gladiolus cultivars evaluated, Red ginger gave tallest plant with longest, broadest and maximum number of leaves, spikes and corms, higher spike weight and longer vase life. American beauty was early in heading with least number of days for floret opening. Longest spike, floret and stalk with maximum floret/spike was found in American Beauty.



Improved cultivars of gladiolus

Studies on the performance of rose varieties under open field conditions

Six cultivars *viz.*, Babe, Yunitta, Rubecon, Odelia, Suntan and Vanessa were evaluated. With respect to various



Flowers of different rose varieties

traits recorded three varieties *viz.*, Babe, Suntan and Rubecon were judged as most ideal variety for using as loose flower under open field conditions of Goa.



Germplasm resources of ornamental climbers

A germplasm block comprising of different ornamental climbers was established at Farm B of the institute and regular observations on growth and flowering are being recorded. Different ornamental climbers viz., *Adenocalymma alliaceum*, *Allamanda cathartica*, *Aristolochia elegans*, *Asparagus plumosus*, *Bignonia unguis-cati*, *Clematis paniculata*, *Clitorea ternatea*, *Ipomoea indica*, *Ipomoea quamoclit*, *Jacquemontia violacea*, *Mandevilla amabilis*, *Mandevilla boliviensis*, *Passiflora laurifolia*, *Pyrostegia venusta*, *Quisqualis indica*, *Senecio confusus*, *Tecoma capensis*, *Thumbergia erecta*, *Tristellateia australasiae* etc have been collected, being maintained and evaluated for their suitability for landscape use.



Ornamental climbers

Germplasm resources of Pteridophytes (Ferns and fern allies) of Western Ghats

Ferns like Sprengeri fern (*Asparagus densiflorus* 'Sprengeri'), Lace fern (*Asparagus setaceus* syn. *Plumosus*), Compact sprengeri fern (*Asparagus densiflorus* 'Sprengeri' compacta), Fox tail fern (*Asparagus densiflorus* 'Myers'), Sword fern (*Nephrolepis exaltata*), Creeping fern / Wart fern (*Polypodium scolopendria*), Fish tail fern (*Nephrolepis biserrata furcans*), Button fern (*Nephrolepis cordifolia* 'Duffii'), Maiden hair fern (*Adiantum raddianum*), Leather leaf fern (*Rumohra adiantiformis*), Peacock fern (*Selaginella willdenowii*), Hard fern (*Blechnum orientale*), Soft fern (*Christella dentate*), Staghorn club moss (*Lycopodiella cernua*), Silverback fern (*Pityrogramma calomelanos*) etc have been



Evaluation of Ferns

collected, maintained and its being evaluated for their suitability for use as cut foliage or fillers.

Studies on value addition in floral products through production of potpourri

Potpourri is a major segment of dry flower industry and it comprises of a mixture of dried, naturally fragrant flower petals, herbs, stems, spice left outs etc. Different dyes viz., Tartrazine, Sunset yellow + Carmosine, Tartrazine + Brilliant blue, Tartrazine + Carmosine + Sunset yellow and Royal blue were used as colouring agents at 1% concentration and rose petals were immersed in dyes for 24 hours. It has been recorded that tinting of rose petals with various colouring agents successfully induced colours in rose petals ranging from lemon yellow, Orange red, Green, orange and blue. Further the tinted rose petals along with left outs from spices like cinnamon and nutmeg were used for potpourri production and its blending with different scents was standardized. Finished product was subjected to sensory evaluation for quality attributes like colour, appearance, aroma, design and uniqueness and overall acceptability.



Potpourri



Project: Design of protected cultivation structures for Year round utilization in western region (MJ Gupta)

Limitations /Problems associated with existing Greenhouses Design in Goa

A study on the existing greenhouse design being used by most of the farmers in Goa for crop production showed that the existing designs had the following problems:

1. Aerodynamic design of greenhouse results in rainwater flowing into the structure causing increase of relative humidity and indirectly increasing fungal and bacterial diseases in plant. If the side rollable curtains are left unopened to prevent rainwater from entering, it results in humidity build up and related disease and pest problems.
2. The semi-circular shape of roof and aerodynamic shape results in higher reduction of transmissivity as compared to Gable and Gothic arch roof and vertical side walls due to algae growth.
3. Naturally ventilated designs have very less air exchange rates (0 -0.05 air exchanges per min as against the recommended 1-3 air exchanges per minute), farmers resort to keeping shade net side walls or even open side walls, which result in high incidence of pests and disease.
4. Research was carried out at ICAR-CCARI with the objective of designing a suitable greenhouse for Western coastal high rainfall, high humidity conditions and also suggesting possible interventions to make the existing greenhouses acceptable for vegetable cultivation.



Vertical sides show less algae growth as compared to aerodynamic shape and thus less

Interventions to modify existing designs of greenhouses for Goan Climatic Conditions

Step by step modifications with study on their microclimate as affected by them with a live crop was conducted and the results showed that following interventions can modify existing structures for crop production

1. Inner side walls to prevent in flow of rainfall into crop area in both sides of poly house.
2. Gutters on both sides along length
3. Mixer fans to maintain uniformity in microclimate
4. Fixing ventilating fans across the shortest width of the greenhouse with insect proof vents on all other vents (total ventilation rate 1-3 air changes per min)
5. Microsprinklers on roof along ridge

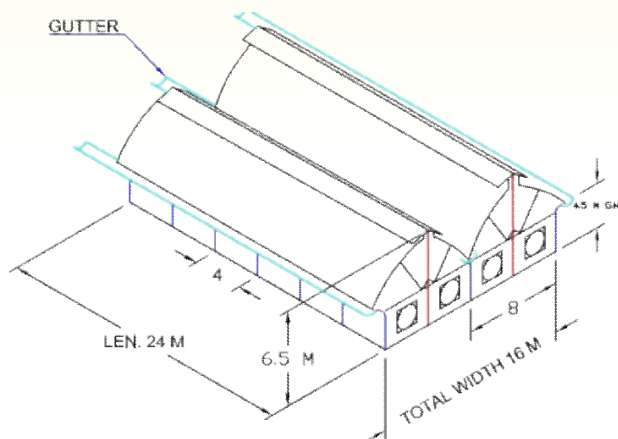


Design of greenhouse suitable for high rainfall, humidity, moderate to high temperature conditions

1. Gable or Gothic arch roof with top vents with bevel and screw arrangement to open and close them.
2. Vertical sides with outward curvature and gutters to shade from incoming rainfall and convey the runoff from covers to collection drains
3. Provision of mixer fans for maintaining uniform microclimate across the length
4. Provision of exhaust fans with insect proof net on all openings for maintaining optimum air flow rates within the greenhouse
5. Periodic operation of micro sprinklers on the ridge of the greenhouse.



The Figure given below is the proposed greenhouse design for coastal region.



Computational Fluid Dynamics model for Greenhouse environment analysis

A computational fluid dynamics model for greenhouse environment analysis of a double span

aerodynamic greenhouse presently being used in Goa has been developed and used for analysis of greenhouse environment *vis a vis* temperature, humidity and airflow patterns as influenced by the ambient wind speed, direction and environmental parameters such as temperature, humidity, radiation *etc.* The validation of the model with actual data is in progress and this model can serve as an efficient tool for analysis of the greenhouse microclimate as influenced by the structure, ambient environmental conditions and inside crop geometry for any location.

Under cost-effective evaporative cooled structure for hydroponic fodder production, the optimum loading rate per tray for maximizing yield was 750 gm. The unit was able to produce hydroponic fodder of 3 kg per unit kg of yellow maize loaded. The temperature and humidity were maintained between 20-34^o C and relative humidity 64.5-99.5 percent.

Project : Development of good agricultural practices through integrated nutrient management for sustainable fruit crop production in coastal regions of India (Maneesha SR)

Banana and papaya are highly remunerative, non seasonal short duration fruit crops preferred by many farmers in the coastal region. But the production and the productivity are poor and there is a scope for improvement of these factors. The proper identification of the nutrient deficiency in the particular region and the application of the same in right quantity are very essential as the deficiency of a particular nutrient can cause the deficiency or excess accumulation of another

nutrient, which will again affect the crop growth. Surveys were conducted in the banana and papaya growing regions of the Goa state. The soil samples were collected from the Tiswadi, Ponda, Pernem talukas of Goa. The lab analysis shows that, the available soil nitrogen content was low in all the samples ranging from 21.95 kg/ ha to 185.02 kg/ha. The pH range is 4.35 to 7.16 and the EC ranged from 48.21 to 94.71 mS.



Nitrogen deficiency in banana



Calcium and Boron deficiency in banana



Animal Science

Project: Preparation/formulation of boar semen extender and pre-insemination fluid for artificial insemination in pigs (EB Chakurkar)

Under this project Boar semen extender NBSE was formulated and tested for boar semen preservation. This was evaluated at institute farm and also in pig farms of Veterinary college Tirupati, Trisur, Hyderabad and NRC Pig, Guwahati. This is also filed for the patent on 11 August, 2015 and at permanent serial number is 3037/MUM/2015. A pre-insemination fluid is formulated and field testing will be completed during 2016-17.



Boar semen extender

Project: Enhancing livestock performance by using advanced managemental and health interventions at institute livestock farms (EB Chakurkar)

Attempts were made to provide ideal and scientific management practices for all the livestock to get optimum production with significantly lower mortality and morbidity rates. Superior indigenous breeds such as Gir cows, Konkan Kanyal goat breed, kittanad ducks for coastal region were introduced to evaluate their production performance. Different feed formulations with quality ingredients have improved the growth rate in goats and pigs, egg production in poultry. Nutritional analysis of feed pellet revealed a total dry matter of 96.16%,

crude protein of 25.82%, fat of 1.17% and fibre of 13.74%. Feeding of sprouted Bengal gram has improved the weight gain and reproduction in adult rabbits.

Characterization of A2 milk protein gene in indigenous dairy cows

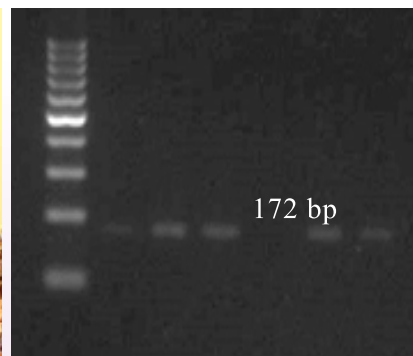
A2 milk protein (beta casein) gene (172 bp) was amplified by PCR using specific primer set targeting ORF region of A2 gene of Sahiwal, Redsindhi cross and Shweta kapila cows.



Gir cow



Kittanad duck



Amplification of 172bp beta casein gene



Implantation of microchips in dairy cows and goats for scientific data recording

Microchips were implanted in dairy cows (40) and goats (45) for proper documentation and identification. Body weight and daily milk yield recording, AI, feeding and nutritional observation recording was standardized with microchip based identification.

Early diagnosis of pregnancy in goats, pigs and dairy cows by employing ultrasonographic method.



Ultrasonography for early pregnancy diagnosis in goats

Health activities

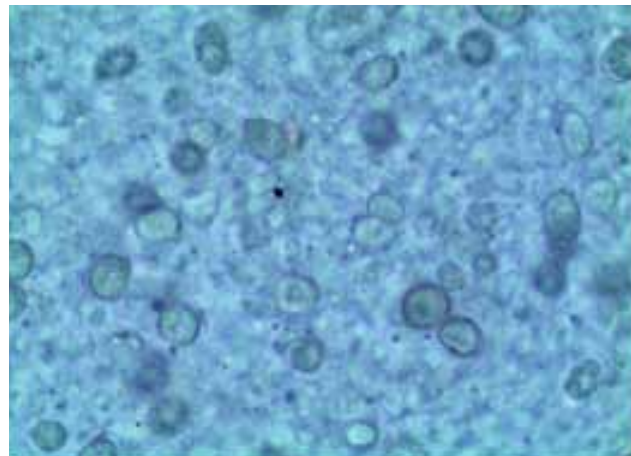
Health activities such as vaccination, deworming treatment and post mortem examination in Institute livestock farms were carried out in order to maintain minimum morbidity and mortality for optimal production. During this year, a total of 390 deworming, 640 vaccinations (FMD, HS, BQ, ET, PPR, CSF and Circo viral vaccine) and 250 treatments for various disease conditions were performed in different livestock units such as dairy, piggery, rabbit, poultry and goat units.



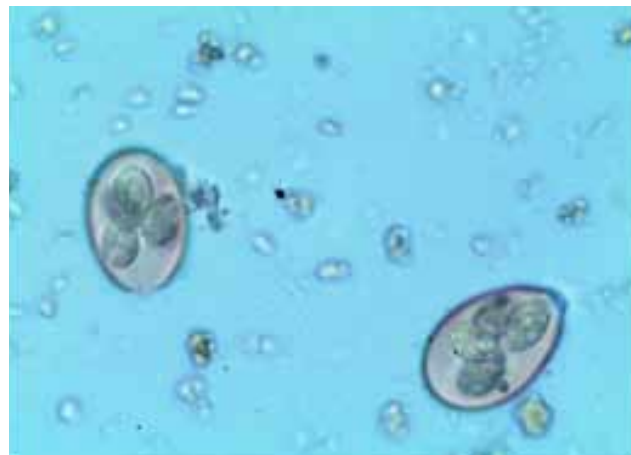
Pyo-granulomatous pneumonia in adult pigs

Necropsy examination

Ninety-four (dairy cattle- 0, pigs- 25, goats- 01, rabbits- 09, poultry- 59) necropsy/post mortem examinations of dead animals were conducted during the year which revealed significantly lower mortality pattern in our livestock farms. The major causes of mortality were haemorrhagic



Coccidia oocysts in poultry



In vitro sporulated Eimeria Spp oocysts in goat faecal samples



Multiple tumours in the of a poultry



Lung tumour in rabbit



enteritis and pneumonia in pigs, septicaemia and paralysis/emaciation in rabbits, Marek's Disease, gastrointestinal nematodiosis and coccidiosis in poultry. In pigs, digestive disorders were more but significantly lower mortality rate was recorded.

In case of poultry stock maintained more than 60 weeks had higher incidence of Marek's disease. Proper housing is must for goats to get less accidental mortality and better growth.

Laboratory diagnosis of samples from livestock

| Laboratory tests | No. of samples screened and positive | | | | |
|---|--------------------------------------|---------|---------|---------|---------------------------|
| | Dairy cows | Goat | Pig | Poultry | Other species (Wild life) |
| CMT test for mastitis | 130 (40) | - | - | - | - |
| Milk Fat and SNF testing | 16 | | | | - |
| Parasitological testing of faecal samples (OPG & EPG) | 20 (10) | 50 (20) | 41 (30) | 19 (13) | 10 (08) |
| Antibiotic sensitivity test | 14 (08) | - | - | - | - |
| Isolation of bacteria | 20 (10) | 20 (09) | - | - | 14 (04) |
| Serum samples for RBPT test <i>Brucella abortus</i> | 25 (06) | 40 | 10 | - | - |
| Skin scrapings/external parasites | | 05 (01) | 05 (02) | - | - |
| Histopathology of tissue samples | 02 | | 08 | | |

Project: Patho-epidemiology and Health interventions of goat diseases in west coastal India (Shivasharanappa N)

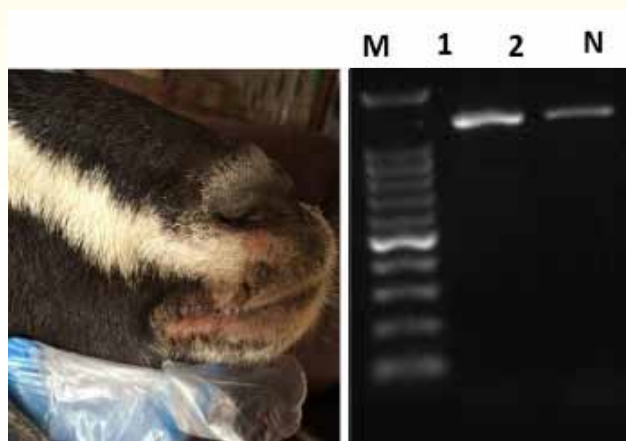
Various places in Goa were visited to study the housing, breeding and scientific goat farming practices and obtained primary information about goat farming practices. Serum, blood, faecal and nasal swab samples were collected for disease investigation. Scientific housing, health and feeding management practices were advised to farmers. Institute goat unit was upgraded by introducing Konkani kanyal goat breed.



Raised platform housing of goats

Rapid Diagnosis of Contagious Ecthyma viral infection (ORFV) in goats by PCR assay

Contagious ecthyma or Orf, is an acute, contagious and zoonotic viral disease of goats, sheep and wild ruminants caused by orf virus (ORFV) of the genus in the family *P. arapoxvirus* of *P. oxviridae*. It is characterized by maculopapular, vesicular pustules and scabs on the skin around the lips, commissures, nostrils and mouth with morbidity near to 100% and mortality as high as 20% in young animals. Orf viral infection was suspected during February, 2016 in a flock of 45 goats affecting 11 animals (1-year age) with clinical signs such as pustular/scab lesions in commissures, lips and around the mouth. PCR amplification of major envelope glycoprotein (B2L) gene (1127bp) was carried out and the virus was confirmed as orf virus (ORFV). Sequencing and phylogenetic analysis of B2L gene revealed that, this isolate is distinct from other isolates of sheep and goat.



Orf viral infection in goats and phylogenetic analysis of ORF virus

Isolation and characterization of *E coli* O157:H7 from goats

Detection and characterization of *E coli* O157:H7 by culture and amplification of virulence genes of *E coli* O157:H7 by PCR and sequencing was carried out. Out of 30 faecal samples processed for selective isolation, 20 isolates were pathogenic *E coli* O157:H7 and these isolates were further characterized based on virulence markers.



Escherichia coli O157:H7 on chromogenic agar; PCR detection of virulence marker- *uspA*

Evaluation of Konkan Kanyal Goat breed in coastal region

Konkan kanyal goat breed was evaluated in the institute farm under stall feeding.

Presently goat unit is having 50 animals which are maintained under stall feeding. Subabul, drumstick and mulberry plant leaves and pods were analysed for nutrient evaluation. The elite breeding males were given to farmers for breeding purpose. Average body weight of adult male and female goats was 38 and 34 kg respectively under stall feed conditions. Health calendar for vaccination and deworming in goats for coastal region was standardised. Training and demonstration of scientific goat farming practices including breeding, nutrition and health management was given to goat farmers. In coastal region, the feeding of these animals is simple as they relish tree leaves and with small quantity of concentrate feed (200-300g/day/animal) which meets their nutritional demand. Raised platform housing system should be practiced with the area of 1.5-2 m²/adult and 0.5-1m²/kid.

| Fodder/Tree leaves | Crude Protein (%) | Fat (%) | Fibre (%) |
|--|-------------------|---------|-----------|
| CO3 (30 th day) | 12.9 | 2.6 | 38.4 |
| CO3 (45 th day) | 13.5 | 1.8 | 30.1 |
| Drumstick (<i>Moringa Oleiera</i>) | 26.8 | 3.8 | 19.8 |
| Mulberry (<i>Morus alba</i>) | 20.2 | 1.2 | 17.1 |
| Subabul (<i>Leucaena leucocephala</i>) | 26.1 | 2.9 | 16.9 |
| Karijali (<i>Acacia nilotica</i>) | 20.6 | 2.5 | 20.9 |



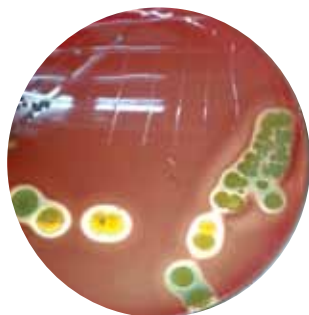
Konkan Kanyal Goat breed (female and male)



Project: Epidemiological surveillance of economically important diseases of dairy animals in the West coast
(Susitha Rajkumar)

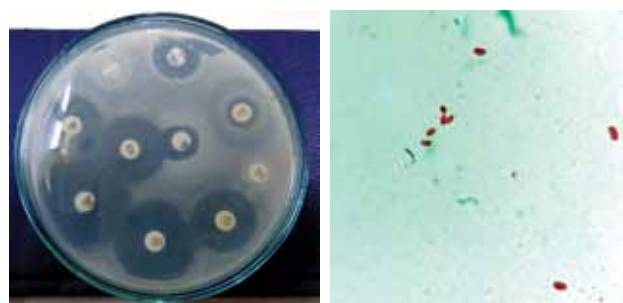
Screening of milk samples for major mastitis causing pathogens

Milk samples were collected from individual quarters of mastitis affected and healthy cows from various small dairy units in Goa. Milk from apparently healthy quarters were subjected to California Mastitis test. A total of 30 milk samples were positive for the presence of *Staphylococcus spp*, *Streptococcus spp*. and *E.coli* based on selective isolation and biochemical characterization.



Colonies of *Staphylococcus sp.*

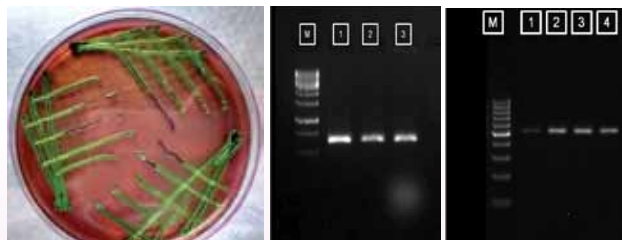
for sensitivity for antibiotics viz. Enrofloxacin, Ciprofloxacin, Levofloxacin, Amikacin and tetracycline. The culture was resistant to Streptomycin, Penicillin G and Oxytetracycline. Resistant colonies were observed in zone of inhibition of all antibiotics and were identified as yeast colonies which could be suspected as *Candida sp.*



Bacterial culture showing zones of inhibition;
Stained smear of *Candida sp*

Screening of diarrheic fecal sample from calves for the presence of pathogenic *E. coli*

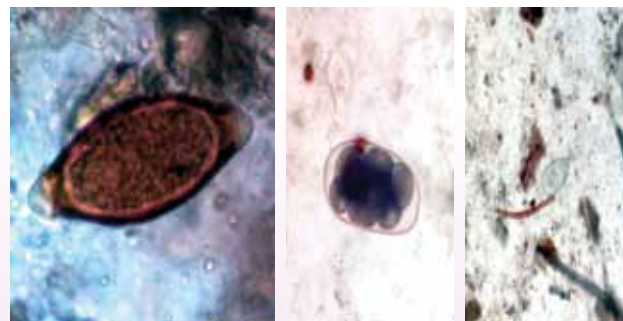
Twenty-two diarrheic fecal samples from calves were collected and were streaked over Mac Conkey agar and thirty - three isolates were identified as *E coli*. DNA was isolated from these isolates and were screened for presence of *stx1*, *stx2*, *aeaA* and *hlyA* genes encoding virulence factors in different types of *E coli*. PCR detected *stx1* gene encoding shigatoxin and *hlyA* gene encoding enterohaemolysin in 3 isolates indicating the presence of shigatoxin producing *E. coli* (STEC) and Enterohaemorrhagic *E. coli* (EHEC) in the diarrheic fecal samples.



E coli on EMB agar; *hlyA* (530bp) and *stx1*(180 bp) genes of *E Coli*

Screening of faecal samples for parasitic eggs

Sixty-four faecal samples were collected from apparently healthy or animals with diarrhea. The animals were from various small dairy units and two Goshalas. Faecal examination revealed protozoan parasite like *Eimeria* (15.63%), *Buxtonella* (29.7%), *Ascarid* (3.12%), *Trichuris* (4.69%), *Strongyle* (6.3%), *Paramphistomum sp.* (3.12%) and various nematode parasites. Presence of large number of *Trichuris* eggs in single field in fecal samples collected from Goshala indicates severe infection.



Eggs of *Trichuris sp*, *Strongyle sp* and *Paramphistomum sp*

Antibiotic sensitivity screening of vaginal swabs

Thirteen vaginal swab samples from cattle affected with endometritis cases were screened



Project: Analysis of rural backyard poultry farming practices in West Coast of India
(R Solomon Rajkumar)

Comparison of egg quality characteristics of improved variety of chicken with free-range indigenous (desi) and commercial chicken

The quality of eggs from the improved varieties of rural backyard chicken is the most important factors for popularization of the backyard farming. There is a widespread consumer preference to these eggs, as they physically resemble the free-range local (*Desi*) eggs. Therefore, the current study has been carried out to evaluate the quality of the egg from improved varieties of rural backyard chicken (*Gramapriya*) in comparison with free-range local (*Desi*) and commercial chicken (White Leghorn). A total of 180 eggs were collected, 60 each from three groups viz Group I (*Gramapriya*), Group II (Free-Range Indigenous-*Desi*) and Group III (*Commercial-White leg*

horn). The external characters like length and width measured using Digimatic Calipers CD-12”C (Mitutoyo Corporation, Japan). Thereafter the eggs were broken and the internal traits like Egg weight, Haugh unit, albumin height, yolk colour and Egg grades based on Haugh units (AA: 72 or higher, A : 71 – 60, B : 59 – 31 and C : 30 or less) were measured using EggAnalyzer® (Orka Food Technology, Israel). The shell thickness was measured by using screw gauge. The analysed data reflected that the *Gramapriya* eggs are superior (significant difference) in Egg weight, shell thickness, albumen height and Haugh Unit in comparison to *Desi* and Commercial eggs. However, the shape index and Yolk colour are superior (significant difference) in *Desi* in comparison to *Gramapriya* and Commercial eggs.

| Parameter (Units) | Mean ± Standard Error | | |
|----------------------|-------------------------|-------------------------|--------------------------|
| | Gramapriya | Desi | Commercial |
| Egg Weight (g) | 60.58±0.68 ^a | 40.52±0.94 ^c | 52.96±0.94 ^b |
| Egg Length (mm) | 58.01±0.36 ^a | 50.59±0.41 ^c | 55.8±0.28 ^b |
| Egg breadth (mm) | 43.02±0.20 ^a | 38.07±0.31 ^b | 42.25±0.13 ^c |
| Shape Index | 74.29±0.47 ^b | 75.33±0.44 ^a | 75.79±0.36 ^{ab} |
| Shell Thickness (mm) | 0.34±0.00 ^a | 0.31±0.00 ^c | 0.33±0.00 ^b |
| Albumen Height (mm) | 5.11±0.18 ^a | 2.79±0.12 ^b | 2.53±0.08 ^b |
| Haugh Unit (Ho) | 67.58±1.77 ^a | 56.29±1.18 ^b | 42.16±1.28 ^c |
| Yolk Color | 5.25±0.16 ^c | 9.51±0.26 ^a | 7.72±0.16 ^b |



Morphological study of rural backyard poultry



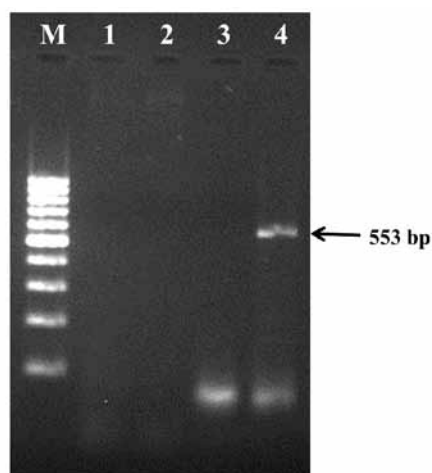
Egg quality analyzer



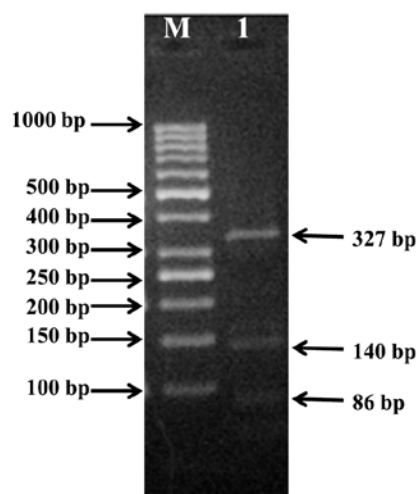
Project: Prevalence of swine associated zoonotic parasitic diseases in Indian West coast (Chethan Kumar H.B)

The project was undertaken to assess the prevalence of major zoonotic parasitic diseases in swine in Indian West coast. Twenty-nine faecal samples, 11 diaphragm samples and 21 serum samples from pigs have been collected from Goa. Further 22 pig sera have also been collected from meat technology unit, College of Veterinary and Animal Sciences, Mannuthy, Kerala. Of the 29

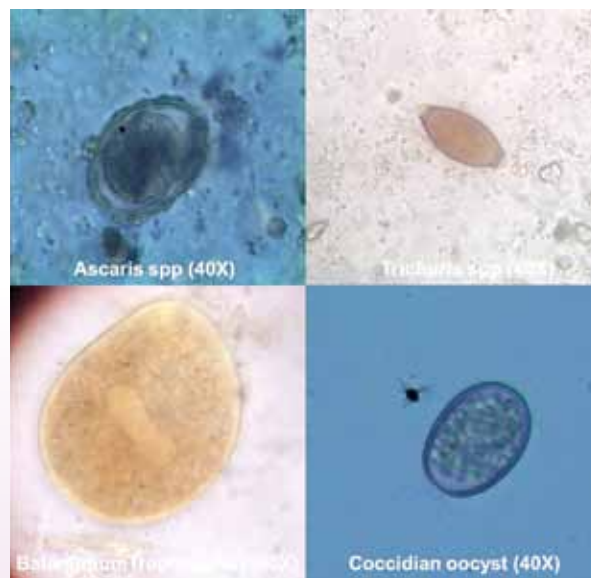
samples, 3 were positive for *Ascaris* spp ova, two for *Trichuris* ova, two for *Balantidium* spp trophozoite and 15 were positive for coccidian oocyst. None of the samples were found positive for *Cryptosporidium* by PCR assay. The 11 diaphragm samples were tested for the presence of *Trichinella* spp larvae using artificial digestion assay and all the samples were found negative.



Standardization of PCR for detection of *Cryptosporidium* spp.
Lane M: 100bp DNA ladder
Lane 1 and 2: Pig fecal DNA
Lane 3: Negative control
Lane 4: Positive control (*Cryptosporidium andersoni*)



Standardization of RFLP for detection of *Cryptosporidium* spp.
Lane M: 50bp DNA ladder
Lane 1: Positive control (*Cryptosporidium andersoni*)



Different parasitic stages found in pig feces



Fisheries Science

Project : Augmentation of fishery and fish biodiversity in the near shore marine areas of Goa through artificial fish habitats (Sreekath GB)

Pre-deployment fishery and fish biodiversity assessment

From the fishing experiment sites selected for AFHs, 213 aquatic species comprising 156 finfish species and 57 shellfish species are documented from Zuari estuary. The 156 finfishes belong to 52 families (Pelagic-22, Demersal-30) and 57 shellfish species belong to 24 families (Crustaceans-5, Molluscans-19). This is the highest record of fish biodiversity from Zuari. These findings are the first benchmark information on fish biodiversity and it is important for conservation of coastal ecosystems.

Comparative studies from natural and other artificial fish habitats

The islands in Goa have extensive coastal and marine resources which are significant in both ecological and livelihood contexts. The studies on the fish assemblages of these islands are limited on account of the cost of sampling and underwater surveys. An MOU was signed by ICAR-CCARI in this regard with DIVEGOA to survey the natural reef patches, rocky reefs, artificial fish habitats in the islands and our deployed sites. A total of 115 finfish species were counted on natural reef patches and shipwrecks of Grande Island using a



non-destructive underwater visual census (UVC). Both the species richness (7.5) and diversity (3.12) were comparatively high and it indicated that the Island holds rich and diversified fish assemblages. The studies on the biomass of fish assemblages and their relationships with rocky reefs, coral rocks and reef patches of the island are in progress.

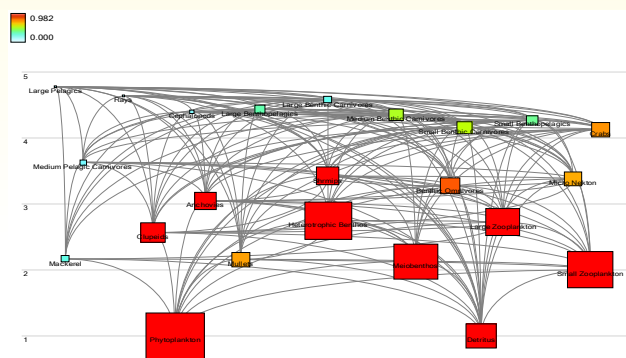
Artificial Fish Habitats

A total of six diving were conducted during January to March at the deployed AFHs at three sites in the mouth of Zuari. The visibility was poor (<1 m) at all samplings and used water proof camera to visualise the fishes on the AFHs. However, the species identification was successful in spite of the low visibility and a total of 21 species were counted on the AFHs and the maximum abundance of *Heniochus acuminatus*, *Halichoeres nigrescens*, *Lutjanus russelli*, *L. fulvus*, *Pomadasys furcatus*, *Acanthurus blochii*, *Chaetodon collare*, *Chromis chromis*, *L. lutjanus* were observed. The studies on the biomass of fish assemblages and their relationships with AFHs are in progress.



Trophic modelling of Zuari estuary using Ecopath with Ecosim

To characterise the ecological structure of the estuary, a trophic model was constructed employing the Ecopath with Ecosim model.



The results suggest that the estuary is immature but a developing ecosystem with adequate strength in reserve to adjust when environmental perturbations occur. The simulation of incremental fishing effort in GN (Motorised gillnet fishery) and AS (Artisanal gillnet fishery) fleet suggests that there are possible chances of collapses for major fishery groups with marginal increase in GN fleet. The simulations have also demonstrated that the increase in AS fleet (75%) will not harm the fish stocks in the estuary. Thus, a sustainable small scale fishery will be possible in the estuary when there will be gradual expansion of fishery (75%) in artisanal fleet and considerable reduction (25%) in the GN fleet.

Economic performance of small scale fisheries in Zuari

In Zuari estuary, the small scale fishery is represented by GN and AS fleets. In this context, techno-economic data were collected from a representative sample of fishermen of covering both these fleets from Zuari estuary. Using this data, a group of economic indicators was determined separately for GN and AS fleets. The comparison of these indicators showed that both GN and AS fleets contributed significantly to the socio-economics of the fisherfolk in Zuari. Both the fleets were found to be economically profitable though GN showed comparatively higher profitability. After validating the results obtained from this study, it can be used as an input for constructing an ecosystem model for the estuary.

Fresh water fish surveys and Live fish gene bank

Fifty five species of fish and 13 species of crustaceans were recorded from the freshwater habitats of Goa. This is the first report on fresh water fish diversity in Goa. A live fish gene bank for Goa has been established at the Institute farm facility with a collection of 45 local indigenous fish germplasm.

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

Economic and ecological evaluation of various coastal aquaculture systems

Economic evaluation was performed for four different aquaculture systems in coastal waters of Goa on an annual basis and the break-even analysis has been carried out to compute the cost structure of different culture systems from 2013 to 2015. An opinion survey was also conducted to study the effect of different aquaculture technologies introduced in coastal waters of Goa. Among the four different culture systems studied, the semi-enclosed multi-species culture system (SEWMS) was the most productive system. Benefit cost ratio (2.63) and rate of return

(142.10 %) were highest for SEWMS. The short payback period (0.7 year) was also recorded in SEWMS. Thus, multi-species culture was found to be more profitable than single species culture for the similar culture period. Moreover, in the semi-enclosed system, the productivity and survival of species was higher due to the control of water flow through sluice gates. Goa is rich in semi-enclosed water bodies which were used for shrimp farming and these can be utilized for multi-species culture. The feedback from the farmers about the dissemination of culture techniques revealed that adequate technical support increases the confidence level of the farmers.



The variation of physico-chemical parameters for different culture systems were estimated. Nitrate nitrogen and ammonia nitrogen values were the highest in semi-enclosed systems (SEWMS and SEWM) and lowest in open water systems (OWSM and OWSMS). The availability of higher nitrate concentration in SEWMS will augment the growth of phytoplankton and thereby the secondary and tertiary productivity. Further, Chlorophyll-*a*, orthophosphate and plankton density were also significantly high in semi-enclosed systems. Generally the water exchange is more than the required levels in aquaculture systems and thus, nutrients will be discharged from these systems before they can be assimilated. Hence in our results, semi-enclosed systems, the water discharge is controlled (with sluice gates) in comparison with open water systems..

Low-cost capture based multi-species culture system for coastal waters of Goa

A low-cost multispecies capture based culture system (SEWMS) was experimented in coastal waters off Goa and in this system; finfishes like red snapper (*Lutjanus argentimaculatus*) and pearlspot (*Etroplus suratensis*) were cultured in combination with a shellfish species, Green mussel, *Perna viridis* for a period of 8 months. Finfish seeds obtained as a by-catch during the normal fishing operations (Average size: Pearlsport-50 mm, Red snapper-200 mm) were separately stocked in nylon (2m x 1.5m x 2 m) positioned with bamboo poles. Mussel seeds (Average size-32 mm) collected from the wild were stocked (1kg/bag) in 15 pre-stitched cotton mosquito net bags with nylon rope and hung from the bamboo poles. Red snapper was fed with chopped discards, pearlspot fed on periphyton



Low cost cages in Manas areas

and mussels with plankton. The total cost and returns from the culture system were ₹ 0.14 lakh and ₹ 0.54 lakh respectively. Thus, this system can function as a source of alternate livelihood for youth.

Utilisation of abandoned quarries and mine rejected areas for aquaculture

It is estimated that Goa holds 200 ha of mine reject pits and quarries, which offers scope for freshwater aquaculture. However, the major concern is the greater depth of these pits which makes aquaculture activities difficult in these systems. Thus, development of specific fish culture techniques will really help in improving the fish production. Small floating cages (*cage1*- 2x1.5x2 m and *cage2*- 4x3x4 m) which can hold 70-100 kg of fish biomass were designed. Species like Pearlsport and Indian Major Carps (IMC) (suitability and marketability) can be reared in these systems for a period of 6-8 months. Two cages (*cage1* and *cage2*) were deployed in the quarry ponds of Ibrahampur. Fingerlings of IMC (size- 80-100 mm) were stocked in these cages (*cage1*- 500 nos., *cage2*- 1000 nos.) in February, 2016. The culture is being monitored for the water quality and fish growth.



Cage structure and stocking



AICRP Main Centres

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

Economics of the rice based integrated farming system based model

A rice based farming system model (crop-livestock) has been developed on 0.5 ha area for typical lowland situations of Goa. Different enterprises of the model are crops (rice followed by sweet corn/brinjal/groundnut/cowpea), forage grown bunds (Hybrid napier), livestock, and kitchen garden. In terms of gross return (₹ 2,09,464) the highest contribution was from crops (69%) followed by dairy (31%). With regards to net return (₹ 1,01,228) the highest contribution were recorded from crops (89%) followed by dairy (11%). An employment of nearly 339 man days worth ₹ 50870 could be generated from the model. A net return of ₹ 1.00 Lakh with benefit:cost ratio was 0.93 (agronomic point of view) was recorded for the above model.

Development of rice-fish based integrated farming system (IFS) for lowland situation of Goa

A rice (Vytilla)-fish (Rohu, *Labeo rohita*) based integrated farming system (IFS) involving different components; poultry (Gramapriya), cowpea (Goa Cowpea-3), fodder (IGFRI-3) and cucurbitaceous vegetables were tested under the low land situation of Goa. The total area of the system was 0.07 ha (Rice - 0.06 ha, fish – a trench - 40 m² and 1 m deep and rest of the area for fodder and vegetables). A poultry unit (Gramapriya - 4



Rice – cowpea - fish - poultry farming system

birds) was kept above the trench so that the poultry litter will fertilise and increase the plankton production in the trench. The total annual cost including annual fixed cost and operating cost was ₹10875. The net profit (excluding lease and labour) of ₹ 5480 was obtained from 0.07 ha area with a benefit cost ratio of 2.37. The order of contribution of the enterprises to net profit was - fish(32%) > poultry (23%) > rice (20%) > Fodder (16%) > cowpea (5%) > cucurbits (4%).

Effect of five integrated farming systems on the microbial activity and carbon sequestration

After successive four years of IFS, the rice-groundnut-dairy and rice-groundnut-fish-poultry could store significantly highest ($p < 0.05$) a stock of 28 Mg C/ha whereas rice brinjal-dairy had 22 Mg C/ha (significantly lowest, $p < 0.05$). The IFS have great potential to act as a potential C sink and sequester more C in soil. Rice-cowpea-dairy, rice-groundnut-dairy and rice-cowpea-fish-poultry makes the soils more biologically active and this was indicated by significantly higher values ($p < 0.05$) of microbial biomass carbon and dehydrogenase activity over the other farming systems.

Upland (plantation crop based) farming system based model

A model of area 0.8 ha comprising of enterprises – plantation crops Crops: Cashew (variety Bhaskara) + Pine apple (Variety Giant Kew), Coconut + Pineapple + Papaya + Noni, Arecanut + Banana), piggery, poultry, vermi-compost unit, compost unit was evaluated for upland situations of Goa. After fifth year of start, the total cost of cultivation (inclusive of the farm labor employed) of the system was around ₹ 1.26 Lakhs whereas the net profit was ₹ 0.92. The highest contribution to net profit was from the cashewnut pineapple (39%) system as both the components started yielding. The contribution of the piggery component to the net profit was 22%.



Project : All India Co-ordinated Research Project on Cashew (ICAR) (AR Desai)

Germplasm collection, conservation, evaluation, characterization and cataloguing

During season 2015, four new accessions from Cotigaon (Badde-1, 2, 3 and 4) having bold nut, bigger apple and higher nut yield, and one accession (Adnem-1) having compact canopy type from Adnem village (Quepem zone) were identified & added to Germplasm collection. The characteristic features of mother trees of these accessions are presented in below table.

With addition of these 5 new accessions to the earlier Germplasm of 89 accessions, a total of 94 germplasm accessions of cashew representing the following different groups is being maintained at Goa Centre.

- Jumbo nut types : 14 accns
- Bold nut types : 36 + 4 accns
- Medium nut and high yielders : 13 accns
- Other high yielders / cluster bearers irrespective of nut size : 23 accns
- Dwarf canopy types : 3 accns
- Very compact canopy type : 1 accns
- Total germplasm collection : 94



Baddi-1 having old nut and big apples

Characterization of selected local bold nut cashew genotypes

Studies on characterization of 14 genotypes viz., Valpoi-1, Valpoi-2, Valpoi-3, Bardez-3, Bardez-9, Tiswadi-7, Tudal-1, Tudal-3, Mayem-1, BKL-1, BKL-2, FMGDI-1, Tiswadi-3 and Balli-2/Goa-1 (Check) revealed that the accession Valpoi-2 showed vigorous growth with maximum tree height of 4.68m with collar girth of 61cm followed by Valpoi-3 with corresponding values of 4.56m and 58 cm respectively, both of which started flowering from 2012 along with other accessions namely, Valpoi-1 and Tiswadi-3 with medium vigorous growth habit. Bardez8/98 recorded the highest nut yield of 2.73kg/tree followed by Mayem-1 with 2.31 kg/tree as compared to 1.48kg/tree of raw nut yield

Cashew accessions newly collected during 2015-16

| Sl. No. | Accession | Special feature | Approx. age (yrs) | Average nut weight (g) | Apple characters | | |
|---------|-----------|-----------------------------|-------------------|------------------------|--------------------------|---------------------------|----------|
| | | | | | Average apple weight (g) | Colour | TSS (°B) |
| 1 | Badde-1 | Bold nut | About 30 | 8.2 | 79.5 | Yellow | 10.0 |
| 2 | Badde--2 | Bold nut | About 20 | 8.0 | 70.6 | Yellow | 10.6 |
| 3 | Badde-3 | Bold nut | About 25 | 8.2 | 68.8 | Yellow with reddish tinge | 12.2 |
| 4 | Badde-4 | Medium nut, cluster bearing | About 15 | 8.6 | 65.0 | Red | 10.8 |
| 5 | Adnem-1 | Medium nut | About 35 | 7.1 | 48.0 | Yellow | 10.2 |



in check. Tiswadi-3, Bardez-9 and Valpoi-2 continued record higher nut weight of >10g. All other accessions excepting Valpoi-3, Bardez 8/98 and BKL-2 recorded the mean nut weight of more than 8g. Among the accessions, apple weight varied from 68.16.g (Bardez 8/98) to 98.39 in Valpoi-2 accession. The significantly differing shelling percentage varied from 27.46 (Bardez-9) to 30.3 as against the highest shelling of 31.1% in check variety. TSS ranged from 10.33^oB (Valpoi-2) to 12.33^oB (Goa-1) and mean apple weight ranged from 65.80 g to 98.33 g.

All the accessions were affected by tea mosquito bug infestation. One tree each of BKL-1, and Bardez-9 died due to Cashew stem and root borer despite application of Chlorpyrifos (10 ml/l).

Varietal evaluation trial (MLT-VI)

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

Though growth of all the varieties was observed to be satisfactory in the evaluation trial comprising of 7 cashew varieties, there was severe incidence of Tea Mosquito Bug and Cashew Stem and Root Borer. Bhaskara, Vengurla-8 and Priyanka recorded better performance with 4.88kg, and 4.24 kg of raw nut yield respectively. Nut and apple size were observed to be stable over seasons. All the varieties recorded higher shelling percentage in the range of 28.4% (Priyanka) to 29.8 % (Vengurla-8) except Raghava variety.

Hybridization and selection

Performance of 1st set of Hybrids (5th harvest)

Hybrids H-31/05, H-22/05 and H21/05 continued to record vigorous growth habit recording the higher tree height and canopy spread. The highest tree height of 5.8 m was recorded in H-31/05 followed by H-22/05 (5.1m) and H-21/05 (4.8m). Similar trend was also observed with respect to collar girth and canopy spread. Three hybrids, H-11/05, 31/05 and H-21/05 showed precocious bearing while H-27/05 was the last to flower. Trees of H-31/05 and H-11/05, H23/05, H-27/05 and 29/05 had higher incidence of TMB and leaf webber.

Growth performance of cashew hybrids

| Hybrid | Tree height (m) | Collar girth (cm) | N-S spread (m) | E-W spread (m) |
|---------|-----------------|-------------------|----------------|----------------|
| H-5/05 | 3.9 | 51.2 | 2.9 | 2.8 |
| H-14/05 | 4.1 | 55.6 | 2.5 | 2.8 |
| H-11/05 | 4.0 | 61.3 | 3.5 | 3.9 |
| H-12/05 | 4.4 | 62.8 | 3.8 | 3.8 |
| H-13/05 | 3.9 | 64.6 | 3.7 | 4.0 |
| H-21/05 | 4.8 | 79.8 | 4.0 | 3.9 |
| H-22/05 | 5.1 | 82.0 | 3.4 | 3.9 |
| H-23/05 | 4.3 | 72.5 | 3.6 | 4.0 |
| H-27/05 | 4.0 | 69.8 | 3.8 | 3.6 |
| H-29/05 | 3.9 | 62.6 | 3.9 | 3.5 |
| H-30/05 | 3.2 | 50.1 | 2.4 | 3.1 |
| H-31/05 | 5.8 | 89.3 | 5.5 | 5.8 |

With respect to nut yield trend, the hybrid 31/05 continued to record the highest yield of 12.45kg per tree followed by the hybrid 21/05 (8.557kg/tree), though former hybrid was severely affected by the TMB. Other hybrids viz., HB-12/05, HB-22/05, HB27/05 also showed better trend at a later stage compared to the former two precocious hybrids.



H-21/05



Apples with nuts of H-27/05

Apple size was observed to vary from 45g in H-31/05 to 90.35g in H-22/05 with juice contents 59.3% and 72.4% having total soluble solids of 12.4^oB and 12.8^oB respectively. The juice per cent varied from 59.3 % (H-31/05) to 72.4 % (H-21/05).



Nut characteristics and yield of first set of hybrids during 2015 (Fifth harvest season)

| Hybrid | Av Nut weight (g) | Nut yield (kg/tree) | Shelling (%) |
|----------|-------------------|---------------------|--------------|
| H- 5/05 | 7.35 | 1.45 | 28.00 |
| H- 14/05 | 8.2 | 3.28 | 27.55 |
| H- 11/05 | 7.21 | 4.90 | 28.35 |
| H- 12/05 | 8.0 | 8.25 | 29.80 |
| H- 13/05 | 7.55 | 1.85 | 27.50 |
| H- 21/05 | 8.2 | 8.55 | 28.86 |
| H- 22/05 | 9.65 | 5.68 | 28.76 |
| H- 23/05 | 7.85 | 4.05 | 28.24 |
| H- 27/05 | 7.90 | 5.35 | 28.42 |
| H- 29/05 | 7.85 | 2.85 | 28.22 |
| H- 30/05 | 7.85 | 2.35 | 27.22 |
| H- 31/05 | 6.85 | 12.45 | 29.24 |

Second set of 34 hybrids of seedlings of the following parental combinations is also planted in the field for evaluation which is under juvenile stage.

Second set of hybrids

| Parental combination | No. Hybrid seedlings |
|--------------------------|----------------------|
| KN 2/98 x Goa-1 | 3 |
| Goa-1 x Tiswadi-3 | 2 |
| Tiswasdi-3 x Red local-1 | 3 |
| Red local-1 x Tiswadi-3 | 5 |
| Tiswadi-3 x Ganje-2 | 1 |
| Ganje-2 x Tiswadi-3 | 5 |
| Vengurla-4 x Tiswadi-3 | 8 |
| Ganje 2 x Valpoi-3 | 5 |
| Valpoi-3 x Red local | 2 |
| Total | 34 |

Third set of 53 Hybrid seedlings of the following parental combinations were planted in the main field.

Third set of hybrids

| Parental combination | No. Hyb. Seedlings |
|---------------------------------------|--------------------|
| Bold nut size Vs High yielding | |
| Tiswadi-3 x Red local | 8 |
| Bardez-9 x Ganje-2 | 17 |
| Tiswadi-3 x Vengurla-4 | 4 |
| High yielding Vs Bold nut size | |
| Red local x Tiswadi-3 | 6 |
| Ganje-2 x Bardez-9 | 14 |
| Vengurla-4 x Tiswadi-3 | 4 |
| Total | 53 |

A 4th set of 81 hybrid seedlings is ready for planting in the main field for further evaluation.



Cashew fruits of Tiswadi-3

Hybridization work

During fruiting season 2015, hybridization work was continued for producing the 5th set of hybrid progeny of parents involving contrast characters like bold nut and high yielding accessions and cluster bearing accessions. A total of 28 new hybrid seeds were collected from the crosses.



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

Evaluation of coconut based cropping system models for Goa

This experiment is taken up with an objective to evaluate the coconut based cropping system models for suitability to Goa.

Treatments details

1. Coconut-Black pepper-Papaya-Drumstick
2. Coconut-Black pepper-Heliconia
3. Coconut-Black pepper-Banana-Lemon
4. Coconut-Black pepper- Passion fruit-Pineapple
5. Coconut-Black pepper-Annona
6. Coconut-Black pepper-Crossandra
7. Coconut monocrop

Initial soil nutrient status in the coconut garden was analysed. Planting of intercrops was taken up during June, 2015 and the mortality, growth traits and initial yield were recorded. All intercrops established well except black pepper.

Nucleus seed garden of Dwarf arecanut

Objective of the experiment is to develop a nucleus garden of dwarf areca. First batch of eight plants of Hirehalli Dwarf were planted during 1989 along the road as avenue plants. These Dwarf areca plants are evaluated for stem traits, yield and, fruit traits. Selected plants among this set were multiplied by selfing and open pollinated seedling progenies. Open pollinated (half-sib) progenies were planted as second phase during 2011 as a block as part of the previous project. Five of these progenies have initiated flowering during the period under report. Off-type segregants from the block were eliminated and the putative dwarf progenies were retained. Segregation in phenotypic data of 190 half sib progeny seedlings analysed for the past four years.

A block of dwarf areca planted as nucleus seed garden with 42 plants during 2015-16 as phase III. An additional set of 21 dwarf progenies were inter planted in Tall Mangala areca plot of Farm B.

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

Multilocation trials are carried out in brinjal (varietal and resistant trial) and chilli (varietal trial). 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.

Brinjal Long IET

Out of six lines under evaluation including check, the earliest flowering was recorded in 2015/BRLVAR-2 (25 days) followed by Kashi Taru/IVBL-9 (C) (26 days). The individual fruit weight ranged from 46.20g (2015/BRLVAR-4) to 120.80g (Kashi Taru/IVBL-9 (C)).

Brinjal Long AVT-I

Out of six lines under evaluation including check, the earliest flowering was Kashi Taru/IVBL-9 (C) (25 days) followed by 2014/BRLVAR-2 (28 days). The individual fruit weight ranged from 49.20g (2014/BRLVAR-2) to 136.40g (Kashi Taru/IVBL-9 (C)).

Brinjal Long AVT-II

Eight lines are being evaluated for different fruit and yield characters. The earliest flowering was recorded in Krishi Taru/IVBL-9 (C) (33 days) followed by 2013/BRLVAR-1 (40 days). The



Best performing brinjal entry Kashi Taru

individual fruit weight ranged from 38.42 g (2013/BRLVAR-6) to 206.80g (2013/BRLVAR-1).

Brinjal Bacterial AVT-II

Eight bacterial wilt resistant varieties are being evaluated for yield and wilt incidence. The wilt incidence ranged from 0.00% (SM-6-7 and Arka Nidhi) to 70.00% (2013/BRBW RES-1). The



Consistently performing brinjal variety SM-6-7 for bacterial wilt resistance

earliest flowering was recorded in Pusa Purple Long (26 days) followed by 31 days in SM-6-7. The individual fruit weight ranged from 47.65g in Arka Nidhi to 85.85g in 2013/BRBW RES-4.

Chilli AVT-I

In chilli, twelve lines are being evaluated under AVT-I. With regard to flowering, the earliest flowering was recorded in 2014/CHIVAR-8 (29 days) followed by 2014/CHIVAR-4 (39 days). The highest plant height of 46.22cm was recorded in 2014/CHIVAR-2.

Chilli AVT-II

Six lines of chilli including check is being evaluated for flowering and yield traits. The earliest flowering was recorded in KA-2 (35 days) with dwarfness (35.55cm).



Chilli varietal checks viz., Kashi Anmol and LCA-334 under Goa condition

Project : All India Co-ordinated Research Project on Pigs (ICAR) (EB Chakurkar)

Livestock improvement will help rural population to increase the related products which will help them to be more sustainable. The production of pork and pork products is a household activity through the traditional knowledge 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.

Suitable breed, crossbreeding of local pig breed, controlled breeding using synchronization and AI, standard balanced feeding, comfortable housing of pigs will lead to improved pig production and benefit the growers. AICRP on pig Goa centre is attempting to provide these knowhow to the pig growers of the region through trainings and demonstrations. Breeding policy is followed as per the technical program of AICRP where experimental animals are crossbred 75 % (Aognda goan XLWY). 1:3



ratio of boar and breeding female is maintained. Each breeding animal is raised in individual pen and are fed with concentrate mixture. Artificial Insemination is strictly followed for breeding. Herd strength of cross bred (75%) ranges between 40 to 80. Mean litter size at birth was 6.50 ± 0.42 and litter weight 7.14 ± 0.47 (Kgs). Litter size at

weaning was 6.28 ± 0.43 whereas litter weight at weaning was 44.88 ± 3.75 (Kgs). Pre weaning mortality rate was 4.3 % whereas post weaning mortality was 4.15 %. Preweaning growth was 153.88 ± 3.48 gm/day whereas post weaning growth was 302.47 ± 7.41 gm/day. Weight at 10 months age was 85.13 ± 2.73 kg.

Project : All India Co-ordinated Research Project on animal disease monitoring and surveillance (ICAR)
(Shivasharanappa N)

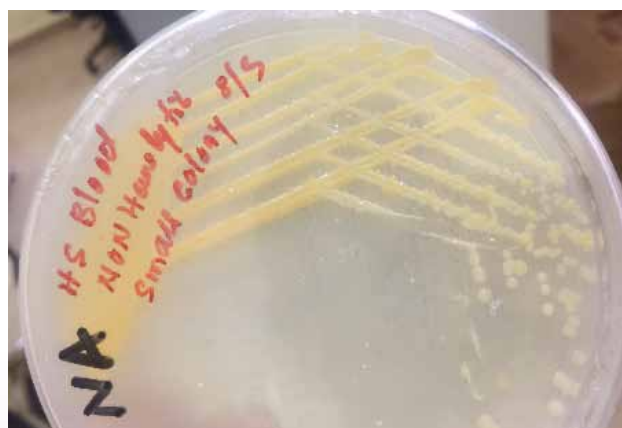
The outbreak of Hemorrhagic Septicemia (HS) occurred in Kurti (Ponda), North Goa in dairy cattle unit. Total animals were 90 and affected were six with mortality of two animals in February, 2016. The outbreak was confirmed based on isolation and identification of *Pasteurella* spp. Swab and blood samples were positive for *P. haemolytica* based on PCR amplification. Samples were negative for *P. multocida*. HS vaccination and treatment was advised to the farmer.

Isolation and characterization of Pasteurellosis caused by *P. multocida* and *P. hemolytica* in dairy cows by culture and PCR

Blood and nasal swabs from dairy cows (total 90, affected 8 and died 2) suspected for Pasteurellosis were collected and processed for isolation and identification of *Pasteurella multocida* and *Pasterurella hemolytica* by culture and PCR. A characteristic haemolytic and non-haemolytic colonies on blood and Mackonky agar was further characterized by PCR amplification of virulence markers.



Haemolytic colonies on blood agar



White round colonies on Mckonkeys agar



AICRP Voluntary Centres

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

About 64 (Initial Variety Trial) and 16 (Advance Variety Trial) lines received from Indian Institute of Rice Research, Hyderabad, were tested under salinity situation in farmers' field at chorao island.

Coastal Salinity Tolerant Variety Trial (CSTVT) - Initial Variety Trial (IVT)

This trial consisted of 64 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,

Mean performance of entreis CSTVT - IVT

| Entry | DDF | PHT (cm) | NPT | GY (kg/ha) |
|---|--------|----------|--------|------------|
| DRRH 106 (Hybrid) | 111.50 | 111.28 | 257.40 | 3632.1 |
| GNV 11-14 (IR 78806-B-B-16-1-2-2-AJY 1) | 98.50 | 111.49 | 221.10 | 3466.0 |
| KAU CUL 27-2 | 112.00 | 104.14 | 210.65 | 3085.4 |
| NVSR-6137 | 104.50 | 124.45 | 178.20 | 2858.3 |
| KAU-CUL 51-5 | 112.50 | 111.16 | 290.40 | 2684.4 |
| CST 7-1 | 121.00 | 130.80 | 231.00 | 1235.0 |
| Jaya (Yield Check) | 101.00 | 103.63 | 174.90 | 1931.3 |
| Korgut (local check) | 91.00 | 156.50 | 224.40 | 1350.0 |
| Mean | 112.34 | 119.01 | 213.51 | 1208.9 |
| SE | 5.05 | 10.38 | 44.69 | 333.03 |
| CD @ 5% | 10.09 | 20.75 | 89.30 | 665.51 |
| CV (%) | 4.49 | 8.72 | 20.93 | 27.55 |

DDF- Days to 50% floweing **PHT**-Plant height
NPT-No. of productive tillers/hill **GY**-Grain yield

North Goa. Soil EC ranged from 2.68 to 5.95 dS/m and soil pH from 5.26 – 5.54. Days to 50% flowering ranged from 90.50 days (4014) to 127 days (4030), plant height ranged from 79.15 cm (4039) to 167.80 cm (4021), productive tiller per sqmts ranged from 122.10 (4022) to 320.10 (4039), while grain yield ranged from 281.25 kgs/ha (4021) to 3632.13 kgs/ha (4035).

Among the test entries, the top 5 ranking entries are DRR H 106 (Hybrid) (3632.13 kg/ha), GNV 11-14 (IR 78806-B-B-16-1-2-2-AJY 1) (3466 kg/ha), KAU CUL 27-2 (3085.42 kg/ha), NVSR-6137 (2858.34 kg/ha) and KAU-CUL 51-5 (2684.38 kg/ha).

Coastal Salinity Tolerant Variety Trial (CSTVT)- Advance Variety Trial (AVT)

This trial consisted of 16 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.

Days to 50% flowering ranged from 89.33 days (1816) to 125 days (1810), plant height ranged from 93.40 cm (1811) to 154.60 cm (1810), productive tiller per sqmts ranged from 147.40 (1814) to 233.20 (1813), while grain yield ranged from 303.33 kgs/ha (1810) to 3690.67 kgs/ha (1804).

Among the test entries, none of the entries recorded significantly higher grain yield compared to the best check i.e. FL 478. Top four entries with respect to grain yield are IR 83421-6-B-3-3-1-1-CR 3364-S 2B-14-2B (3080.00 kg/ha), Gosaba 9-2 (3016.00 kg/ha), DRR H 102 (Hybrid) (2989.33 kg/ha) and RP 5899-47-39-2-2-2-1 (2674.67 kg/ha).



Mean performance of entreis CSTVT - AVT

| Entry | DFE | PHT (cm) | NPT | GY (kg/ha) |
|--|--------|----------|--------|------------|
| IR 83421-6- B-3-3-1-1-CR 3364-S 2B-14-2B | 102.00 | 116.67 | 213.40 | 3080.0 |
| Gosaba 9-2 DRR | 102.67 | 110.93 | 204.60 | 3016.0 |
| H 102 (Hybrid) | 101.00 | 117.13 | 178.20 | 2989.3 |
| RP 5899-47-39-2-2-2-1t | 122.67 | 119.53 | 178.20 | 2520.0 |
| FL 478 | 89.33 | 100.20 | 187.00 | 2418.7 |
| Korgut Local check | 92.33 | 133.13 | 233.20 | 1989.7 |
| Mean | 110.88 | 114.46 | 192.23 | 2017.3 |
| SE | 2.64 | 4.24 | 16.49 | 377.21 |
| CD @ 5% | 5.38 | 8.65 | 33.68 | 770.36 |
| CV (%) | 2.91 | 4.53 | 10.51 | 22.90 |
| CD @ 5% | 10.09 | 20.75 | 89.30 | 665.51 |
| CV (%) | 4.49 | 8.72 | 20.93 | 27.55 |



Field view of CSTVT trials at choroa island in farmers field



Phenotyping for salinity stress

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

Project : All India Co-ordinated Research Project on Arid Legumes (ICAR)
(Manohara KK)

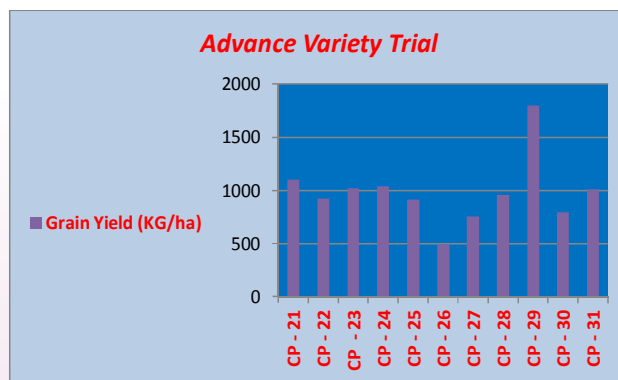
Advance Variety Trial

Under this project, 11 lines of Cowpea were evaluated during rabi season of 2015-16 in rice fallow. The trial was laid out in Randomized Complete Block design with two replication with

plot of 5.4 sqmts for each of the treatment. The line CP – 29 recorded highest seed yield (1801.85 kg/ha) followed by CP – 21 (1098.14 kg/ha) and CP – 24 (1042.14 kg/ha).



Field view of Cowpea trial during rabi season of 2015-16 at institute farm



Mean performance of the entries under Advance Variety Trial



Externally Funded Projects

Project : Stress Tolerant Rice for Poor Farmers of Asia and South Asia (BGMF)

(Narendra Pratap Singh)

Salinity Tolerant Breeding Network – evaluation of rice lines under coastal salinity condition

Thirty rice cultures were evaluated under coastal salinity situation in farmers' field at Chorao Island of North Goa district. The soil EC ranged from 1.36 to 8.72 dS/m and soil pH from 6.01 to 6.36. The experiment was carried out in Randomized Complete Block Design (RCBD) with three replications. Data on all the yield and yield related parameters was recorded during the various growth stages of the crop.



Field view of STBN at Chorao Island

Mean performance of top five entries under STBN trial

| Variety | DDF | PHT (cm) | NPT | GY (kg/ha) |
|--------------------------|------|----------|-------|------------|
| IR 87830-B-SDO1-2-B | 116 | 123 | 5.80 | 2860.00 |
| IR 87831-3-1-1-2-2-BAY B | 117 | 123 | 6.73 | 2971.67 |
| IR 87938-1-1-2-1-3-B | 111 | 110 | 6.87 | 3113.33 |
| IR87848-301-2-1-3-B | 102 | 115 | 7.53 | 2958.33 |
| RYT – 3207 | 107 | 115 | 5.80 | 2941.67 |
| CSR 36 (Check 1) | 113 | 115 | 6.33 | 2823.33 |
| CST 7-1 (Check 2) | 119 | 123 | 7.07 | 2513.33 |
| CSR 27 (Check 3) | 106 | 118 | 5.80 | 2561.67 |
| Korgut (Local check) | 95 | 146 | 6.27 | 1780.00 |
| Mean | 109 | 118 | 6.26 | 2362.50 |
| SE | 3.18 | 5.36 | 0.77 | 560.66 |
| CD @ 5% | 6.36 | 10.73 | 1.54 | 1122.27 |
| CV (%) | 3.56 | 5.53 | 15.01 | 29.06 |

DDF- Days to 50% flowering **PHT**-Plant height
NPT-No. of productive tillers/hill **GY**-Grain yield

Analysis of variance revealed significant differences among the entries for all the characters studied. With regard to grain yield, none of the entries recorded significantly higher yield compared to the three check varieties CSR-36 (2823.33 kg/ha), CSR-27 (2561.67 kg/ha) and CST 7-1 (2513.33 kg/ha). However, entries viz., IR 87938-1-1-2-1-3-B (3113.33 kg/ha), IR 87831-3-1-1-2-2-BAY B (2971.67 kg/ha), IR87848-301-2-1-3-B (2958.33kg/ha) and RYT – 3207 (2941.67 kg/ha) recorded significantly higher grain yield compared to the local check variety Korgut (1780 kgs/ha).



Promising STBN culture



Project : Amelioration and management of coastal saline soils for rice production in Goa (DST&E) (GR Mahajan)

Salinity tolerant microorganism for plant growth promotion in rice under coastal saline soils

Two salinity tolerant microorganisms as alone and consortia were tested for plant growth promoting activity in rice crop. Application of one of the two microorganisms, *Bacillus methylotrophicus* Strain STC-4, either as alone or in combination with farmyard manure caused significantly higher ($p < 0.05$) root length, volume and weight and straw weight (dry) over all the treatments. The corresponding values of these parameter in farmyard treated pots were 21 cm, 46.4 mL, 38.8 g/pot, 39.1 g/pot. Application of microorganisms did not bring any significant changes in the soil pH and electrical conductivity. Positive effect of this strain was also recorded on soil biological activity - soil enzymes, soil microbial biomass carbon, microbial biomass as fraction of soil organic carbon and basal soil respiration when applied with farmyard manure.

Spatial and temporal variability in microbial activities of coastal acid saline soils of Goa, India

The aim of the present investigation was to study the spatio-temporal variability of the microbial activities in coastal saline soils (locally called *Khazan*) of Goa, India (west coast region). Three replicated global positioning system based soil samples (0–0.20 m depth) from each of four salinity groups i.e. non-saline ($EC = 0.08 \pm 0.06$ dS m^{-1}), weakly saline ($EC = 2.04 \pm 0.06$ dS m^{-1}), moderately saline ($EC = 3.50 \pm 0.57$ dS m^{-1}) and strongly saline ($EC = 5.49 \pm 0.49$ dS m^{-1}) during three seasons—monsoon, post-monsoon and pre-monsoon were collected. Soil microbial activity in terms of soil microbial carbon (MBC), MBC as a fraction of soil organic carbon (SOC) (MBC/SOC), basal soil respiration (BSR), metabolic quotient (qCO_2) and soil enzyme activities—



A view of the pot experiment on evaluation of salinity tolerant microorganisms

dehydrogenase, phosphatase and urease was tested. In all the seasons, the soil cationic composition depended significantly ($p < 0.01$) on salinity levels and the exchangeable sodium (Na) was the second most dominant among the tested cations. The MBC, MBC/SOC and BSR reduced significantly with increasing salinity, whereas qCO_2 increased with increased salinity levels. In general, MBC, MBC/SOC and BSR and soil enzyme activities were observed as: salinity levels—strongly saline < moderately saline < weakly saline < non-saline and season—post—monsoon > monsoon > during pre-monsoon season. The mean MBC and MBC/SOC of non-saline soils were 1.61 and 2.28 times higher than that of strongly saline soils, whereas qCO_2 of strongly saline soils was 2.4 times higher than that of non-saline soils. This indirectly indicates the salinity stress on the soil microorganisms. Irrespective of season, the soil enzyme activities decreased significantly ($p < 0.05$) with increasing salinity levels. Suitable countermeasures needs to be taken up to alleviate the depressive salinity effect on the microbial and activity for the sustainable crop production in the coastal saline soils of Goa, India.



Project : Agro-morphological characterization and DNA finger printing of rice landraces of Goa (DST&E) (Manohara KK)

Agro-morphological characterization

The project aims at collection, conservation, evaluation and characterization of traditional rice landraces of Goa. The present investigation to characterize all the 18 landraces was carried out at the institute farm during *Kharif* season 2015-16, in Randomized Complete Block Design with three replications. Landraces / traditional rice varieties were characterized for 27 different agro-morphological and 12 yield and its contributing characters at four phases *viz.*, Seedling Phase,

Vegetative Phase, Reproductive Phase and at Maturity Phase.

From the study, characters *viz.*, length of awns and lemma pubescence of leaf blade showed wide variation (four classes) among the genotypes followed by basal leaf sheath colour, lemma and palea colour, panicle exertion, spikelet density pubescence of lemma and secondary branching (three distinct classes). Eleven characters showed two distinct classes and eight of them have shown no variation among the studied landraces.

Grouping of genotypes based on descriptors showing wide variation

| Descriptor | State | Frequency | Genotypes |
|----------------------|------------------------|-----------|---|
| Three classes | | | |
| BLSC | Green | 8 | G5, G7, G8, G10, G12, G13, G14, G16 |
| | Purple Lines | 9 | G1, G2, G3, G4, G6, G9, G11, G17, G18 |
| | Uniform Purple | 1 | G15 |
| LP | Straw | 8 | G1, G3, G5, G7, G10, G13, G15, G16 |
| | Brown furrows on straw | 9 | G2, G6, G8, G9, G11, G12, G14, G17, G18 |
| | Black | 1 | G4 |
| PE | Partly exerted | 1 | G15 |
| | Mostly exerted | 9 | G1, G2, G5, G6, G7, G12, G13, G17, G18 |
| | Well exerted | 8 | G3, G4, G8, G9, G10, G11, G14, G16 |
| SDPL | Medium | 5 | G7, G11, G12, G15, G16 |
| | Strong | 10 | G1, G3, G4, G5, G6, G8, G10, G13, G14, G18 |
| | Very Strong | 3 | G2, G9, G17 |
| PSB | Weak | 4 | G7, G8, G16, G18 |
| | Strong | 13 | G1, G2, G3, G4, G6, G9, G10, G11, G12, G13, G14, G15, G17 |
| | Clustered | 1 | G5 |
| Four classes | | | |
| PLA | Very short | 1 | G16 |
| | Short | 2 | G1, G5 |
| | Medium | 3 | G3, G6, G9 |
| | Long | 2 | G7, G18 |
| LPOBS | Absent | 1 | G10 |
| | Medium | 11 | G1, G2, G4, G5, G8, G9, G11, G12, G14, G16, G18 |
| | Strong | 5 | G3, G6, G13, G15, G17 |
| | Very Strong | 1 | G7 |

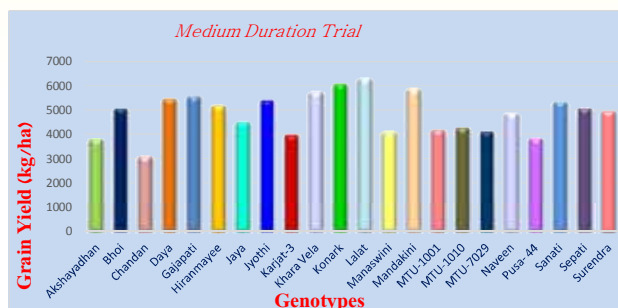


BLSC- Basal Leaf Sheath Colour; PL- Lemma & Palea colour; PE-Panicle exertion; SDPL - Spikelet Density Pubescence of lemma; PSB - Secondary branching; PAB - Panicle:Attitude of branches; PLA - Length of longest awns; LPOBS - Lemma pubescence of leaf blade.

Evaluation of medium duration rice varieties under rainfed lowland situation

Twenty two medium duration rice varieties were evaluated under rainfed lowland ecology in three replication. Of the varieties tested,

Lalat recorded highest grain yield (6298.23 kg/ha) followed by Konark (6067.15 kg/ha) and Mandakini (5869.36 kg/ha). The grain yield of all the entreis tested is given in the below graph.



Performance of the rice varieties under rainfed lowland situation

Project : Integrated Farming System for improvement of nutrition and livelihood of farm women under different agro-ecosystems (ICAR) (Vishwanath Reddy K)

The project was taken up with collaboration of ICAR- CIWA, Bhubaneswar. Villages with crop based (Surla) and livestock based (Ibrahimpur) farming system were selected for the survey work on socio- economic aspect. About 50 farmers were selected for survey work.

Crop based farming (Surla village)

As the agriculture of the village is mainly dominated by plantation crop based farming, maximum area is under plantation crops like as coconut, arecanut, banana, cashew and mango, however, rice is the predominant field crop in rainy season. Socio- economic assessment revealed major problems related to agriculture like lack of knowledge about farming, labor scarcity, sudden climatic changes, abandonment of agriculture and irrigation to urban areas, non-availability of credit or loans for constructing fencing to protect the crop damage from wild animals' menace, lack of awareness biogas plant

and its construction, lack of knowledge about soil testing, lack of information about the agricultural exhibitions and krishi melas, etc..

Livestock based farming (Ibrahimpur village)

By analyzing the farmer's data on gender participation in livestock production activities, it was found that the access and control on livestock resources is by men and women jointly in the village. In breeding, feeding activities, health care and management activities of livestock and processing, marketing and decision making, both men and women are jointly involved. The farmers are getting their agricultural loans from Institutional source of finance- State Bank of India for the purchase of livestock. Based on the survey, it is evident that livestock farming has improved the livelihood of the farmers. Major portion of farm income is spent on food items, small amount of income is being spent on clothing, education and health etc.



Project : ICAR- Network Project in Transgenic Crops (Functional genomics): Genetic Mapping of Salinity Tolerant Genes in Rice (Manohara KK)

Hybridization and generation advancement

With an objective of mapping genes for salinity tolerance, different crosses were attempted involving high yielding salinity sensitive genotypes and tolerant landraces, for developing mapping populations. The crosses were initiated in 2014 *kharif* and during the current year about 10 different cross combinations were advanced to F₂ (*kharif*) and F₃ (*Rabi*) generation, following single seed descent method.

Different cross combinations used in developing mapping populations

| Crosses | Segregants |
|--------------------------|------------|
| Naveen X KS - 16 - 1 | 780 |
| Naveen X KS - 19 - 2 | 541 |
| MTU 1010 X KS - 16 - 1 | 293 |
| Karjat - 3 X KS - 19 - 2 | 289 |
| Chandan X KS - 17 | 286 |
| Karjat - 3 X KS - 17 | 279 |
| Pusa - 44 X KS - 17 | 267 |
| Naveen X Shidde | 256 |
| MTU 1001 X Shidde | 212 |
| MTU 1001 X KS - 17 | 180 |



Field view of F₃ population during rabi season

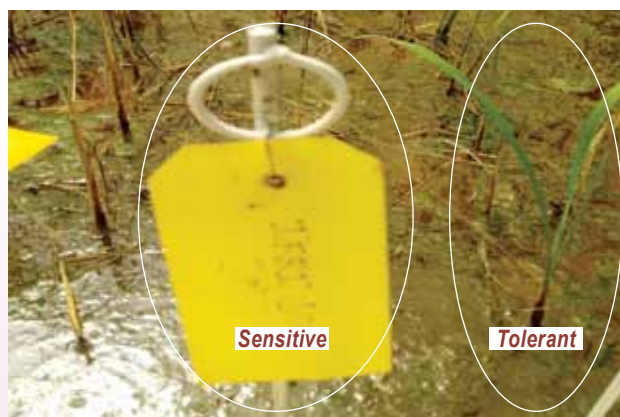
Screening of landraces and wild rice collections under micro-plot conditions:

60 germplasm comprising 20 landraces, 23 wild rice, 9 advanced breeding lines, 6 improved

cultivars and 2 check varieties (Tolerant Pokkali, Sensitive IR-29) were screened under micro-plot conditions for salinity stress tolerance at seedling stage during rabi season. Genotypes were exposed to salinity stress (EC = 12 dS/M) at seedling stage and scoring was done according to the SES system of evaluation given by IRRI, Philippines. Eight genotypes shown in the below table fallen in the group of highly tolerant (SES score 1) and tolerant (SES score 3) category.

SES scoring of the genotypes at seedling stage salinity screening

| Genotypes | | SES score | Tolerance |
|-----------|-------------------------|-----------|-----------------|
| Korgut | Landrace | 1 | Highly tolerant |
| KS-17 | Selection from Korgut | 1 | Highly tolerant |
| WR-18 | Wild rice | 1 | Highly tolerant |
| KS-12 | Selection from Korgut | 3 | Tolerant |
| KS-16-1 | Selection from Korgut | 3 | Tolerant |
| KS-19-2 | Selection from Korgut | 3 | Tolerant |
| KS-4 | Selection from Korgut | 3 | Tolerant |
| Kagga | Landrace from Karnataka | 3 | Tolerant |



Tolerant and Sensitive genotypes



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

Validation of LAMP PCR for detection of *R. solanacearum*

LAMP PCR was standardized to detect *R. solanacearum* directly from soil. The detection technology was validated using the field soil samples collected from Taleigao. Various detection techniques were used. Plating on SMSA medium is the best method (100% detection) to detect *R. solanacearum* followed by LAMP-PCR in a isothermal water bath (97.62%). When the studies of the previous season were combined, it is observed that LAMP PCR in a isothermal water bath detected *R. solanacearum* from 98.85% soil samples. The next best method was plating on selective medium (90.8% positive). Conventional and Bio PCR with *R. solanacearum* specific primers recorded the lowest detection percentage (9 to 11%). LAMP PCR in a isothermal water bath with dye detected *R. solanacearum* from 70.11% soil samples and any increase in detection level of this method would really be very useful in the field level as it is very simple method. Studies from both the seasons indicated that *R. solanacearum* was detected even from the samples collected from apparently healthy plants. The positive detection from healthy plants was as comparable to the samples collected from wilted plants. This indicates the possible presence of the pathogen in the field and it is just the matter of time before the plants died.

Identification of effectors in *R. solanacearum*

R. solanacearum, mutants of *hrcV* and *hrpB* genes were developed by insertional mutagenesis. Based on the whole genome sequences, two type III effector genes of *R. solanacearum* were

selected, cloned into destination vector and transformed to wild type *R. solanacearum* to study the translocation of effector in the wild type and mutants.

Development of transcriptome profile of resistant and susceptible brinjal varieties

Resistant and susceptible brinjal varieties were used to develop the complete transcriptome data to identify the genes involved in resistant reaction when the pathogen infects the plant. Plants were challenge inoculated with *R. solanacearum* and sampling at different intervals was taken and transcriptomics work is in progress.

Studies on the transmission of *R. solanacearum* to seeds from the diseased brinjal

R. solanacearum is primarily a soil-borne pathogen and in vegetative propagated plants it is carried through planting materials like rhizomes and tubers. However, in case of other plants, the seed transmission is not reported widely and it has just been speculated as carrier in few cases. Experiments were conducted to look out for the seed transmission of the bacterium, both external contamination (seed wash) and internal presence (seed macerate) through classical plating and detection by PCR using specific primers. Results indicated that no *R. solanacearum* growth was observed in the plates, and in PCR test no *R. solanacearum* was detected. Seeds sown in soil did not show any wilting. This further confirms that *R. solanacearum* is not carried to seeds from the diseased brinjal plant.



Variation wrt fruit size and colour in brinjal segregating generation (F_2)



Development of suitable segregating population for bacterial wilt management

46 lines of F_5 and 222 lines of F_6 were advance for their stabilation. All the lines vary in fruit colour, fruit shape, fruit size, colour pattern and bearing habit. The lines will be evaluated for phenotyping (bacterial wilt resistance) in the next generation. Further, farmers groups visited the experimental units and selected some of the lines, which are preferred according to their evaluation on various criteria like colour, size of the fruits and the quantity of seeds *etc.*

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

Evaluation of grafts for methods for the management of bacterial wilt in brinjal and tomato

Locally preferred brinjal cultivars, *Agassaim* and *Taleigao* are highly susceptible to bacterial wilt and a wild relative of cultivated brinjal and Surya were identified as resistant to this disease. Further, five AVRDC brinjal lines (Accession nos S00003, S00004, S00019, S00022 and TS02257) were obtained from ICAR-IIVR, Varanasi. Seedlings of the wild type and cultivates species were raised and the susceptible plants were grafted on the wild types. Bacterial wilt resistant root stock used were wild type (*Solanum torvum*), Surya, S00004; bacterial wilt susceptible scion used were *Agassaim*, *Taleigao* (Brinjal) and Balaji, Mose, Myca (tomato).

Evaluation of tomato plants grafted on wild brinjal to bacterial wilt

In experiment 1, wilt started three days after inoculation and 100 per cent plants wilted four days after inoculation in case of seedlings.

However, maximum of 20 per cent plants only wilted in case of grafts (var: Balaji). In experiment 2, wilt started five days after inoculation and 100 per cent plants wilted after eight days (Balaji); 80 per cent plants wilted after seven days (Mose) and ten days (Myca) of inoculation in seedlings. However in grafts, wilting started on 10th day in Balaji and Myca and the maximum of 12.5 per cent plants wilted. No wilting was observed in Mose grafts..

Evaluation of tomato plants grafted on Surya and S-4 to bacterial wilt

No bacterial wilt incidence was observed in the grafts of all three varieties until 21 days. However in control 100 per cent plants wilted within 16 days of inoculation.

Evaluation of cultivated brinjal root stocks for bacterial wilt resistance

Seeds of the accessions received from IIVR, Varanasi were raised and the characteristics of the accessions were recorded. Further the accessions were evaluated for bacterial wilt resistance. Bacterial wilt was recorded in all the accessions and the experiment is being repeated.

Evaluation of brinjal plants grafted on Surya to bacterial wilt

Further, based on our previous findings, Surya was used as root stock for grafting *Agassaim* and *Taleigao* brinjal. The grafts were inoculated with *R. solanacearum*. In experiment 1, wilting was not observed up to 9 days in any of the grafts. In experiment 2, brinjal plants (*Agassaim*) grafted on Surya did not wilt. The plants grafted on S4 showed wilting up to 50 per cent. However, the seedlings of *Agassaim* recorded 100 % wilt.



Farmers visit to the brinjal field experiment: Segregating population



Grafting of cultivated brinjal on wild brinjal-Field evaluation

Trial 3 was conducted from Nov 2014 to June 2015 in which grafts and seedlings of *Agassaim* and *Taleigao* were planted alternatively in the field with many replications where bacterial wilt incidence is not reported earlier. Four lines (36_1_15, 1_1_15, 5_1_22 and 5_1_25) from segregating population were also planted in the experiment. None of the grafted plants died during the entire crop period. Even in control seedlings, the incidence of wilt was very low, probably due

to the experimental plot where bacterial wilt incidence was not reported.

Training and demonstration of grafting technology to farmers

Grafts were provided to some farmers and farmer's groups for planting in the fields. After the successful crop, they are convinced about the technology. Farmers visited the grafting experimental units and training on grafting was provided.

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

Promising rhizosphere bacterium in plant health management in Coastal ecosystem

Bacillus methylotrophicus Strain RCh6-2b has been identified as one of the promising bio-agent in suppression of various plant pathogens (*Macrophomina phaseolina*, *Rhizoctonia solani*, *Sclerotium rolfsii*, *Phytophthora capsici* and *Ralstonia solanacearum*) during the screening and field experiments. The strain was identified based on morphological, biochemical and 16S rRNA sequence (NCBI Accession number of 16s rRNA sequence is KU682845). The culture is deposited in the national repository of NBAIM, Mau with the accession number NAIMCC-B-01889 and with MTCC, IMTECH with the accession number MTCC 12535. Further studies of the bacterium indicated that it produced more than one antimicrobial compounds, which are inhibitory to the test pathogens. Being a good rhizosphere colonizer, broad spectrum pathogen inhibition ability and secretor of antimicrobial compounds with longer shelf life in the formulation, the strain is a promising biological agent in plant health management under coastal ecosystems.

Promising salt tolerant bacterium for plant growth promotion in coastal regions

Bacillus methylotrophicus Strain STC-4 is a plant growth promoter and is tolerant to salt concentration of up to 1.5M. The strain was identified based on morphological, biochemical and 16S rRNA sequence (NCBI Accession number of 16s rRNA sequence is KU682846). The culture is deposited in the national repository of NBAIM, Mau with the accession number NAIMCC-B-01890. Application of this strain to paddy crop either alone or with farm yard manure recorded highest soil biological activity in terms of soil enzymes, soil microbial biomass carbon, microbial biomass as fraction of soil organic carbon and basal soil respiration. Significant improvement in plant growth parameters also recorded in the treatments. Hence, this bacterium could be used in saline soils of west coast for improved plant growth in paddy and other crops.

Standardization of medium and growth time of promising bacterial antagonists

Growth curve experiments for other promising plant growth promoting bacteria/bacterial antagonists (STC-4, RCh23-b and RSH-



9) indicated that maximum growth was recorded in NB broth after 24 hours. In case of RCh6-2b and STC-4, there is decline in population after 24 hours. However in case of RCh23-b and RSH-9, the population remained constant or slightly increased up to 52 hours.

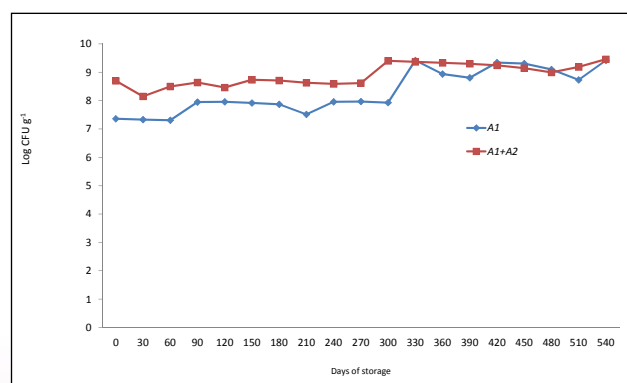
Standardization of synthetic medium for RCh6-2b

Growth of bacterium in the media containing fructose as C- source and Ammonium acetate, ammonium chloride and ammonium sulphate as N-sources was comparable with the control medium. Population in the formulation developed from the bacterial biomass form synthetic medium was at par with the control and hence this medium could be used for mass multiplication of RCh6-2b.

Evaluation of various formulations of *B. methylotrophicus* (*B. amyloliquefaciens*) (RCh6-2b) for its viability

Talc formulation

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 8.0 Log CFU g⁻¹ in A1 and A1+A2 after 540 days. Spore population of *Bacillus* sp. (RCh6-2b) in different talc formulation after 18 months indicated that most of the population is from the spores in the formulation.



Population of *Bacillus* sp. (RCh6-2b) in talc formulation prepared with different media

Liquid formulations

Bacterium grown in medium containing glycerol:- 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⁻¹ after 510 days (A), 315 days (B) and 420 days (C). Spore population of *Bacillus* sp. (RCh6-2b) in different liquid formulation after the same period indicated that most of the population is from the spores in the formulation.

Bacterium grown in modified medium without glycerol

Population of *Bacillus* sp. (RCh6-2b) in different liquid formulations (A, B and C) indicated that the population is above 7.0 Log CFU mL⁻¹ after 525 days (A and B) and 465 days (C).

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 15 months. From the various studies and available information, liquid formulations (A and B) were prepared in the modified medium (without glycerol on growth medium) and stored with glycerol (2%). Results indicated the population of bacterium in the formulations was the above 8.0 Log CFU mL⁻¹ after 210 days (B) and 375 days (A).

Emulsion formulation

An emulsion formulation of RCh6-2b was standardized and the results indicated that the population of bacterium in the emulsion was 8.0 Log CFU mL⁻¹ till 120 days.

Alginate formulation

Sodium alginate formulation of RCh6-2b was prepared according to the standardized method. The bacterial population in the formulation was above 9.0 Log CFU mL⁻¹ till 345 days. Spore population of *Bacillus* sp. (RCh6-2b) in the formulation after the same period indicated that most of the population is from the spores in the formulation.

Fermenter biomass

Various parameters and fermenter conditions were standardized to produce biomass of RCh6-2b. Talc and liquid formulations were prepared from this biomass as per the standardized protocols. The bacterial population in the formulation was above 9.0 Log CFU g⁻¹ till 270 days in talc formulation.



Evaluation of talc formulation and of liquid formulation of bacterial bio-agents for their growth promoting ability in vegetables

Different methods of application *viz.* seed coating, soil application and seedling drench of various formulation of RCh6-2b were followed.

Talc formulation of RCh6-2b in brinjal

Soil application of both old (9 months) and new (1 month) formulations improved the growth parameters in nursery. In transplanted seedlings, plant height was higher in soil application and soil application+ seedling drench treatments when both old and new formulations were used. Soil application, seed coating+ seedling drench and soil application+ seedling drench improved other growth parameters *viz.* shoot weight and root weight.

Talc formulation of RCh6-2b in tomato

Soil application of both old (9 months) and new (1 month) formulations improved the growth parameters in nursery. In transplanted seedlings, plant height was higher in soil application and soil application+ seedling drench treatments when both old and new formulations were used. Further, it was noticed that the plant height in all the days of observation was higher in the old formulation compared to the new formulation.

Talc formulation of RCh6-2b in cowpea

Higher germination percentage was recorded in control followed by soil application. Though initial plant height at 7th day was high in control, seedling drench and seed coating+ seedling drenching recorded higher plant height compared to other treatments on 14th day. Overall growth performance was higher in seed coating+ seedling drenching and soil application treatments.

Talc formulation of RCh6-2b in cucumber

Higher germination percentage was recorded in seed coating+ seedling drenching and seedling

drench. Root length was higher in soil application and seedling drenching treatment. Higher root weight was recorded in seedling drenching and seed coating+ seedling drenching treatment. Overall growth performance was higher in seedling drenching.

Liquid formulation of RCh6-2b in brinjal

Coating of seeds with both old (14 months) and new (6 month) liquid formulations did not show any improvement in the growth parameters in the nursery. In transplanted seedlings, there was no significant increase in plant height in the treatment with both old and new formulations.

Liquid formulation of RCh6-2b in tomato

Coating of seeds with both old (14 months) and new (6 month) liquid formulations improved root length in the nursery. In transplanted seedlings, there was no significant increase in plant height in the treatment with both old and new formulations.

Talc formulation of RSH-9 in brinjal

Coating of seeds with talc formulation increased shoot length and shoot weight. Soil application with the talc formulation increased shoot length, shoot weight and root weight. In transplanted seedlings, higher plant height was recorded in soil application and soil application+ seedling drench treatments. Higher growth parameters were recorded in seed coating+ seedling drench and soil application+ seedling drench treatments.

Talc formulation of RSH-9 in tomato

Coating of seeds with talc formulation increased shoot length, root length, shoot weight and root weight. Soil application with the talc formulation also increased all the growth parameters compared to control. In transplanted seedlings, higher plant height was recorded in soil application and seedling drench treatments.



Project : Mega Seed Project (ICAR)

a) Seed Production in Agricultural Crops (*Manohara KK*)

The major objective of the project is to take up quality seed production in major field crops which are of importance in Goa and adjoining regions. The local demand for the seed and also the target fixed by the council was taken into account for producing seeds. Keeping in view of the above points, seed production was undertaken in rice during *kharif* and in Cowpea and Green gram during *Rabi* season.

Seed production in rice (*Kharif* season 2015)

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 2015, seed production of rice varieties Karjat-3 and Jyothi was taken up in an area of 0.8ha at the institute farm.

Seed production in Cowpea and Green gram (*Rabi* Season 2015-16)

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 0.3ha area was taken up for its seed production. Small quantity of seed was also produced in few local collections of cowpea and in one improved variety of green gram *var* TM-96-2.

Details of seed production

| Crop | Varieties | Quantity seed produced |
|------------|-------------------|------------------------|
| Rice | Karjat-3 | 6 Q |
| | Jyothi | 8 Q |
| | Vytilla | 2 Q |
| Cowpea | Goa Cowpea-3 | 2 Q |
| | Local Collections | 0.5 Q |
| Green gram | TM-96-2 | 0.5 Q |



Seed production in rice variety Karjat-3



Seed production in rice variety Jyothi



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



Seed production in cowpea variety - Goa Cowpea - 3



b) Seed Production in Horticultural Crops (V Arunchalam)

Quality planting materials numbering 1044 covering eight horticultural crops were generated and sold during the year. Planting material of the major crops covered and the number sold are listed as below.

| Crop | Propagule | Number sold |
|--------------|----------------|-------------|
| Banana | Sucker | 39 |
| Coconut | Seedling | 179 |
| Black pepper | Rooted cutting | 69 |
| Pine apple | Sucker | 16 |
| Arecanut | Seedling | 681 |
| Curry leaf | Sucker | 20 |

| | | |
|------------|----------------|----|
| Rose apple | Air layer | 20 |
| Cherry | Rooted cutting | 20 |

Selection of mother palms is usually carried out using the yield and phenotypic traits of parental palms. About 450 open pollinated seedling progenies of 19 mother palms of four varieties of coconut (Benaulim, Goa Benaulim Pani, COD, MYD) were scored for eight DUS traits. The study led to identification of further superior mother palms among the selected ones. Similar effort is in progress in Mangala and Hirehalli Dwarf varieties of Arecanut.

c) Seed Production in Ornamental Fisheries (Manju Lekshmi N)

Opportunities in ornamental fisheries in Goa

Under this project, 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. Propagation was started for aquatic plants like *Ceratophyllum*, *Cabomba*,

Hydrilla and *Vallisneria* etc. A formulated feed was available for the ornamental fishes which have good demand even in retail shops.

Total ornamental fish produced during 2015-16 was 2560 and quantity of feed produced was 50 kg.



Pethia setanai



Gold fish

Ornamental fish seed sale (2015-2016)

| S. N. | Item | Particulars | Number sold | Revenue (₹) |
|-------|----------------|---|-------------|-------------|
| 1 | Fish seeds | Guppy, molly, platy etc | 1228 | 12280 |
| 2 | Fish seeds | Koicarp, gouramies, gold fish, sword tail etc | 790 | 11850 |
| 3 | Aquatic plants | Plants and miscellaneous | 231 piece | 2310 |
| 4 | Feed | Ornamental fish feed | 22 Kg | 4400 |

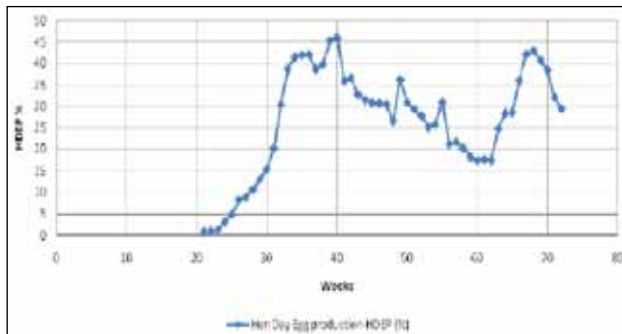


Project : Poultry Seed Project (ICAR) (R Solomon Rajkumar)

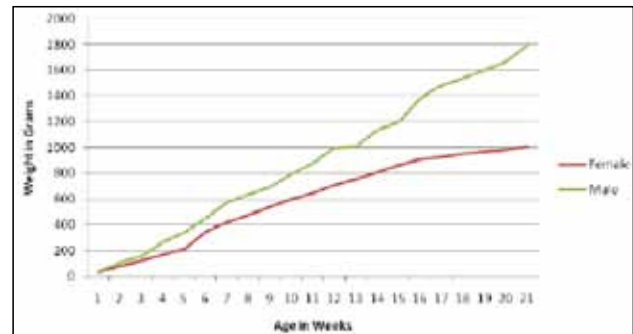
The activities of the project started with the procurement of Parent stock of *Gramapriya* day old chicks supplied by the ICAR-Directorate of Poultry Research, Hyderabad.

The Parent stock of *Gramapriya* day old chicks were cage brooded and reared under intensive system with strict biosecurity and best managerial practices. One batch of Parent Rearing had been completed. The growth

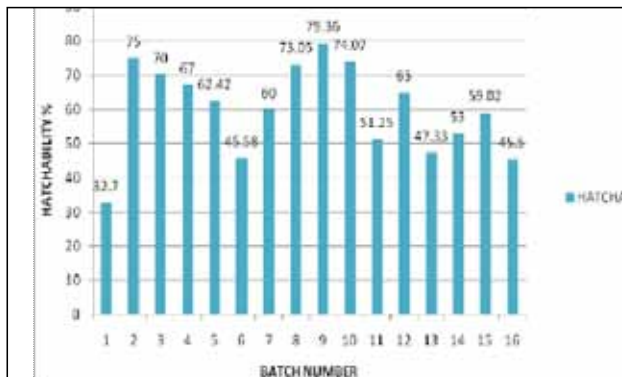
performance and the mortality pattern of the *Gramapriya* Parent stock are depicted below. The growth performance, Hen day egg production and Fertility-Hatchability pattern of the *Gramapriya* Parent stock are depicted in the Graph 1, Graph 2 and Graph 3, respectively. The average fertility of 82.6% achieved in the parent stock of Gramapriya. A total of 5624 Chicks were produced through artificial Incubation, out of which a total of 3885 Chicks were distributed to 135 farmers of Goa.



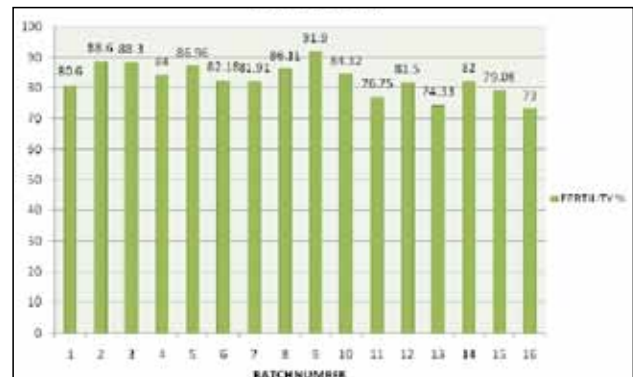
Hen day egg production (%)



Growth rate of Gramapriya parent stock (0-20 weeks)



Hatchability (%)



Fertility (%)



Chicks distributed at Ibrahimpur village



Gramapriya backyard poultry



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

Eleven accessions of *Morinda citrifolia* L. from Goa and 8 accessions of *Morinda citrifolia* L. from Maharashtra were collected and conserved at NBPGR New Delhi from the project with the following national identity (IC Indigenous collection) numbers (IC 0595272 to 0595277; 0598228 to 0598235; 0598515 to 0598516; 0612951 to 0612953). The field gene bank of all 19 accessions, one *M tinctoria* accession are being maintained at ICAR-CCARI, Old Goa farm at two locations.

The ICAR-CCARI farm currently supports 280 noni plants of 19 different accessions of Goa and Maharashtra. Characterization data for additional floral traits for pollinator preference were recorded in field noni genebank. Characterization data for fruit and seed traits were recorded in 150 additional noni plants at field planted noni germplasm at Block C.

Variation in one qualitative (pin/thrum type of gynoecium) and five quantitative traits (number of petals, length and circumference of corolla tube, number of functional and non-functional anthers were recorded in 54 surviving noni plants in first set of germplasm planted in Block B of ICAR Farm.

One variegated leaf branch was used as scion and was grafted on normal green leaf noni to maintain the periclinal variegated chimeric mutant of Vazare noni.

Two interspecific grafts of *M. citrifolia* taken as the stock and *M. tinctoria* taken as the scion were successfully developed. The reverse combination is also being attempted. Air Layering of the noni plants was perfected and the plants are ready for planting.

Project : Augmentation of rural pig production for socio-economic upliftment of the rural poor in Goa through artificial insemination (DBT) (EB Chakurkar)

Ejaculates were collected, evaluated and preserved on regular basis using semen extenders (NBSE/ FBSE) developed at the institute as well as commercially available semen extender (BTS and Safcell from IMV- France). During the year 2015-16, 80 semen ejaculates were collected from boars (LWY-27 ejaculates, Duroc-13, Agonda Goan- 5 and Crossbreeds- 30 ejaculates) with high quality semen, physically sound, healthy and high reproductibility prowess. After quality assesment of collected semen, 500 semen doses were prepared in different semen extenders (258 semen doses in NBSE, 63 doses in FBSE, 159 and 120 semen doses in Safcell and BTS semen extenders). One hundred seventy seven artificial

inseminations were carried during 2015-16 out of which 90 in institute pig farm and 87 A.I at 20 different farmer's field. Conception rate of 60% was recorded at institute pig farm after 34 pigs delivered and 20 more being confirmed as pregnant after diagnosis with ultrasonography. In the Farmers field conception rate of artificial insemination was 75.86%. Average live litter size of piglet was 7.23 ± 0.32 in institute pig farm where as it was 7.83 ± 0.86 in farmers feild. National Training Program on Artificial Insemination in Pigs was organized from 24th to 26th October 2015 for professionals. Two Crossbreed Pig Production units has been established at farmer's field one in North Goa District and One in South Goa district.



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

Under the financial assistance of NFDB demonstration, trails were carried out on coastal aquaculture systems like mussel culture and multispecies culture systems with the technical

support and guidance from the institute. On farm trainings and demonstrations (4 units) were conducted for the transfer of these aquaculture technologies with the help of NFDB.



Rack structure



Harvested mussels

Project : Coconut production statistics survey at Goa (CDB) (V Arunachalam)

In North Goa district of Goa, 5 taluks were identified for the survey viz., Bardez, Bicholim, Tiswadi, Ponda, Sattari. In South Goa district, Salcete, Sanquem, Quepem, Marmugoa, Canacona and Darbandora taluks are the 5 taluks identified for the survey.

About 100 holdings with 40 palms and above were studied during the survey work. In each holding, nuts, buttons in each of the bunch of ten randomly selected palms were counted manually by engaging climber.

The production is estimated by multiplying the area (2013-14) with the average productivity per hectare.

Estimates for the year 2015-16 related to Goa state

| Item | Estimate |
|--------------------------------|----------|
| Productivity per ha | 10074 |
| Productivity per palm | 69 |
| Palm density per ha | 158 |
| Average farm size (ha) | 0.59 |
| Number of bearing palms per ha | 146 |
| Percentage of bearing palms | 92 |

Estimated production of coconuts for the year 2015-16

| Location | Area in hectares | Production (million nuts) |
|-----------|------------------|---------------------------|
| North Goa | 11379 | 81 |
| South Goa | 14371 | 164 |
| Goa | 25750 | 245 |



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

Variation in leaf colour in the selected amaranthus genotypes was evaluated using CIE L*,a*,b* values initially used to screen a set of cultivars/accessions 5 green, 5 intermediate and 14 red leaf color genotypes and 2 released cultivars. Betacyanin content was measured using spectrophotometer in the leaves of 14 genotypes. A potential betacyanin pigment rich (416.26±19 microgm/gm fresh weight) genetic stock (IC-598190) was identified. It was superior to Arka Arunima a released red amaranth variety with 314.89±22 microgm/gm fresh weight of betacyanins. The potential of betacyanin rich amaranth IC-598190 in food pigment industry is emphasized.



Incomplete dominance of red leaf color in Amaranthus tricolor

Pepper

A block of Panniyur-5 black pepper plants were established with glyricidia support in coconut garden in 2011. Three of them had a compact canopy and early and high yields. P5-3 is an open pollinated seedling progeny and is multiplied by cuttings.

A replicated experiment was initiated with the progenies of above three clonal selections of Panniyur-5 plants with local check Canacona with two live supports viz. noni and glyricidia in

block B. 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. All the piper plants in these experiments were evaluated using height and length of vine and eight vegetative DUS traits.

A new mutant was identified in black pepper with lobed leaf shape in the eight progenies of Panniyur-5. Cuttings are raised for rooting from the selected mutant plants for further analysis.



Leaf shape mutation in Black pepper -Panniyur-5

Generation of quality planting materials

Planting material of the following major crops were generated and the number sold during the period under report is listed as table below.

| Crop | Propagule | Number sold |
|--------------|----------------|-------------|
| Coconut | Seedling | 33 |
| Black pepper | Rooted cutting | 86 |
| Pine apple | Sucker | 80 |
| Arecanut | Seedling | 51 |



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

Evaluation of gerbera under polyhouse

Thirteen varieties of gerbera were evaluated under naturally ventilated polyhouse for cut flower production. The flower stalk length was highest in Dune (79.20cm) followed by Goliath (74.20cm). The lowest stalk length was recorded in Shimmer (52.65cm). With respect to flower diameter, Dana Ellen recorded the highest value (12.13 cm) and smallest flower was observed in Shimmer (9.51 cm). The average flower production per plant ranged from 38.45 (Pre Intense) to 51.25 (Malibou) per year.



Dana Ellen



Malibou

Evaluation of capsicum hybrids under polyhouse

Two commercial capsicum hybrids viz., Bachata and Massilia were planted under naturally ventilated polyhouse for coloured capsicum production. The cumulative yield per plant was highest in Massilia (1.95kg) followed by Bachata (1.45kg). The average individual fruit weight ranged from 180g to 275g.



Massilia-Bachata

Evaluation of Orchid varieties under shadenet house

Six varieties of Orchids viz., Sonia (Purple), 5N (White), Charming white (White and Red), Sonia Earsakul (Red, Purple and White), Mona Red DC-0666 (Red) and Airy Red Bull (Red) were planted for an evaluation trial under shade net house. The highest spike length was recorded in Airy Red Bull (59.52cm) followed by Sonia Earsakul (54.60cm). The highest number of florets was recorded in Sonia Earsakul and Charming White (15.80) followed by 15.40 in Airy Red Bull.



Airy Red Bull

Evaluation of Gladiolus varieties under open field

Out of nine varieties of gladiolus evaluated under open condition, the highest spike length (72.20cm) was recorded in Summer Shine which was closely followed by Souvenir Yellow (70.00cm). But the number of florets per spike was highest in Souvenir Yellow (14.00) followed by Summer Pearl (12.20). In general, days to first flowering ranged from 68 to 75 days from sowing.



Souvenir Yellow- Summer Shine-Summer Pearl



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

Collection and conservation of germplasm in major vegetable crops

In major vegetable crops, local accessions were collected for evaluation and multiplication Red Amaranthus (28), Green Amaranthus (5), Chillies (21), Okra (14), Pumpkin (3), Broad bean (1), Cucumbers (7), Snap melon (5), Vegetable cowpea (15), Brinjal (7), Bottle gourd (4), Ridge gourd (7), Cluster beans (3), Snake gourd (2) and Onion (2)

Evaluation of Amaranthus accessions for yield and seed production

Thirty six accessions of amaranthus comprising of red, green and white types is being evaluated for yield and other traits. The earliest flowering was noticed in Amar 14-76 Warkhand (27 days) which is not a desirable traits for leafy

type amaranthus. Amaranthus accessions like Amar 10-44 Gulem, Amar 12-58 Arlem took 68 days for first flowering. The highest leaf length was recorded in Amar 04-2015 Karmali (1996cm) followed by Amar 5-25 Bendurdem (13.08cm).



Diversity in Amaranthus for leaf characters

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

Papaya seedlings of variety Arka Prabhat and Co-8 have been planted in main field during 2nd week of Jan 2015. There was a severe incidence of PRSV and Lethal yellowing, which lead to death of 60% of the population. The trial is being continued. Field trial has been laid out with dripline and fertigation facilities. High density planting with TC plants and conventional suckers of local varieties has been done in May, 2015. The study is under progress. Pineapple suckers of variety Giant Kew have been planted in trenches in May 2015. Flowering has initiated in the suckers. Demonstration plots of banana and pineapple have been laid out in Gondongrim. Similarly, demonstration plot on banana has been laid out in Aldona village. Advanced technologies like, tissue culture plants, drip irrigation, nutrients through fertigation, bunch

covers, plant protection measures, use of *Trichoderma etc* have been taken to these farms. Inputs like water soluble fertilizers, normal fertilizers, manures, plant protection chemicals *etc* have been procured with the allotted budget. The required material is being sent to farmers' fields as and when required.



Field view



Mortality in Papaya



Project : Empowering farmers of Goa for adoption of low cost polyhouses through training and demonstration (RKVY) (Mathala Gupta)

Demonstration of cucumber, tomato, and capsicum under double and single span polyhouses was done to the farmer beneficiaries visiting the facility. Also the farmers and their trainers *i.e.* officers of state agril. Department were educated about the structures operation and maintenance and the modifications possible to improve their existing structures.

Tomato crop experiments

During 2015, four varieties of tomato *viz.* Abhinav (F₁) (Syngenta), Ruhi (F₁) (Known-You Seed, Sikinder (F₁) (Semillas Fito India Ltd), Red Beauty (F₁) (Sakata) were grown. But by start, the plants started showing symptoms of various diseases like bacterial wilt, Stem canker *etc.* In Ruhi, Red Beauty, Sikinder and Abhinav the percentage dead and sick plants were 42.59%, 69.44%, 68.75% and 18.75% respectively. Hence, the trial was discontinued.

Based on previous study it was decided to standardise production practices for the relatively less susceptible tomato variety Abhinav (F₁) of Syngenta. The treatments were mulch and no mulch and distance from vents and mixer fans. Since the experiment was basically to see if the plants could be kept alive and healthy for the whole crop period of 5-6 months. Initially by first week of December high mortality of plants due to bacterial wilt was seen in the mulched beds 22.57% as compared to 4.86% in non-mulched beds. The demonstration is under progress.



Tomato crop experiment

Cucumber crop experiments

Three varieties of cucumber *viz.*, Hilton, Infinity and Mini Angel were directly seeded in the single span naturally ventilated polyhouse. Except for slight incidence of Leaf spot, blight, fruit drop, and aphids, the crop performed well though the period of crop was for three months after which blight problem was severe. The yield of the varieties were Hilton (7.7 kg/sq.m), Infinity (5.8 kg/sq.m), Mini Angel (5.65 kg/sq.m).



Cucumber crop experiment

Based on preference in Goa market for crisp fruits of cucumbar Kian (F₁) of Nunhems seeds Pvt. Ltd., was chosen for standardization of package of practices. The seeds were directly sown and the crop performed satisfactorily except for minor incidence of leaf blight, powdery mildew, fruit drop and aphids. The yield achieved was 7.66 kg/sq.m (50 X 40 cm spacing) with per plant fruit yield varying from 1.35 – 2.20 kg.

Capsicum crop experiments

This year Seedlings of three varieties of Capsicum, Red Queen (F₁), Yellow Queen (F₁), Asha (F₁) were grown in the double span polyhouse to study their suitability for cultivation in Goa. But the crop faced severe attack of thrips, mites, blight, powdery mildew and bacterial wilt and hence, the experiment was terminated.



Project : Production and supplementation of bypass fat to dairy animals for enhancement of milk production and livelihood security of dairy farmers of Goa (RKVY)
(EB Chakurkar)

Under this project, 9861 Kgs of bypass fat was produced and 6090 kgs were sold to farmers from Goa, Hyderabad and Nagpur. Field trial of bypass fat feeding was undertaken in four dairy units where material was provided under TSP. Farmers expressed happiness about the product as they could get better price for the milk due to high fat content. Three training programs were conducted on 30th June 2015, 5th September 2015 and 4th February 2016.



Production of bypass fat

Project : Training, demonstration and research on hydroponic green fodder production (RKVY)
(EB Chakurkar)

Under this program, total of 51,941.2kg biomass was produced from 14,296.8 kg maize seeds. Training program of National level was organized on 29th June 2015 where more than 60 participants attended the training. A Low cost Hydroponic Unit is established at the institute and data of performance of unit with respect to the amount of green fodder yield per kg of seed, humidity and temperature of the unit for one year is recorded.



Production of hydroponic green fodder

ICAR-CCARI, Goa

Annual Report 2015-16

INSTITUTIONAL ACTIVITIES

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



Transfer of Technology

TRIBAL SUB PLAN

Demonstration of a soil testing kit at Krishi Melava at Cancona and Pernem

The Institute has participated in the Krishi Melava of Goa at Canacona (2nd June 2015) and Pernem (4th June 2015). A demonstration on soil testing kit – PUSA STFR Meter was given to the farmers for rapid soil analysis at village level. The demonstration was jointly carried out by ICAR-CCARI and KVK, Old Goa. The portable PUSA STFR meter is capable of analyzing soil pH, EC, organic carbon, phosphorus, sulphur, boron and zinc and recommending fertilizers for selected crops. The five kits was distributed to five tribal SHGs of Goa. Selected farmers were trained for analyzing the soils using kit. The aim of the demonstration and awareness programme on the soil testing kit is basically to reach larger number of farmers at village level and to ensure the balanced nutrient application to different cultivated crops.



Front Line Demonstrations (FLD) on turmeric (Pratibha) and ginger (Garo and Nadia) at Santa Cruz

FLDs on cashew and Mango established by Taleshir SHG of Bhars village under TSP programmes were monitored. The group produced 12 tons of turmeric seed rhizomes of the variety Pratibha. Farm inputs, fertilizers, micronutrients and plant protection chemicals, brush cutters and power sprayers were provided to the deserving Self Help Groups of tribal farmers in Cancona

zone. Six tons of turmeric seed rhizomes were provided to the tribal farmers for expanding the turmeric area in the tribal area of Cotigao village of Cancona zone.



Farm inputs Distribution at Cola village in South Goa

Under the TSP project, a programme on farm inputs distribution to tribal farmers was organised on 4th April, 2015 at Cola village, South Goa. The farm inputs viz. power tillers with all accessories, power sprayers, brush cutters, fertilizers and agrochemicals were distributed to six self-help groups of tribal farmers.

Programme was chaired by Shri. Narendra Sawaikar, Hon'ble Member of Parliament, South Goa. He appreciated the institute for its dedicated work for Goa while pointing out to the farmers that they should utilize the inputs and expertise of Scientists for agricultural development of their areas. The chief guest of the function was Dr. Alok Kumar Sikka, Hon'ble DDG (NRM), ICAR, New Delhi. He interacted with tribal farmers and asked them what are all the agricultural inputs are required for better farming. He also requested the beneficiaries to maintain, share and utilize the equipment's properly. The function was presided by Dr. Narendra Pratap Singh, Director, ICAR– Central Coastal Agricultural



Research Institute. He gave a background about the Tribal Sub Plan programmes of the institute during the past three years for tribal farmers of Goa. Scientists, PC, In-Charge, KVK and other staff of ICAR-CCARI participated in the event.



Distribution of fishing gear materials and safety devices to tribal fishermen along Zuari estuary

A programme on “Distribution of eco-friendly fishing gears and safety devices” under TSP project was organised by ICAR-CCARI at Shree Shantadurga Fishermen Association, Cacra on 13th April, 2015. Fishing gear (gillnet) materials and life jacket floats were distributed among the tribal fisher-folk of Nauxim, Cacra and Odxal. Dr. Narendra Pratap Singh, Director, ICAR-CCARI welcomed the gathering and briefed about the research and extension activities of the Institute. He mentioned about the Tribal Sub Plan programme of Govt. of India and how the fishermen and farmers can be benefitted through the project. While inaugurating the distribution of materials. Hon’ble Minister for Environment and Forest, Govt. of Goa, Smt. Alina Saldanha



appreciated the efforts of ICAR-CCARI for improving the livelihood of fishermen and farmers through their research and extension services. Dr. A. K. Vasisht, Assistant Director General (PIM/ESM) and Dr. Shamila Monteiro, Director of Fisheries, Govt. of Goa were present during the function. The occasion was blessed with the presence of Sarpanchs and members of Taligao, Curca, Bambolim and St. Cruz.

Soil testing and fertilizer recommendation using PUSA STFR meter

The year 2015 has been declared as ‘International year of soil’ by food and Agricultural Organization, Rome, Italy considering the paramount importance of soil. As a part of celebrating International Year of soil, a one day program on ‘Soil testing and fertilizer recommendation using PUSA STFR meter under TSP was organized on 25th May, 2015. Dr. Narendra Pratap Singh, Director, in his inaugural address, emphasized on the use of the kit for soil health management and employment generation. The portable PUSA STFR meter is capable of analyzing soil pH, EC, organic carbon, phosphorus, sulphur, boron and zinc and recommending fertilizers for selected crops. The five kits will be distributed to five ST SHGs of Goa. Selected farmers were trained for analyzing the soils using kit. The training was attended by farmers and official soil testing laboratories of the Department of Agriculture, Govt of Goa. The farmers themselves analyzed soil simultaneously during the training. By making use of the PUSA STFR meters farmers can get the soils analyzed and fertilizer recommendation in the village in





a very short span of time. Additionally, it will generate employment opportunities for rural youth.

Awareness cum training programmes to tribal farmers of Goa on Value addition in Jack fruit and kokum

Under the TSP aided programme on 'Empowering Tribes of Goa with post harvest machinery for processing and value addition in minor fruits' a series of five training programmes on Value addition in jack fruit was conducted for tribal farm women in villages like Cotigaon and Surla by Dr. S. Priya Devi and S. Talaulikar. The first training was conducted at Cotigaon (Ward: Yeda) on 10th June, 2015, in which 40 farm women participated. The other four training programmes were conducted in Surla, the village adopted under *Mera Gaon Mera Gaurav* Programme. Initial awareness trainings were conducted in four wards in a series. The first programme was conducted in Ward Khodgine, with 15 participants, in the residence of Namdev Khodginkar, on 24th June, 2015. The second training programme was conducted in Ward Ghadiwada (20 participants) at Community Hall on 27th June, 2015. The third training was conducted in Ward Bayem, with 28 participants, at Sports Club Building on 3rd July, 2015. The fourth training was conducted in Ward Deulwada, at MP Hall, on 13th July, 2015, with 29 participants. A recipe competition was also held for items made exclusively from jack fruit. Various items like jack fruit puree, jack fruit *halwa*, jack pickle, jack chips, jack *bhaji*, and jack seed *payasam* were demonstrated during the five different trainings, for a total of 133 women.



Distribution of Turmeric rhizomes at Cotigao

A programme on turmeric rhizomes distribution to tribal farmers was organised on 11th June, 2015 at Cotigao village, Canacona, South Goa District. The function was chaired by Dr. Narendra Pratap Singh, Director, ICAR–Central Coastal Agricultural Research Institute. He interacted with tribal farmers and asked about their requirements for doing better farming. Six tonnes of turmeric rhizomes were distributed to 30 farmers and they are going to plant an area of 4 ha. More than 60 farmers participated in this programme. Cotigao panchayat president Mrs Meena Gaonkar were also present in this programme.



Distribution of agricultural and animal husbandry inputs to the farmers

Shri. Narendra K Sawaikar, Hon'ble MP (South Goa) distributed power sprayers, grass-cutting machines, fertilizers and by-pass fat to 40 tribal farmers under Tribal Sub Plan on 5th September, 2015 at the Institute. Dr. Narendra Pratap Singh, Director requested the farmers to make use of the inputs. Dr EB Chakurkar, Head, Animal Sciences





and Dr AR Desai, Senior Scientist (Horticulture) detailed various technologies to the farmers for better yield and returns. Scientists and technical staff were present during the function.

Training programme on fresh water aquaculture

A one day training programme on “Freshwater Aquaculture” sponsored by Tribal Sub Plan, Govt. of India was organised by ICAR-CCARI in collaboration with ICAR-CIFE, Mumbai on 27th November, 2015. The training covered deliberations on the technical aspects of scientific freshwater fish culture. Dr. V. K Tiwari, Principal Scientist, Aquaculture Division, ICAR-CIFE Mumbai was the key speaker and co-ordinator of the training programme. A total of 23 tribal fishermen from different parts of North and South Goa participated in the programme.



Two day training programme on mushroom production technology

Two day training programme on Mushroom Production Technology was organized on 6th to 7th January, 2016 at KVK North Goa in collaboration with ICAR-CCARI, Old Goa and Directorate of Mushroom Research, Chambaghat, Solan for the benefit of tribal farmers.

Inaugural session was addressed by Dr. Narendra Pratap Singh, Director, CCARI and Dr. V.P. Sharma, Director DMR, Solan. Programme covered lecture cum demonstration on different aspects such as production technology of oyster, button and paddy straw mushroom, spawn production, compost production of white button mushroom *etc.*



Training programme on power tillers and other agro machinery: operation and maintenance

A three day training programme on operation and maintenance of power tillers and other agro machinery was co-ordinated and organised by Dr. M. J. Gupta during 4th to 6th February, 2016 in Gaodongrim, Shristhal and cola villages for tribal farmers, youth and agro machinery operators. Hands on use of power tillers and all attachments with special training on use of cultivators, mould board plough and Htp pump for tillage, inter cultivation in orchards and use for spraying in plantation crops, mini rotary tillers and brush cutters. The participants were also trained on maintenance and servicing needs of these machinery. The common mistakes in handling on these machinery and the ill-effects of the same were elucidated by the various service engineers and experts from the company headquarters in Bangalore, Mumbai *etc.* The service providers assured the beneficiaries and villagers of better and timely servicing and ready availability of spare parts for their machinery.





Distribution of fishing gear materials and ropes to tribal fishermen along Zuari estuary

A programme on “Distribution of eco-friendly fishing gears and ropes” was organised at ICAR-CCARI, Old Goa on 15th February, 2016. Sustainable ecofriendly fishing gear (gillnet) materials (300 kg) and ropes (200 kg) were distributed among thirty tribal fisher-folk of Nauxim, Cacara, Odxal and Siridao. Dr. Narendra Pratap Singh, Director, ICAR-CCARI welcomed the gathering and briefed about the research and extension activities of the institute. While inaugurating the function, Secretary (Fisheries), Govt. of Goa, Shri. Amjad Tak, IAS appreciated the efforts of ICAR-CCARI for improving the livelihood of fishermen and agricultural farmers through their research and extension services. There was series of publications (Book- “Goan Sea Food Recipes” and Posters on Fisheries Resources of Goa) released from ICAR-CCARI during the function.



NERA GAON NERA GAURAV

On-field training cum demonstration on advanced cultivation practices in flower crops

As part of “Mera Gaon Mera Gaurav” programme, discussions were held with farmers regarding the intervention in Floriculture. Involved in transfer of technology in Surla village, Bicholim Taluka for “Mera Gaon Mera Gaurav” programme. Demonstration plots were laid out at different

locations of farmer’s field in Surla village at Bicholim taluka comprising six different rose varieties viz., Babe, Yunitta, Rubecon, Odelia, Suntan and Vanessa. The investigation was carried out to assess the performance of the improved cultivars of rose for loose flower purpose under agro climatic conditions of Goa. The crops are performing well and the farmers expressed their satisfaction and happiness about the kind of support given by ICAR-CCARI. An On-Field Training cum Demonstration on Advanced Cultivation Practices in Flower Crops was organised under this programme on December 29, 2015 at Surla village, Bicholim Taluka, Goa. Farmers were requested to use the opportunity to update their knowledge about flower crops and adopt improved technologies in cultivation of flower crops for livelihood enhancement.



Training on women empowerment through ornamental fish farming and economic dairy production

A training programme on Women Empowerment through Ornamental Fish Farming and Economic Dairy production under “Mera Gaon Mera Gaurav” programme was organised on 12th January, 2016 at Ibrahimpur Village, Goa. Training was co-ordinated by Jan Shikshan Sansthan, Goa. About 35 women from the village actively participated in this programme who are interested in Ornamental fish breeding and



calf management. The training ended with visit to farmer's field at various locations in Ibrahimpur.

Training programme on advances in production technology of Banana

A field level training programme on advances in production technology of banana was conducted by ICAR-CCARI, Goa on 19th February, 2016 at Ibrahimpur village of Pernem Taluka as part of the 'Mera Goan Mera Gaurav programme'. The objective of this programme was to introduce the advanced technologies in banana production to the farmers with the help of audio-visual aids. The director of the institute Dr. Narendra Pratap Singh inaugurated the training. Distribution of banana suckers and vegetable seeds to the farmers was also done after the programme.



Training programme on Entrepreneurship development through Value addition in floral products

A training programme on entrepreneurship development through value addition in floral products for farm women, housewives and unemployed youth was held on 27th February, 2016. The training programme was organised under "Mera Gaon Mera Gaurav" programme, in collaboration with Surla Farming Co-operative Society at Temple Hall, Devulwada, Surla, Goa. The deliberations included presentation on "Value addition in floral products" followed by method demonstration. Dr. Safeena S.A. trained the participants on dry flower technology and flower arrangement techniques. In practical session, participants were taught the techniques of dry flower making, potpourri making, use of pressed flowers and foliages in designing of book marks, greeting cards, photo frames, flower arrangements etc.





Intellectual Property Rights (IPR) Cell

Activities

- A provisional application for patent for technology entitled “Process for preparing cashew apple crunch and resultant food product thereof” was submitted to patent attorney Inventillect Consultancy Services Pvt. Ltd., Pune. The same has been recorded by the Indian Patent Office on 8th April, 2016 (“Priority Date”) at the application serial No. 201621012413.

- A provisional application for patent for technology entitled “Process for preparing Nutmeg Taffy and resultant food product thereof” was submitted to patent attorney Inventillect Consultancy Services Pvt. Ltd., Pune. The same has been recorded by the Indian Patent Office on 8th April 2016 (“Priority Date”) at the application serial No. 201621012414.

- Application for filing of provisional patent application for technology entitled “Extender for Preservation of Boar Semen” has been recorded by the Indian Patent Office on 11th August, 2015 (“Priority Date”) at the permanent serial No. 3037/MUM/2015 and further procedure is under process.

- An application for technology entitled “Process For Fermentation of Cashew Apple Juice Using Microbial Consortium” (Patent No. 150/MUM/2014) has been published in the official journal of the Indian Patent Office on 28th August 2015.
- 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. The application has been admitted before the Copyright Office at the Sr. No. 5028/2015CO/SW.
- Two bacterial strains cultures viz. *Bacillus methylotrophicus* RCh6-2b and *Bacillus methylotrophicus* STC-4 has been deposited NAIMM, Mau and assigned the following accession no. NAIMCC-B-01889 and NAIMCC-B-01890 under the technical expertise of Dr. R. Ramesh, Sr. Scientist (Plant pathology).
- A local Pig breed “Agonda Goan Pig”, was registered with NBAGR, Karnal, Haryana, with registration no. INDIA_PIG_3500_AGONDAGOAN_09003 on 6th January, 2015 under the technical expertise of Dr. E.B. Chakurkar, Principal Scientist, (Animal Reproduction & Gynaecology).
- Process for commercialization of the Institute Technology viz. “Technology for production of bypass fat indigenously” has been initiated with a dairy farmer (Mr. Devendra Saju Shilkar, Goa).



MoU / MTA Signed

- A memorandum of Understanding (MoU) was signed between ICAR-Central Coastal Agricultural Research Institute (ICAR-CCARI), Old Goa and DIVEGOA, a private recreational diving training centre, Panjim Goa on 30th September, 2015. This MoU is signed for fostering research and development activities in the area of fisheries science and marine habitat on Public Private Partnership (PPP) mode for mutual benefits.
- A Material Transfer Agreement (MTA) was signed between Indian Institute of Vegetable Research (IIVR) Varanasi, and ICAR- Central Coastal Agricultural Research Institute, Goa on 9-11-2015 for procurement of germplasm *viz.* Brinjal Seeds for research purpose.



Meetings held

- Four meetings of Institute Technology Management Unit (ITMU) and one Institute Germplasm Identification Committee (IGIC) were convened during the year 2015-16 to discuss various IPR related issues in the Institute

Programmes conducted

- Facilitated Awareness programme on “Protection of Plant varieties and farmers Right act 2001” organized by KVK, North Goa conducted at this Institute on 22nd March, 2016. Member Secretary, Dr. A.R. Desai, Sr. Scientist (Hort.) & IPR cell co-ordinator made a detail presentation and briefed the farmers about the PPV &FR act-2001 and also apprised them about the plant genome savior farmer reward/recognition and Plant Genome Savior Community Award that are offered by the PPV & FR Authority, New Delhi.





Education and Training

Education

R Ramesh

- Guided Ph.D student of Goa University, Taleigao Plateau, Goa on the topic “*Ralstonia solanacearum* in eggplant: Diversity, virulence and factors influencing its survival in soil” Degree awarded - April 2015.

MThangam

- Acted as External Examiner to conduct the final viva-voce examination of Ph.D. students of Tamil Nadu Agricultural University, Coimbatore.
- Evaluated the Ph.D. (Hort) thesis of Tamil Nadu Agricultural University, Coimbatore.
- Evaluated the M.Sc. (Hort) thesis of Tamil Nadu Agricultural University, Coimbatore.

Sreekanth GB

- Member of the advisory committee of Mr. Prem Singh Prajapat for his MFSc. Dissertation in Fisheries Resource Management division, ICAR-CIFE, Mumbai entitled “A study on the biology of white sardine (*Escualosa thoracata*) along Goa coast of India”.

Manju Lekshmi N

- Member of the advisory committee of Ms. Anjali P Tilakan for her MFSc. Dissertation in Aquatic Environmental Management Division, ICAR-CIFE, Mumbai entitled “Effect of biofloc on water quality and growth performance of *Eetroplus surtensis*”.

Lectures delivered by the Scientist

| Date | Lecture Topic/Programme | Participants | Venue |
|----------------------|---|---------------------|---|
| V Arunachalam | | | |
| 04-01-2016 | Maturity indices in harvesting of fruit crops | Students | Goa University Dona Paula |
| AR Desai | | | |
| 06-10-2015 | Multistoried cropping system in horticulture Crops under coastal agro-ecosystem | Trainees | College of Horticulture (UHS), Sirsi, Uttara Kannada, |
| 22-03-2016 | Provisions of protection of plant varieties & farmers' rights Act, 2001. | Farmers | KVK, ICAR-CCARI, Old Goa |
| 28-03-2015 | Principles and methods of fruit preservation | Students | Department of Botany, Goa University, Taligaon Goa |
| M Thangam | | | |
| 30-09-2015 | Kitchen gardening | Progressive Farmers | Surla, Sattari, Goa |



| | | | |
|----------------------|---|-----------------------------|--|
| 11-03-2016 | Improved methods in Chilli cultivation | Farmers | Shrital, Canacona |
| 29-03-2016 | Advances in vegetable production | Farmers | ICAR- CCARI, Old Goa |
| 30-03-2016 | Protected cultivation of vegetable crops | Officers | SAMETI, Old Goa |
| R Ramesh | | | |
| 10-08-2015 | Management of diseases through root feeding | Farmers | KVK, ICAR-CCARI, Old Goa |
| 11-03-2016 | Diseases of chilli and their management | Farmers | Shristal, Canacona |
| 21-03-2016 | Diseases of chilli and their management | Farmers | Salgini, Netravali, Sanguem |
| 14-03-2016 | Post harvest diseases of fruits and their management | Students | Department of Botany, Goa University |
| 30-03-2016 | Diseases of chilli and their management, and grafting technique in brinjal for bacterial wilt management | Farmers | ICAR-CCARI, Old Goa |
| S Priya Devi | | | |
| 06-06-2015 | Medicinal plants for household' to urban | Farmers | KVK, North Goa, Old Goa |
| 07-12-2015 | Scope of post harvest value addition in fruits like kokum and jack fruit | Tribal farmers | SAG Ground, Canacona, Goa |
| 10-12-2015 | High density planting in fruit crops | Farmers and Officers | ICAR-CCARI, Old Goa |
| Mathala Gupta | | | |
| 05-10-2015 | Agriculture : Attracting Youth ? | Students | Annapoorna Institute of Management Research, Sankeshwar, Karnataka |
| 25-01-2016 | Methods of storage of fruit crops | Students | Department of Botany, Goa university |
| 08-02-2016 | Modified Atmospheric storage (MAS) and Packaging. | Students | ICAR-CCARI, Old Goa |
| 05-03-2016 | Greenhouse for higher income | Trainees | Govt. High School, Shelop Khurd, Satttari, Goa |
| 12-03-2016 | Successful Cultivation under Protected Cultivation Structures in Goa | Farmers | KVK, South Goa, Margao, Goa |
| 17-03-2016 | Scope of Engineering in agriculture | Students | Department of Mechanical Engineering, PCCE, Verna, Goa |
| 30-03-2016 | Structural design of polyhouses for local condition, Greenhouse Environment management and Soil sterilization, plastic mulching, fertigation, irrigation under greenhouse | State Agricultural Officers | SAMETI training hall. Ela, Old Goa |



| Safeena SA | | | |
|--------------------------|--|---|---|
| 19-10-2015 | Diversification in floriculture for commercialisation | Students, Progressive farmers and Officers | ICAR-CCARI, Old Goa |
| 12-11-2015 | Importance of medicinal plants in kitchen garden | Farmers | KVK, North Goa, CARI, Old Goa |
| 29-12-2015 | Adoption of advanced practices in flower crop cultivation | Farmers | Surla, Bicholim, Goa |
| 27-02-2016 | Value addition in floral products | Farm women, housewives and unemployed youth | Surla, Bicholim, Goa |
| R Maruthadurai | | | |
| 11-03-2016 | Integrated pest management of chilli insect pests | Farmers, Agriculture officers | Shristal, Canacona |
| 30-03-2016 | Integrated pest management of insect pests of chilli and other crops | Farmers | ICAR -CCARI, Old Goa |
| GR Mahajan | | | |
| 08-09-2015 | Soil health management and soil testing | Trainees | Directorate of Education, Porvorim, Goa |
| 06-10-2015 | Soil testing | Students | LHBD, Govt. High School. Thane, Sattari, Goa |
| 11-10-2015 | Importance of soil testing, soil health, fertilizer use | Farmers | Kelbiwada, Curti, Ponda, Goa |
| 27-02-2016 | A session on soil science | Students | Ramanata Crishna Pai Raikar School of Agriculture, Savoi-Verem, Goa |
| Shivasharanappa N | | | |
| 14-10-2015 | Importance, advances of goat farming and status of goat farming in Goa and goat breeds suitable for coastal region | Farmers | ICAR -CCARI, Old Goa |
| 15-10-2015 | Nutrition and feeding management of goats and common diseases of goats and their management | Farmers | ICAR -CCARI, Old Goa |



| R Solomon Rajkumar | | | |
|---------------------------|---|----------------------|--|
| 14-10-2015 | Hygienic goat meat production, value addition and marketing | Farmers | ICAR -CCARI, Old Goa |
| 19-12-2015 | Management of backyard poultry chicks, growers and layers | Farmers | ICAR -CCARI, Old Goa |
| 05-02-2016 | Value addition of pork and pork products | Farmers | ICAR -CCARI, Old Goa |
| Srrekanth GB | | | |
| 21-08-2015 | Ornamental fisheries sector: A general overview | Farmers and students | Field Training Centre, Dept. of Fisheries, Dhauji |
| 27-11-2015 | Scope of freshwater aquaculture in Goa | Trainees | ICAR-CCARI, Old Goa |
| 22-01-2016 | Integrated fish farming | Farmers and students | Field Training Centre, Dept. of Fisheries, Dhauji |
| Manju Lekshmi N | | | |
| 09-01-2016 | Opportunities in ornamental fish farming | Trainees | Public library Navelim Goa |
| 22-01-2016 | Value addition in fisheries | Trainees | Training Center, Dhauji |
| Chethan Kumar HB | | | |
| 27-06-2015 | Awareness on Brucellosis | Farm workers | Nandini Semen Station of Karnataka Milk Federation, Hesarghatta, Bengaluru |
| 19-12-2016 | Healthcare management of backyard poultry | Poultry farmers | ICAR-CCARI, Goa |
| 05-02-2016 | Health care management of pigs | Pig farmers | ICAR-CCARI, Goa |
| Paramesha V | | | |
| 25-03-2016 | Integrated farming systems | Students | ICAR – CCARI, Old Goa |
| Maneesha SR | | | |
| 12-11-2015 | Importance of kitchen garden and cultivation of vegetables and fruits | Urban farmers | KVK, North Goa, Old Goa |

Training programmes organized by the Institute

| SI No | Name of the Training | Venue | Period |
|-------|--|----------------------|---------------|
| 1 | Soil testing and fertilizer recommendation using PUSA STFR meter | ICAR- CCARI, Old Goa | May 25, 2015 |
| 2. | Value addition in Jack fruit | Cotigaon | June 10, 2015 |



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|-----|---|-------------------------------|---------------------|
| 3. | Value addition in Jack fruit | Khodgine, Surla | June 24, 2015 |
| 4. | Value addition in Jack fruit | Ghadiwada, Surla | June 27, 2015 |
| 5. | Hydroponic fodder production | ICAR-CCARI, Old Goa | June 29, 2015 |
| 6. | Importance of bypass fat in dairy production | ICAR-CCARI, Old Goa | June 30, 2015 |
| 7. | Value addition in Jack fruit | Bayem, Surla | July 4, 2015 |
| 8. | Value addition in Jack fruit | Deulwada, Surla | July 13, 2015 |
| 9. | Integrated nutrient management practices and management of CSRB in cashew | Gaodongruim, Canacona | September 14, 2015 |
| 10. | Scientific goat farming | ICAR-CCARI, Old Goa | October 14-15, 2015 |
| 11. | Artificial Insemination in Pigs | ICAR-CCARI, Old Goa | October 24-26, 2015 |
| 12. | Freshwater Aquaculture | ICAR-CCARI, Old Goa | November 27, 2015 |
| 13. | Canopy management in fruit crops' | ICAR-CCARI, Old Goa | December 10, 2015 |
| 14. | World Soil Day | ICAR- CCARI, Old Goa | December 12, 2015 |
| 15. | Management practices adopted in rearing backyard poultry | ICAR- CCARI, Old Goa | December 19, 2015 |
| 16. | Advanced Cultivation Practices in Fruit and Flower Crops | Surla, Bicholim, Goa | December 29, 2015 |
| 17. | Women Empowerment through Ornamental Fish Farming and Economic Dairy Production | Ibrahimpur Village | January, 12, 2015 |
| 18. | Entrepreneurship development in fisheries sector | Field Training Centre, Dhauji | January 14-22, 2016 |
| 19. | Scientific management of piggery | ICAR- CCARI, Old Goa | February 2, 2016 |
| 20. | Power Tillers and other Agro Machinery: Operation and maintenance | Canacona, Goa | February 4-6, 2016 |
| 21. | Advances in production technology of banana' | Ibrahampur, Perenem Goa | February 19, 2016 |
| 22. | Entrepreneurship development through value addition in floral products | Surla, Bicholim, Goa | February 27, 2016 |
| 23. | Grafting in brinjal for bacterial wilt management | Madgaon Goa | March 23, 2016 |
| 24. | Advanced production technologies in Horticulture | Raia, Goa | March 29, 2016 |

Awareness programmes organized by the Institute

| Sl No | Name of the Programme | Venue | Period |
|-------|---|-----------------------------|----------------|
| 1. | Diseases of chilli and their management | Shristal, Canacona | March 11, 2016 |
| 2. | Diseases of chilli and their management | Salgini, Netravali, Sanguem | March 21, 2016 |



Training and Capacity Development

| Date | Name | Programme | Venue |
|---------------------------------|--------------------|--|---|
| May 15 – August 14, 2015 | Chethan Kumar HB | Professional Attachment Training | ICAR-National Institute of Veterinary Epidemiology and Disease Informatics (ICAR-NI VEDI), Bengaluru. |
| September 7-11, 2015 | Maneesha SR | Training on Communication And Presentation Skills (CAPS) | International Centre, Dona Paula, Goa |
| September 29, 2015 | M Thangam | Training on Micro Finance | NABARD, Panaji |
| November 2 – 6, 2015 | Manohara KK | Training on Quantitative Techniques for Analysis of Breeding Experiments | NAARM, Hyderabad |
| November 11 – December 12, 2015 | Chethan Kumar HB | CAFT Training Program on Techniques for Exact Identification and Parasitic Disease Diagnosis in Domestic Animals | Department of Veterinary Parasitology, Veterinary College, Bengaluru |
| November 26 - December 16, 2015 | Shivasharanapp N | ICAR Winter School on Application of One Health Concepts for Control of Emerging Zoonoses and Health Threat | Kerala Veterinary University, Veterinary College, Pookode |
| December 3-10, 2015 | Safeena SA | Model Training Course on Value Addition and Post Harvest Management in Medicinal and Aromatic Crops | ICAR- Directorate of Medicinal and Aromatic Plants Research, Anand, Gujarat. |
| February 10-12, 2016 | Viswanatha Reddy K | Training Workshop on Competency Development of HRD Nodal Officers of ICAR. | ICAR-NAARM Hyderabad |



Awards and Recognition

Dr. V Arunachalam

- Recognized as Faculty member to guide interns under the NNMCB (National Network for mathematical and computational biology) supported by Science and Engineering Research Board, Government of India 2015-16.



Dr. R Ramesh

- Conferred Fellow of National Academy of Biological Sciences (FNABS) by the President, NABS on 22nd August, 2015 to honour the significant contributions in research, extension and academics in the field of Agriculture-Plant Pathology.



Dr. GR Mahajan

- International Plant Nutrition Institute's (IPNI) 2014 photo contest Award - Awarded second prize in potassium category in the International Plant Nutrition Institute's (IPNI) 2013 photo contest for crop nutrient deficiency symptoms.



Smt. Lizette Noronha

- Awarded the Administrative Category Employees National Award of ICAR, New Delhi at the hands of the Hon. Union Minister of State for Agriculture Dr. Sanjeev Kumar Balyan and Shri Mohan Bhai Kundariya during 87th ICAR foundation day & Award Ceremony at Sri Krishna Memorial Hall, Patna on 25 July, 2015.



ICAR-CCARI wins laurels at the ICAR Inter Zonal Sports Meet (West Zone)

- The ICAR Inter Zonal Sports Meet (West Zone) - 2015 was held at CSWRI, Avikanagar from November 2 - 6, 2015. The Institute were winners in various events:

| | |
|------------------------|-------------|
| Football | - II Place |
| Volleyball | - II Place |
| Carrom | - II Place |
| 4 x 100 mts relay race | - III place |





Ongoing Research Projects

| Sr. No. | Project Title | PI | Co – PI | Duration |
|------------------------------------|---|----------------|---|-----------|
| Natural Resource Management | | | | |
| 1. | Development and evaluation of soil and water conservation measures for sustainable production of major horticultural crops in Goa. | GR Mahajan | | 2008 – 16 |
| 2. | An economic analysis of agricultural sustainability in western coast of India | V Reddy | | 2015-17 |
| Crop Science | | | | |
| 3. | Breeding high yielding salt tolerant rice varieties for coastal saline soils | Manohara KK | | 2015 – 20 |
| 4. | Insect pest management strategies for major crops of Goa region | Maruthadurai R | AR Desai | 2012 -16 |
| 5. | Plant disease management by bacterial, fungal agents and other non- conventional methods under coastal ecosystem | R Ramesh | | 2011 –16 |
| 6. | Monitoring and study on the incidence of diseases and insect pests in protected cultivation | R. Ramesh | Maruthadurai R | 2015-17 |
| Horticultural Science | | | | |
| 7. | Allele mining of banana genome sequences for genetic improvement | V Arunachalam | | 2014 -17 |
| 8. | Collection, evaluation and management of fruit and spices | AR Desai | S Priya Devi, Maneesha SR and V Reddy | 2011 – 16 |
| 9. | Survey, collection, evaluation and management of under utilized fruits of coastal region | S Priya Devi | | 2013 -18 |
| 10. | Standardization and validation of Precision Farming Technologies (PFT) for major vegetable crops under climatic conditions of Goa | M Thangam | Safeena SA | 2013 – 17 |
| 11. | 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 |



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|-------------------------|--|--------------------------------------|--|-----------|
| 12. | Design of protected cultivation structures for year round utilization in Western region | MJ Gupta | | 2011-16 |
| 13. | Development of good agricultural practices through integrated nutrient management for sustainable fruit production in coastal regions of India | Maneesha SR | Mahajan GR | 2015-18 |
| Animal Sciences | | | | |
| 14. | Economic milk production under climate change scenario | SK Das (upto November, 2015) | | 2013-15 |
| 15. | Preparation / formulation of boar semen extender and pre insemination fluid for artificial insemination in pigs | EB Chakurkar | | 2014 - 17 |
| 16. | Enhancing livestock performance by using advanced managerial and health interventions at Institute livestock farms | EB Chakurkar | SK Das, Shivasharanappa N, RS Rajkumar, Susitha Rajkumar & Chetan Kumar HB | 2015 - 18 |
| 17. | Evaluation of Srinidhi Chicken performance under different rearing systems | K Muniswamy (Upto December, 2015) | | 2014 - 16 |
| 18. | Analysis of rural backyard poultry based livelihood alternatives in west coast of India | RS Rajkumar | | 2015 -17 |
| 19. | Epidemiological surveillance of economically important disease of dairy animals in west coast | Susitha Rajkumar | Shivasharanappa N | 2015-18 |
| 20. | Patho - epidemiology and health interventions of goat diseases in west coastal India | Shivasharanappa N | Susitha Rajkumar | 2015-18 |
| 21. | Prevalence of swine associated zoonotic parasitic diseases in Indian west coast | Chethan Kumar HB | Rajkumar S | 2015-17 |
| Fishery Sciences | | | | |
| 22. | 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 |
| 23. | Development of coastal mariculture in brackish water areas of Goa | N Manju Lekshmi | GB Sreekanth | 2013 - 16 |



AICRP Main Centres

| Sr. No | Project Title | PI | Co-PI |
|--------|---|-------------------|-------------------------------------|
| 1. | All India Co-ordinated Research Project on Cashew | AR Desai | |
| 2. | All India Co-ordinated Research Project on Pig | EB Chakurkar | |
| 3. | All India Co-ordinated Research Project on Integrated Farming Systems | NP Singh | Mahajan GR |
| 4. | All India Co-ordinated Research Project on Vegetables | M Thangam | |
| 5. | All India Co-ordinated Research Project on Palms | V Arunachalam | |
| 6. | All India Co-ordinated Research Project on Animal Disease Monitoring and Surveillance (ADMAS) | Shivasharanappa N | Sushita Rajkumar Chetan Kumar HB |

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 | Manohara KK |

Externally Funded Projects

| Sr. No | Project Title | PI | Co-PI (s) |
|----------------------|---|--------------------|-----------------------------------|
| <i>Foreign Aided</i> | | | |
| 1. | Stress Tolerant Rice for Africa and South Asia | NP Singh | Manohara KK |
| <i>DBT</i> | | | |
| 2. | Augmentation of rural pig production for socio economic upliftment of rural poor in Goa through artificial insemination | EB Chakurkar | |
| <i>ICAR</i> | | | |
| 3. | Integrated farming system for improvement of nutrition and livelihood of farm women under different agro-ecosystems | Vishwanath Reddy K | |
| 4. | Network project on transgenic crops (functional genomics): genetic mapping of salinity tolerant genes in rice | Manohara KK | |
| 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, horticultural crops and fisheries | Manohara KK | V. Arunachalam Manju Lekshmi N |
| 8. | Poultry seed project | RS Rajkumar | |



| Noni Foundation | | | |
|------------------------|--|-----------------|---|
| 9. | Genetic diversity of noni in konkan coast of India | V Arunachalam | |
| DST and E, Goa | | | |
| 10. | Amelioration and management of coastal saline soils of Goa | GR Mahajan | |
| 11. | Agro - morphological characterization and DNA fingerprinting of rice land races of Goa | Manohara KK | |
| NFDB | | | |
| 12. | Technology demonstration on mariculture for improving the livelihood status of youth and women in Goa | Manju Lekshmi N | |
| CDB | | | |
| 13. | Coconut production statistics survey at Goa | V Arunachalam | |
| RKVY | | | |
| 14. | Generation of elite planting material in horticultural crops for Goa | V Arunachalam | M Thangam MJ Gupta S Priyadevi |
| 15. | Establishment of protected structures for high value flower and vegetable crops for training and demonstration | M Thangam | Safeena SA S Priyadevi NP Singh |
| 16. | Conservation of traditional varieties of vegetable crops and entrepreneurship development for its seed production | M Thangam | |
| 17. | Development of comprehensive <i>e-agriculture portal</i> for information and knowledge sharing in Goa | M Thangam | |
| 18. | Demonstration of Precision Farming Technologies (PFT) in banana, pineapple and papaya in farmers' fields of Goa | S Priya Devi | |
| 19. | Empowering farmers of Goa for sustainable adoption of low-cost protected cultivation structures through training and demonstration | MJ Gupta | V Arunachalam M Thangam S Priyadevi |
| 20. | Production and supplementation of bypass fat to dairy animals for enhancement of milk production and livelihood security of dairy farmers of Goa | EB Chakurkar | |
| 21. | Feed blocks for dairy animals for effective utilization of locally available feed resources and higher productivity | EB Chakurkar | |
| 22. | 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 11-16, 2015 | Manohara KK | 50 th Annual Rice Research Group Meeting | ICAR - DRR, Hyderabad |
| April 16-19, 2015 | Narendra Pratap Singh | National Seminar on Harmonizing Biodiversity and Climate Change, Challenges and Opportunity | ICAR-CARI, Port Blair |
| May 18-19, 2015 | Narendra Pratap Singh | Review Workshop of AICRP on IFS | ICAR-IIFSR, Modipuram, Meerut |
| May 21-24, 2015 | M Thangam | 33 rd Group Meeting of AICRP on Vegetable Crops | ICAR-IIVR, Varanasi |
| May 26-29, 2015 | V Arunachalam | 24 th Annual Group Meeting of All India Coordinated Research Project on Palms | ICAR- CCARI, Old Goa |
| June 8-9, 2015 | Manohara KK | 31 st Annual Workshop of AICRP on Arid Legumes | ICAR- CAZRI, Jodhpur. |
| June 11-12, 2015 | GR Mahajan and Viswanatha Reddy K | Inception Workshop on Collaborative Research Project on Integrated Farming Systems | ICAR-CIWA, Bhubaneshwar, Odisha |
| August 4-5, 2015 | R Ramesh | Workshop of Nodal Officers of ICAR on KRISHI Portal and Research Data Repository | NASC complex, New Delhi. |
| August 9-11, 2015 | Maneesha SR | National Symposium on Germplasm to Genes: Harnessing Biotechnology for Food Security and Health | NASC complex, New Delhi |
| August 20, 2015 | S Priya Devi | One day Workshop on <i>Garcinia species</i> | Central Horticultural Experimental Station, Chetali, ICAR-IIHR, Bangalore |
| August 21-22, 2015 | R Ramesh | NABS National Seminar on Biological Products for Crop, Animal and Human Health-Problems and Prospects | University of Mysore, Mysore, Karnataka |
| August 24-25, 2015 | Manohara KK | 10 th Annual Review Meeting of ICAR Seed Project "Seed Production in Agricultural Crops" | ICAR-CCARI, Old Goa |
| September 7 -9, 2015 | Shivasharanappa N | National Workshop on Molecular Subtyping of Microbes using Pulse Field Gel Electrophoresis | Veterinary College, MAFSU, Nagpur |



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| September 10 - 11, 2015 | V Arunachalam | Garuda-NKN (National Knowledge Network) Partners Meet | National Institute of Advanced Studies (NIAS), Benaguru |
| September 17, 2015. | EB Chakurkar | Workshop on AICRP on Pigs | NASC , New Delhi |
| September 18-19, 2015 | R Solomon Rajkumar | Annual Review Meeting of AICRP on Poultry and Poultry Seed Project | NASC, New Delhi |
| September, 29 -30, 2015 | Manju Lekshmi N | Annual Review Meeting of National Fisheries Development Board | NFDB, Hyderabad |
| October 6-10, 2015 | Shivasharanappa N | 12 th International Double Stranded RNA Virus Symposium, | Marriot, Panaji, Goa |
| October 21, 2015 | RS Rajkumar | Seminar on Role of Minerals in Veterinary Practice | State Training Center, Curti, Ponda |
| October, 30 2015 | Manju Lekshmi N | Second Joint Working Group Meeting of India and Bangladesh and Cooperatives of Fisheries | Taj Residency, Goa |
| November 2-3, 2015 | S Priya Devi | International Conference on Vertical Farming | IIHR, Bengaluru |
| November 2-4, 2015 | AR Desai | Annual Group Meeting of AICRP on Cashew | RFRS Vengurla. |
| November 4 -5, 2015 | EB Chakurkar | 3 rd Conference of Indian Academy of Veterinary Nutrition and Animal Welfare | Department of Animal Nutrition, College of Veterinary & Animal Sciences, CSKHPKV, Palampur. |
| November 7, 2015 | Manohara K K | 9 th Annual Review Meeting of ICAR-NPTC project | NRCPB, New Delhi |
| November 18 -21, 2015 | RS Rajkumar | XXXII Annual Conference of Indian Poultry Science Association (IPSACON 2015) and National Symposium on "Clean and Green Poultry Production" | College of Avian Sciences and Management, Thiruvazhamkannu, Pallakad |
| November 23-24, 2015 | GR Mahajan | Brainstorming Session on Raising Awareness on the Importance of Soil in Sustaining Life System on Earth | NASC Complex, New Delhi |



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| November 24, 2015 | Paramesha V | Workshop on Discussion and Finalization of Statistical analytical Methodology for On Station and On Farm IFS Experiments | ICAR-IASRI, New Delhi |
| November 25-28, 2015 | Manju Lekshmi N | 5 th International Symposium on Cage Aquaculture | Dreams Hotel, Kochi. |
| December 2-3, 2015 | Sreekanth GB | International Conference on Biodiversity and Evaluation-Perspectives and Paradigm Shifts | Sree Sankara College, Kalady, Kerala |
| December 7-8, 2015 | Maruthadurai R | National Seminar on Advances in Life Sciences | St. Xaviers College, Mapusa, Goa |
| December 9-11, 2015 | Viswanatha Reddy K | Workshop on Strategies for Promoting Farmers Producers Organizations (FPOs). | ICAR-NAARM Hyderabad |
| December 11, 2015 | RS Rajkumar | Seminar on Animal Nutrition | Hotel Taj Vivanta, Panaji Goa |
| December 13, 2015 | RS Rajkumar | Seminar on Pet Animal Nutrition | Hotel Mandovi, Panaji Goa |
| December 11-12, 2015. | Safeena SA | International Symposium on Biodiversity, Agriculture, Environment and Forestry | Fortune Resort Sullivan Court, Ooty, Tamil Nadu, |
| December 16-18, 2015 | Narendra Pratap Singh GR Mahajan | Group Meeting of AICRP on IFS | Assam Agricultural University, Jorhat |
| January, 4-7 2016 | GR Mahajan and Sreekanth GB | 103 rd Indian Science Congress | University of Mysore, Mysore, Karnataka |
| January 14-16, 2016 | Narendra Pratap Singh AR Desai M Thangam MJ Gupta | 11 th National Symposium on Innovations in Coastal Agriculture – Current Status and Potential under Changing Environment | ICAR-IIWM, Bhubaneswar |
| January 19-21, 2016 | MJ Gupta | ISAE 50 th Convention and Symposium on Agricultural Engineering in Nation Building: Contributions and Challenges | College of Agril. Engineering and Technology, OUAT, Bhubaneshwar, Odisha |
| February 6, 2016 | RS Rajkumar | Seminar on Renal Failure in Dogs | Hotel Mi Casa, Panaji Goa |
| February 9, 2016 | Manohara KK | Review Meeting of Half Yearly Progress of Foreign Aided Project | Krishi Anusandhan Bhavan, New Delhi |
| February 10-12, 2015 | V Arunachalam and S Priya Devi | International Conference on Biodiversity and Bioactive Natural Products for Human Welfare-2016 | Govt Arts College, Karur, Tamil Nadu |



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| 19-20, February 2016 | AR Desai | National Seminar on Strategies for Development of Cashew | RFRS, Vengurla |
| February 23-27, 2016 | R Ramesh | 6 th International Conference on Plant, Pathogens and People: Challenges in Plant Pathology to Benefit Human Kind | NASC Complex, New Delhi, |
| February 25-26, 2016 | RS Rajkumar | II Annual Convention of Association of Meat Scientists and Technologists and National Seminar on Food: Safety, Health and Environment | Madras Veterinary College, Vepery, Chennai |
| February 26, 2016 | M Thangam | Field Day on Amaranthus | NBPGR Regional Centre, Thrissur, Kerala |
| March 1, 2016 | Bappa Das | User's Meet of IMD | Science centre, Panjim, Goa |
| March 3-4, 2016 | Bappa Das | Recent Advances in Statistical Tools for Agriculture and Allied Sciences | BCKV, Mohanpur, Nadia |
| March 5, 2016 | Bappa Das | Climate Change and Extreme Weather: Assessment of Vulnerability for Early Warning | Indian Museum, Kolkata |
| March 10-11, 2016 | G R Mahajan | Brainstorming Session on Groundnut Area Expansion in Non-Traditional Areas and Newer Cropping Systems | ICAR-DGR, Junagadh, Gujarat |
| March 19-21, 2016 | Narendra Pratap Singh | 2 nd World Noni Congress Noni and Medicinal Plants for Inclusion Growth and Wellness | SRM University, Chennai |



List of Publications

Research Articles

- Das SK, Karunakaran M, Barbuddhe SB and Singh NP (2015) Effect of Orientation, Ventilation, Floor Space Allowance and Cooling Arrangement on Milk yield and Microclimate of Dairy Shed in Goa. *J. Anim. Res.*, 5: 231-235.
- Gupta MJ (2016) Greenhouse design for high rainfall, high humidity, moderate to high temperature coastal regions. *New Age Protected Cultivation*, 2: 23-24.
- Karunakaran M, Ratnakaran U, Naik PK and Chakurkar EB (2015) Electrophoretic profile of boar seminal proteins. *J. Appl. Anim. Res.*, 44: 403-405.
- Karunakaran M, Chakurkar EB, Ratnakaran U, Naik PK, Mondal M, Mondal A and Singh NP (2016) Characteristics of boar semen preserved at liquid state. *J. Appl. Anim. Res.*, DOI: 10.1080/09712119.2016.1150848.
- Krishnamurthy SL, Sharma SK, Sharma DK, Sharma PC, Singh YP, Misha VK, Burman D, Maji B, Bandyopadhyay BK, Manda S, Sarangi, SK, Gautam RK, Singh PK, Manohara KK, Marandi BC, Singh DP, Pamavathi G, Vanve PB, Patil KD, Thirumeni S, Verma OP, Khan AH, Tiwari S, Shaikla M, Ismail AM, Gregorio GB and Singh RK (2015) Analysis of stability and G X E interaction of rice genotypes across saline and alkaline environments in India. *Cereal Res Commun.*, DOI: 10.1556/0806.43.2015 .055.
- Manjunath BL, Mahajan GR, Ramesh R and Singh NP (2016) Effect of improved nutrient management on grain yield of rice (*Oryzasativa L.*) and soil health under organic management. *Indian J. Agron.*, 61: 20-27.
- Mahajan GR, Manjunath BL, Latore AM, D'Souza R, Vishwakarma S and Singh NP (2015) Spatial and temporal variability in microbial activities of coastal acid saline soils of Goa, India. *Solid earth discuss.*, 7: 3087-3115.
- Mahajan GR, Manjunath BL, Latore AM, D'Souza R, Vishwakarma S and Singh NP (2015) Fertility Status of the Unique Coastal Acid Saline Soils of Goa. *J. Indian Soc. Soil Sci.*, 63: 232-237.
- Mahajan GR, Manjunath BL, Latore AM, D'Souza R, Vishwakarma S and Singh NP (2015) Microbial and Enzyme Activities and Carbon Stock in Unique Coastal Acid Saline Soils of Goa. *Proc. Nat. Acad. Sci. India Sec. B Biol. Sci.*, DOI 10.1007/s40011-015-0552-7.
- Manohara KK and Singh NP (2015) Genetic Variability, Correlation and Path Analysis in Rice (*Oryza sativa L.*) under Coastal Salinity Conditions of Goa. *J. Indian Soc. Coast. Agri. Res.*, 33: 34-39.
- Manohara KK, Chattopadhyay K, Marandi BC, Singh ON and Singh NP (2015) Korgut (IC0599689; INGR 14055), a Rice (*Oryza sativa L.*) Germplasm Tolerant (SES score 3) to Salinity Stress (EC=12 dsm⁻¹) at seedling stage. *Indian J. Plant Gen. Res.*, 28: 366-367



Murugesan P, Maryrani KL, Ramajayam D, Sunil Kumar K, Mathur RK, Ravichandran G, Naveen Kumar P and Arunachalam V (2015) Genetic diversity of vegetative and bunch traits of African oil palm (*Elaeis guineensis*) germplasm in India. *Indian J. Agri. Sci.*, 85: 32-35.

Premkrishnan BV and Arunachalam V (2016) Database of predicted SCAR markers in five fruit and three vegetable crops. *J. Genet.*, 95: 171-175.

Sreekanth GB, Manju Lekshmi N and Singh NP (2015) Temporal patterns in fish Community structure: environmental perturbations in a well-mixed tropical estuary. *Proc. Nat. Acad. Sci. India Sec. B Biol. Sci.*, DOI: 10.1007/s40011-015-0581-2.

Sreekanth GB, Manju Lekshmi N and Singh NP (2015) Fisheries profile of Zuari Estuary. *Inter. J. Fish. Aquat. Stud.*, 3: 24-34.

Sreekanth GB, Zacharia PU, Praveen KV, Manju Lekshmi N and Singh NP (2015) An inquiry in to the trends in landings and marketing efficiency of threadfin breams, a trawl by catch resource along Kerala coast. *South Asian J. Multidisci. Stud.*, 2: 23-36.

Paper Presented/ Conference / Abstracts

Anandaraj M, Singh D, Eapen SJ, Gopalakrishnan C, Reddy MK, Prameela TP, Ramesh R, Rosana OB, Singh BP, Sagar V, Bhai RS, Pati VV and Srivastava V (2016) Comparative genomics of *Ralstonia solanacearum* strains from India reveals their phyletic profiles and diverse effectomes. 6th International conference on Plant pathogens and people: Challenges in plant pathology to benefit human kind, 23-27, February, 2016, NASC Complex, New Delhi, pp 14.

Anjali PT, Manju Lekshmi N, Sreekanth GB, Singh NP, Ratheesh Kumar R and Pandey PK (2015) Effect of biofloc on growth, proximate composition and digestive enzyme activities of *Etroplus suratensis*. 5th International Symposium on Cage Aquaculture Asia, 25-28, November, 2015, Kochi, pp 117.

Arunachalam V (2016) Amaranth biodiversity for foliar betacyanin content. International Conference on Biodiversity and bioactive natural substances for human welfare, 10-12, February, 2016, Government Arts College, Karur, Tamil Nadu.

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| Annual Report (2014-2015) pp.1-134 | Singh N P, Ramesh R, Priya Devi S, Rajkumar R S, Maruthadurai R, Mahajan G R and Manju Lekshmi N. |
| Research achievements of 25 years (1989 – 2014) pp. 1-242 | Singh N P, Manjunath B L, Barbuddhe S B, Arunachala V, Manohara K K and Manju Lekshmi N. |
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| Vol. XVI. No.1 January – April, 2014 pp1-14 | Mahajan G R, Sreekanth G B and Manju Lekshmi N. |
| Vol. XVI. No.2 May – August, 2014 pp1-16 | Mahajan G R, Sreekanth G B and Manju Lekshmi N. |
| Vol. XVI. No.3 September – December, 2014 pp1-10 | Mahajan G R, Sreekanth G B and Manju Lekshmi N. |



Workshops, Seminars and Other Events

Visit of Dr. Alok Kumar Sikka, DDG (NRM)

Dr. A K Sikka, DDG (NRM), visited the Institute on 2nd to 4th April, 2015. He visited various research units of Sections - Crop Sciences, Horticulture, Animal Science and KVK and inaugurated the renovated Mandovi Guest House and Salinity Screening Facility at the Institute. A meeting with the scientific, technical, administrative and skilled support staff of ICAR-CCARI was organized. Dr. Narendra Pratap Singh, Director of the Institute welcomed and briefed about the Institute research activities. Three publications including two technical bulletins and Newsletter were released by Dr. A. K. Sikka. He appreciated the work done by the Institute and assured his continuous support.



24th Annual Group Meeting of AICRP on Palms

24th Annual Group Meeting of All India Coordinated Research Project on Palms was held at ICAR-Central Coastal Agricultural Research Institute (ICAR - CCARI), Old Goa from 26th to 29th May, 2015. The Chief Guest of the programme, Mr. Manoj Kumar Sahoo, IAS, Secretary (Agriculture), Govt of Goa addressed the gathering of all the renowned scientists involved in the above AICRP on Palms and deliberated the various issues on palms research in the country. Dr. Narendra Pratap Singh, Director, ICAR-CCARI emphasized the need and scope for palm research in the coastal region. Dr. S.K. Sharma, (Director, ICAR-CIAH), Dr. P. L. Saroj (Director, ICAR-DCR) and Dr. A. S Kumaraswamy (Former Dean (Education), UAHS, Shimoga) also

addressed the gathering. Dr. H. P Maheshwarappa, Project Co-ordinator (Palms) presented the technical report of the program and highlighted significant achievements. Five publications were released during the occasion. Plenary session was chaired by Dr N. K Krishnakumar, Deputy Director General (Horticultural Science), ICAR, New Delhi.



National Workshop on Hydroponic Maize Fodder Production and Use of Bypass Fat in Dairy Animals

Two day National workshop on “Hydroponic maize fodder production and Use of Bypass fat in dairy animals” was held during 29-30th June, 2015 at ICAR – Central Coastal Agricultural Research Institute, Old Goa. Shri. Narendra K. Sawaikar, Hon’ble Member of Parliament (South Goa) inaugurated the workshop. The function was graced by Dr. N.C. Sawant, Managing Director, Goa Dairy and Dr. R. B Dhuri, Manager, Goa Dairy. Dr. Narendra Pratap Singh, Director, ICAR-CCARI, Old Goa presided over the function and





emphasized the importance of the Hydroponic green fodder production. About 60 progressive farmers from Goa and other states of the country participated training program at ICAR Institute, Old Goa. The farmers were demonstrated the hydroponic green fodder technology at the field level. The programme is being supported by Govt of India under Rastriya Krishi Vikas Yojana (RKVY).

National Training Program on Use of Bypass Fat in Dairy Animals

One day national training program on use of Bypass fat in dairy animals” was conducted on 30th June, 2015 at ICAR – Central Coastal Agricultural Research Institute, Old Goa. About 40 progressive farmers from Goa and other states of the country participated training program at ICAR Institute, Old Goa. The farmers were demonstrated the by pass fat production at the field level. The function was graced by Dr. R. B Dhuri, Manager, Goa Dairy and Dr. Narendra Pratap Singh, Director, ICAR-CCARI-Old Goa presided over the function and emphasized the importance of the use of bypass fat production and conservation of the indigenous cattle breeds.



ICAR-CCARI Observes its Silver Jubilee

ICAR-Central Coastal Agricultural Institute celebrated its silver jubilee on 21st July, 2015. This occasion was blessed with the presence of Chief Guest Smt. Mridula Sinha, Hon. Governor of Goa and Guest of Honour, Smt. Nila Mohanan, IAS, District Magistrate and Collector, North Goa. Dr. B. Mohan Kumar, Assistant Director General (AAF&CC), Dr. V. S. Korikanthimath and Dr. P.

G. Adsule (Former Directors of the institute) were also present during the event. The former staff members of the Institute were also invited for the silver jubilee celebrations. During the inaugural session, welcoming the invitees, Dr. Narendra Pratap Singh, Director, ICARCCARI highlighted the journey of the institute from a research station to a full-fledged central institute. A brief presentation of the research achievements of the institute was followed. The institute honoured the former staff members and the present members with more than 25 years of service. Two silver jubilee publications (Souvenir, 25 Year Research Achievements and History of the institute) were released during the event. The logo of the institute was also officially released during the function. Smt. Mridula Sinha and Smt. Nila Mohanan congratulated the whole team of ICAR-CCARI for their team work, salient achievements and ensured whole hearted support for the institute in future. Dr. B Mohan Kumar appreciated the staff of the institute for its successful journey of 25 years. The former directors of the institute, Dr. VS Korikanthimath and Dr. PG Adsule briefed about the research and development activities that the institute has carried out during the last twenty five years and they also recommended research opportunities for the institute as an ambassador for agricultural research in the coastal region.



10th Annual Review Meeting of ICAR Seed Project

10th Annual Review Meeting of ICAR Seed Project was held during 24th to 25th August, 2015 at ICAR-CCARI. Shri. Pratap Singh Raoji Rane, Former Chief Minister of Goa was the chief guest of the function. The other dignitaries



were Dr. J. S Sandhu (DDG (Crops), ICAR), Dr. R. R Hanchinal (Chairperson, PPV&FRA), Dr. J. S Chauhan (ADG (Seeds), ICAR) and Dr. S. Rajendra Prasad (PD, DSR, Mau). Dr. Narendra Pratap Singh, Director, ICAR-CCARI explained the activities and achievements of the institute. Dr. J. S Chauhan, ADG (Seed) presented the insights of the ICAR Seed Project. Decadal progress of ICAR Seed Project was presented by Dr. S. Rajendra Prasad (PD, DSR). Shri. Pratap Singh Raoji Rane emphasized on the research aspects of salt tolerant varieties for Low lying lands in the state of Goa. Guest of Honour Dr. R. R Hanchinal congratulated all the scientists involved in this project for making tremendous improvement in producing and making available the quality seed of newly released varieties to the farming community of the country. In the Presidential address, Dr. J. S Sandhu highlighted the importance of Seed Project mentioned the use of biodiversity in improving the existing varieties.



Shree Satyanarayan Pooja Performed at the Institute

Shri Satya Narayan Pooja was celebrated at ICAR-CCARI on 9th September, 2015. The pooja was participated with pomp and fervour by all the staff of the Institute along with their family members, officials from nearby organisations and other people in the vicinity. The main objective of celebrating Satyanarayan Pooja was to seek blessings from the almighty and to maintain peace, harmony and working environment in the Institute. Dr. Narendra Pratap Singh, Director of the Institute along with his wife, Mrs. Nirmala Singh performed formalities of pooja as “Yazman” on behalf of the staff of the Institute.

During the pooja celebrations, Bhajan, Kirtan and Fugdi were carried out and Mahaprasad was served.



Shramdan at the Institute

The staff of the Institute participated widely in the ‘Shramdan’ under the dynamic leadership of Dr. Narendra Pratap Singh, Director and undertook a cleanliness drive on 11th September, 2015. All staff of the Institute including contractual, SRFs, RAs and labourers whole heartedly participated in the cleaning and planting of ornamental plants on outer wall side area of KVK.



संस्थान द्वारा इस वर्ष मनाए गए हिन्दी पखवाड़ा का संक्षिप्त विवरण

इस वर्ष संस्थान द्वारा दिनांक 14 सप्टेंबर 2015 मे 26 सप्टेंबर 2015 तक हिन्दी पखवाड़ा का आयोजन किया गया । हिन्दी पखवाड़ा कार्यक्रम का उद्घाटन माननीय निदेशक महोदय जी के करकमलों से हुआ। इस अवसर पर उन्होने 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 पखवाड़ा 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 किया गया।



ICAR-CCARI leads "Swachh Bharat Mission" at Old Goa

Owing to the importance of "Swachh Bharat Abhiyan" or Clean India Mission" lead by the Government of India, the ICAR- Central Coastal Agricultural Research Institute has actively organised a cleanliness drive on 29th September, 2015 and 1st October 2015. The main objective was to propagate a cleanliness drive in the surroundings of Old Goa especially in and around the UNESCO World Heritage Site, Basilica of Bom Jesus, Gandhi circle, Canara Bank, State Bank of India, Old Goa Police Station, Karamali Railway Station and premises of Krishi Vigyan Kendra etc.. The scientists, technical, administrative,



supporting and contractual staff of the institute and Krishi Vigyan Kendra (KVK), North Goa undertook a cleanliness drive under the dynamic leadership of Dr. Narendra Pratap Singh, Director of the institute. He also emphasised that everybody should spend at least two hours in a week for the accomplishment of hygiene of our environment. The institute has called for the whole-souled co-operation of the public for cleaner Old Goa under the mission. Through the official website (www.ccar.res.in) and facebook community (ICAR-CCARI), the institute triggered the campaign to the people of the global village.

Workshop on Development of Road Map for Agricultural Development in West Coast Plains and Ghats Agro Climatic Zone

A one day workshop on "Development of Road Map for Agricultural Development in West Coast Plains and Ghats Agro Climatic Zone" was organised on 16th October, 2015. Dr. K. K. Singh, ADG (F. Engg.) was the Chairman and Dr. Sreenath Dixit, Director, ATARI and Dr. Narendra Pratap Singh Director, ICAR-CCARI were the coordinators of the workshop. About 85 participants from ICAR, SAUs, KVKs, departments like Agriculture, Animal Husbandry and Fisheries and progressive farmers attended and shared their suggestions for the development of agriculture. There were deliberations from all the participants with recommendations on technologies, farming practices and processing of various crops, animal and fishery components. The workshop has come out with brief region specific recommendations for the development of agriculture.





Heliconia Day Celebrated with Lots of Flower Enthusiasts

Heliconia day was celebrated on 19th October, 2015, in which 90 participants comprising of students and faculties from colleges, progressive farmers, officers from Forest Department, Department of Agriculture, and flower enthusiasts. During the programme, an exhibition on 45 varieties of heliconia and 10 types of related species were presented. Mrs. Vijayadevi Rane, Ex Chairperson, Bal Bhavan attended the programme as Chief Guest. She narrated her experience in establishing commercial cultivation of Heliconia at her farm and urged the ICAR to facilitate technical knowhow including supply of quality planting materials and marketing intervention. Dr. Narendra Pratap Singh, Director of ICAR presided over the function. He emphasized the need to go for commercial venture in under exploited flower crops like Heliconia in Goa as it was done for gerbera and orchids. Dr. M. Thangam, Sr. Scientist was the co-ordinator for the programme.



National Training Program on Artificial Insemination in Pigs

ICAR-CCARI conducted a National Training Program on Artificial Insemination in Pigs Sponsored by DBT, Govt. of India from 24th to 26th October, 2015. Dr. A. S Ninawe, Advisor, DBT was the Chief Guest of the function. The other dignitaries were Dr V. K. Mishra (Head, ICAR-CSSRI, Lucknow) and Dr C. M. Karunakaran, Senior Scientist (Animal Reproduction), NDRI. Dr. Narendra Pratap Singh, Director, ICAR-CCARI presided over the function and had given

emphasis on the importance of livestock in agricultural economy. Veterinary professionals (Scientists, Academicians and Veterinary Officers) from the states of Maharashtra, Goa, Karnataka, Kerala, Tamil Nadu and Uttar Pradesh have participated in the training program. The participants were given practical demonstration and hands on experience in collection, evaluation and preservation of Boar semen.



Visit of Union Minister of State for Agriculture and Farmers Welfare

Honourable. Dr. Sanjeev Kumar Balyan, Union Minister of State for Agriculture and Farmers Welfare, Govt. of India visited the Institute on 18th November, 2015. During the visit, he was appraised about the Institutional activities including various technologies developed at the Institute and laboratory facilities. On the occasion, Dr. Narendra Pratap Singh Director, ICAR-CCARI welcomed the Hon. Minister which was followed by a brief presentation about the history, research and extension activities of the Institute. The Union Minister laid foundation stone for the





production facility for Virgin Coconut Oil and inaugurated the renovated KVK building. He stressed upon dissemination of technologies to the farm for improving livelihood of the farmers. The programme was also graced by Dr. Bhola Singh (MP, Bulandshahr, Uttar Pradesh), Sri. Satish Kumar Gautam (MP, Aligarh, Uttar Pradesh). The Hon. Minister visited experimental farms, units and demonstration plots of the Institute and KVK. The Union Minister appreciated the research work and extension activities being carried out by the Institute.

ICAR-CCARI Observed World Soil Day

ICAR-CCARI observed and celebrated the World Soil Day on 5th December, 2015 at the Institute. Year 2015 has been declared by the United Nations as 'International years of soils' considering the paramount importance of soil. The programme was attended by farmer groups from different villages. Dr. Narendra Pratap Singh, Director, ICAR-CCARI stressed upon the need of applying nutrients based on soil testing. The chief guest of the programme, Sh. Narendra Sawaikar, Hon. MP (South Goa), emphasized on the importance of the soil in human life and urged farmers to keep pace with the new technologies for better farming. Sh. Pandurang Madkaikar, Hon. MLA, Govt. of Goa appealed the farmers to make use of the soil health cards for application of fertilizers in a scientific way. The aim of the programme is to raise the awareness about the soil and soil health. During the programme, soil health cards were distributed to farmers and were explained for further use. An android app, FERTILIZER CALCULATOR GOA was also launched during the programme for public use.



A guide to use the FERTILIZER CALCULATOR APP was also released during the programme. During the programme, a soil testing kit was also distributed to the beneficiary under TSP programme.

Training on Canopy Management in Fruit Crops

A one day training programme on Canopy Management in Fruit crops was held at the Institute on 10th December, 2015. The inaugural speech was given by Dr. Narendra Pratap Singh, Director, CCARI, Old Goa. Dr. Dushyant Mishra, Senior Scientist, ICAR-IIFSR, Modipuram, U.P explained the techniques of canopy management in fruit crops with special reference to mango. Field demonstrations on pruning guava and mango was also organised for the farmers. Progressive farmers and the officials from the State Agriculture Department participated in the programme.



Participation in Aqua Goa Mega Fish Festival-2016

ICAR-Central Coastal Agricultural Research Institute has actively participated with a scientific exhibition stall in the Third Aqua Goa Mega Fish Festival-2016 organised by Directorate of Fisheries, Govt. of Goa in collaboration with the National Fisheries Development Board, Hyderabad at Navelim from 7th to 10th January, 2016. Hon. Deputy Chief Minister of Goa, Shri. Francis D'Souza inaugurated the four days mega event in the presence of Hon. Fisheries minister, Shri. Avertano Furtado, Shri. Digambar Kamat (MLA, Margao) and Shri. Caitano Silva (MLA, Benaulim). The moto of the festival is to promote



Goa's rich fish culture and fishing industry and to create awareness among the general public. The festival has provided a common platform for stakeholders to help build a sustainable fisheries sector and to form a bond between the traditional fishing industry and a technology-driven industry, which will benefit the fishing community. During this occasion, striped grey mullet, *Mugil cephalus* commonly known as "Shevto" was declared as the state fish for Goa.



Participation in SCI-FFI, First Science Film Festival of India-2016

ICAR-Central Coastal Agricultural Research Institute actively participated in the SCI-FFI, First Science Film Festival of India, an unique festival held in the ESG premises, Panaji from 14th to 17th January 2016. The three-day event was packed with film screenings, discussions, interactive sessions and workshops with experts and scientists. A symbolic release of the film festival poster by vice chairman of Entertainment Society of Goa Shri. Damu Naik and Patron of the festival, Chairman, Dempo Group of Industries, Shri. Srinivas Dempo threw open



the three-day festival. The Institute had a huge stall wherein CCARI displayed specimens and posters representing their research and extension activities. Dr. E. B. Chakurkar also made a presentation and two films on ICAR and ICAR-CCARI were screened. This was followed with an interactive session with the participants. The Institute stall was visited by hundreds of students and science enthusiasts every day.

Visit of Deputy Chief Minister, Govt. of Goa

Honourable Shri. Francis D'Souza Deputy Chief Minister, Govt. of Goa visited this institute on 23rd February, 2016. During the visit, he was apprised about the Institutional activities and various technologies developed at the Institute. He visited to piggery unit, fodder unit, rabbit unit, poultry and quail unit, hydroponic fodder production unit and dairy unit of the Institute. He also visited to rice and other experimental crop fields and appreciated the scientists of ICAR for conducting very good research work and giving valuable output to the farmers of Goa.





Committees and Meetings

Research Advisory Committee

The VII Research Advisory Committee (RAC) for ICAR- Central Coastal Agricultural Research Institute 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)
Vasantrao 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, Thrissur – 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

Shri Shrirang V. Jambhale **Member**
Savai (Ghano), P.O. Vere,
Taluka - Ponda Goa - 403 401

Shri Babu N. Komarpant **Member**
Near Dhavalikar Hospital,
Devabag Palolem
Canacona, South Goa 403 702

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**
Principal Scientist,
ICAR-CCARI, Old Goa

The second meeting of the VII RAC was held on 29th to 30th October, 2015 at ICAR – CCARI, Old Goa. The meeting was chaired by Dr. R. B. Deshmukh, Chairman, and attended by following members Dr. S. P. Bharadwaj, 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. Dr. H. Rehman, Director, ICAR-NIVEDI was present as an expert and special invitee along with Shri Shrirang Venkatesh Jambhale and Shri Babu Narhari Komarpant as farmer representatives.

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 follows

1. The institute projects should be innovative, farmer friendly and potential socio-economic impact analysis should be part of the project. The projects should not be of routine and duplicative nature.
2. The economic benefits derived by the farming community through the interventions of technologies developed / given by the institute may be quantified and published in the form of booklet.
3. A letter may be sent to AYUSH Ministry with a request for study on the effect of Homeopathy medicines on cure / prevention of cattle diseases and for collaboration.
4. Since the centre is upgraded to shoulder the responsibility of whole of the west and East coast regions appropriate staff need to be provided.
5. Review the institute research programmes submitted by newly joined scientists of Animal Sciences Section after visiting NIVEDI, Bangalore and modify as per the discussion.
6. Studies on implications of climatic changes on agriculture and allied sectors and corrective practices in coastal regions
7. Development of aquaculture based self sustaining IFS module for coastal regions of India
8. The new projects to be proposed in future should integrate different disciplines, institutes in order to study in a holistic manner especially in IFS related projects.
9. Projects may be initiated to study the soil, water and its management and monitoring in West and East coast regions.

Institute Research Council

The 26th Annual Institute Research Committee meeting of the Institute was held during 1st to 3rd September, 2015 at the Institute. The meeting was chaired by Dr. Narendra Pratap Singh, Director of the institute. He welcomed all the scientists and highlighted about the importance of this meeting as this institute was upgraded for coastal region. He emphasized for transfer of technology to the farmer's field and publication of research findings in peer reviewed journal.



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. Six newly joined scientists presented their new research project proposals. The chairman reviewed all the projects thoroughly and made critical comments for the further improvement of projects.

The IRC reviewed the progress made under various research projects for the year 2014-15 and finalized the technical programmes of the ongoing research projects for the year 2015-16. The Committee of the IRC is as follows

| | |
|--|---------------------------|
| Dr. N. P. Singh Director, ICAR-CCARI, Old Goa | - Chairman |
| All Project Leaders | - Members |
| Dr. S. K. Das Principal Scientist ICAR-CCARI, Old Goa | - Member Secretary |



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**
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 25th June, 2015 and 2nd March, 2016.





Distinguished Visitors

| Date | Name of Visitor | Designation/ Institute/ Place |
|--------------------------|----------------------------|--|
| 21-07-2015 | Smt. Mridula Sinha | Honourable Governor of Goa |
| 18-11-2015 | Dr. Sanjeev Kumar Balyan | Honourable Union Minister of State for Agriculture and Farmers Welfare, Govt. of India |
| 23-02-2016 | Shri. Francis D'Souza | Honourable Deputy Chief Minister, Govt. of Goa |
| 05-09-2015 05-12-2015 | Shri. Narendra Sawaikar | Member of Parliament, South Goa |
| 18-11-2015 | Dr. Bhola Singh | Member of Parliament, Bulandshahar,, Uttar Pradesh |
| 18-11-2015 | Sri. Satish Kumar Gautam | Member of Parliament, Aligarh, Uttar Pradesh. |
| 20-06-2015 | Shri. Pramod Sawant | Member of Legislative Assembly and Chairman, GSIDC, Govt of Goa |
| 05-12-2015 | Shri. Pandurang Madkaikar | Member of Legislative Assembly, Cumbharjua, Goa |
| 21-07-2015 | Smt. Nila Mohanan, IAS | District Magistrate and Collector, North Goa |
| 26-05-2015 | Mr. Manoj Kumar Sahoo, IAS | Secretary (Agriculture), Govt. of Goa |
| 15-02-2016 | Shri. Amjad Tak, IAS | Secretary (Fisheries), Govt. of Goa |
| 02-04-2015 | Dr. Alok Kumar Sikka | Deputy Director General (NRM), ICAR New Delhi |
| 25-08-2015 | Dr J. S. Sandhu | Deputy Director General (Crops), ICAR, New Delhi |
| 29-05-2015 | Dr. N. K. Krishnakumar | Deputy Director General (Horticultural Science), ICAR, New Delhi |
| 13-04-2015 | Dr. A. K. Vasisht | Assistant Director General (PIM/ESM), ICAR, New delhi |
| 25-08-2015 | Dr J. S. Chauhan | Assistant Director General (Seed), ICAR, New Delhi |
| 16-10-2015 | Dr. K. K. Singh | Assistant Director General (Farm Engg.), ICAR, New Delhi |



| | | |
|------------|--------------------------|---|
| 22-08-2015 | Dr. A. K. Srivastava | Director, ICAR-National Dairy Research Institute, Karnal |
| 27-09-2015 | Dr. T. R. Sharma | Project Director, ICAR-National Research Centre on Plant Biotechnology, New Delhi |
| 25-08-2015 | Dr S Rajendra Prasad | Project Director, ICAR-Directorate of Seed Research, Mau. |
| 26-05-2015 | Dr. S.K. Sharma | Director, ICAR-Central Institute of Arid Horticulture, Lucknow |
| 26-05-2015 | Dr. P. L. Saroj | Director, ICAR-Directorate of Cashew Research, Puttur |
| 26-05-2015 | Dr. H. P Maheshwarappa | Project Co-ordinator, AICRP on Palms, ICAR-CPCRI, Kasargod |
| 16-10-2015 | Dr. Sreenath Dixit | Director, ICAR-ATARI, Bangalore |
| 13-04-2015 | Shri. Devendra Kumar | Director (Finance), ICAR, New Delhi |
| 24-10-2016 | Dr. A. S Ninawe, | Advisor, DBT, Govt. of India, New Delhi |
| 25-08-2015 | Dr. R. R. Hanchinal | Chairperson, PPV & FRA, New Delhi |
| 26-05-2015 | Dr. A. S Kumaraswamy | Former Dean (Education), UAHS, Shimoga |
| 21-07-2015 | Dr. V. S. Korikanthimath | Former Director, ICAR Research Complex for Goa, Old Goa |
| 21-07-2015 | Dr. P. G. Adsule | Former Director, ICAR Research Complex for Goa, Old Goa |
| 19-10-2015 | Mrs. Vijayadevi Rane | Former Chairperson, Bal Bhawan, Goa |



Personnel

Institute

| Sr. No. | Name | Designation | Additional Charge |
|----------------------------|---------------------------|---|--|
| Research Management | | | |
| 1. | Dr. Narendra Pratap Singh | Director | |
| Scientific Staff | | | |
| 1. | Dr. EB Chakurkar | Principal Scientist (Animal Reproduction) | Section I/c - Animal Science and Estate |
| 2. | Dr. V Arunachalam | Principal Scientist (Horticulture) | |
| 3. | Dr. M Thangam | Principal Scientist (Horticulture) | RFD/ RAC |
| 4. | Dr. R Ramesh | Principal Scientist (Plant Pathology) | Section I/c - Crop Science, AKMU Cell and PIMS |
| 5. | Dr. AR Desai | Senior Scientist (Horticulture) | Section I/c - Horticulture Science, PME and IPR Cell |
| 6. | Dr. S Priya Devi | Senior Scientist (Horticulture) | RKVY |
| 7. | Dr. Safeena SA | Scientist (Horticulture) | HRD |
| 8. | Dr. Manohara KK | Scientist (Plant Breeding) | Farm |
| 9. | Dr. MJ Gupta | Scientist (Agricultural Structures and Process Engineering) | |
| 10. | Dr. R Maruthadurai | Scientist (Agricultural Entomology) | TSP |
| 11. | Dr. RS Rajkumar | Scientist (Livestock Products Technology) | ATDC |
| 12. | Dr. Susitha Rajkumar | Scientist (Veterinary Pathology) | |
| 13. | Dr. Shivasharanappa N | Scientist (Veterinary Pathology) | |
| 14. | Dr. Mahajan GR | Scientist (Soil Science) | Section I/c - NRM and IRC |
| 15. | Shri. Viswanatha Reddy K | Scientist (Agricultural Economics) | |
| 16. | Shri. Sreekanth GB | Scientist (Fisheries Resource Management) | Fishery Science Section, Library, Press and Media |



| | | | |
|-----|---------------------|---|---------|
| 17. | Ms. Manju Lekshmi N | Scientist (Fisheries Resource Management) | Canteen |
| 18. | Ms Maneesha SR | Scientist (Fruit Science) | |
| 19. | Dr. Chethan Kumar | Scientist (Veterinary Public Health) | |
| 20. | Shri. Bappa Das | Scientist (Agricultural Meteorology) | |
| 21. | Dr. Paramesha V | Scientist (Agronomy) | |

Technical Staff

| | | | |
|-----|-------------------------------------|---------------------------------------|--|
| 1. | Ms. Madina Sollapuri | Senior Technical Officer (Estate) | |
| 2. | Mr. Raghurama Kukkude | Senior Technical Officer (Library) | |
| 3. | Mr. Vinod Ubharhande | Farm Superintendent | |
| 4. | Mr. Rahul Kulkarni | Senior Technical Officer (Agronomy) | |
| 5. | Mr. Edward Crasto | Technical Officer (Stockman) | |
| 6. | Mr. Sidharth K. Marathe | Technical Officer (PME Cell) | |
| 7. | Ms. Pranjali Wadekar | Technical Officer (AKMU) | |
| 8. | Mr. Yoganand Gaude | Technical Officer (Electrical) | |
| 9. | Mr. Suresh M Gomes | Technical Assistant (Tractor Driver), | |
| 10. | Mr. Omar Illroy Francisco De Ursula | Technical Assistant | |
| 11. | Mr. Upendra Kumar | Technician | |
| 12. | Mr. Prakash Parwar | Technician | |
| 13. | Mr. Gokuldas Gawas | Technician | |
| 14. | Mr. Data Velip | Technician | |
| 15. | Mr. Laxman Naik | Technician | |

Administrative & Accounts Staff

| | | | |
|----|----------------------------------|----------------------------------|------------------------|
| 1. | Mr. P Rajendran | Administrative Officer | |
| 2. | Mr. Saurabh Muni | Finance & Accounts Officer | |
| 3. | Ms. Lizette Maria Carmel Noronha | Private Secretary | |
| 4. | Ms. Montia Rita D'Silva | Assistant Administrative Officer | Estt./ Bills |
| 5. | Mr. Agostinho Fernandes | Assistant Administrative Officer | Store/ DDO/ Vehicle |
| 6. | Ms. Sneha Arlekar | Assistant Administrative Officer | Works |
| 7. | Ms. Pratibha Sawant | Assistant | |



| | | | |
|-----|-----------------------|------------------------|--|
| 8. | Ms. Sohni Sawant | Assistant | |
| 9. | Ms. Tarika Maulignkar | Personal Assistant | |
| 10. | Mr. Vinod Pagi | UDC | |
| 11. | Ms Bushra Ansari | Stenographer Grade.III | |
| 12. | Ms Chitra Madkaikar | LDC | |
| 13. | Mr. Tushar Mangaraj | LDC | |
| 14. | Mr. Vyas Hiren Kumar | LDC | |
| 15. | Mr. Vikrant Gupta | LDC | |
| 16. | Ms Sujatha S. Kamble | LDC | |

Skilled Supporting Staff

| | | | |
|-----|-------------------------|--|--|
| 1. | Mr. Subhash Melekar | | |
| 2. | Mr. Francisco Fernandes | | |
| 3. | Mr. Dugu Khandeparkar | | |
| 4. | Mr.Ashok Gadekar | | |
| 5. | Mr. Ravi S Kadam | | |
| 6. | Mr. Chimmnu Tivrekar | | |
| 7. | Mr. Umakant Haldankar | | |
| 8. | Ms. Sunitha Salgaonkar | | |
| 9. | Mr. Anil Khandeparkar | | |
| 10. | Ms.Maria S Varella | | |
| 11. | Mr. Giri Madkaikar | | |
| 12. | Mr.Gokuldas Kasker | | |
| 13. | Mr. Umesh Marcelkar | | |
| 14. | Mr. Vittal Porwar | | |
| 15. | Ms. Prafulla Gadekar | | |
| 16. | Ms. Rekha V Naik | | |
| 17. | Ms. Lalitha Gadekar | | |
| 18. | Ms. Pratibha Folkar | | |
| 19. | Mr.Vilas P Gaonkar | | |
| 20. | Mr. Prabhakar Goankar | | |



| | | | |
|-----|-----------------------------|--|--|
| 21. | Mr. Sitaram Kuncollikar | | |
| 22. | Ms. Janika S Shirodkar | | |
| 23. | Mr. Shanu G Velip | | |
| 24. | Mr. Nitin J. Naik | | |
| 25. | Mr. Mayur. N. Mandrekar | | |
| 26. | Ms. Swati R. Khandeparkar | | |
| 27. | Mr. Prallhad H. Zambaulikar | | |

KVK, North Goa

| Sr. | Name | Designation | Additional Charge |
|---------------------------------|------------------------|--|------------------------|
| <i>Technical Staff</i> | | | |
| 1. | Mr. HRC Prabhu | Subject Matter Specialist T-9 (Plant Protection) | Programme Co-ordinator |
| 2. | Ms. Sunetra Talaulikar | Subject Matter Specialist T-9 (Home Science) | |
| 3. | Dr. Vilas Sakharkar | Subject Matter Specialist T-6 (Extension) | |
| 4. | Dr. SK Udharwar | Subject Matter Specialist T-6 (Animal Science) | |
| 5. | Mr. Shashi Vishwakarma | T-4 (Lab Technician) | |
| 6. | Mr. Prajapati VS | T-4 (Computer) | |
| 7. | Mr. Irappa M Chalwadi | Driver-cum-Mechanic T-4 | |
| 8. | Mr. 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 Shelko | | |



Staff activities

Appointments / Joining

| Name | Post | Date of Joining |
|------------------------|---------------------------------------|-----------------|
| Dr. Shivasharanappa N | Scientist (Veterinary Pathology) | 19-12-2015 |
| Shri. Viswanatha Reddy | Scientists (Agricultural Economics) | 22-04-2015 |
| Ms Maneesha SR | Scientist (Fruit Science) | 01-04-2015 |
| Dr. Chethan Kumar | Scientist (Veterinary Public Health) | 10-04-2015 |
| Shri. Bappa Das | Scientist (Agricultural Meteorology) | 09-10-2015 |
| Dr. Paramesha V | Scientist (Agronomy) | 12-10-2015 |

Promotions

| Name & Designation | Post held | Promoted Post | Date of promotion |
|----------------------|--------------------------------------|--------------------------------------|-------------------|
| Dr.S. Priya Devi | Senior Scientist Grade Pay - 8000 | Senior Scientist Grade Pay - 9000 | 19/11/2013 |
| Dr. Z. B Dubal | Scientist Grade Pay - 7000 | Senior Scientist Grade Pay - 9000 | 01/01/2014 |
| Dr. R. Maruthadurai | Scientist Grade Pay- 6000 | Scientist Grade Pay- 7000 | 27/04/2015 |
| Shri. Rahul Kulkarni | Technical Officer (T-5) | Senior Technical Officer (T-6) | 01-01-2015 |
| Smt. Sneha Arlekar | Assistant | Assistant Administrative Officer | 02-11-2015 |

Superannuation

| Name | Post held | Date of Retirement |
|--------------------------|----------------------------------|--------------------|
| Shri. Vishram Gaonkar | Subject Matter Specialist | 31-07-2015 |
| Shri. Vinayak Kulkarni | Asst. Chief Technical Officer | 29-02-2016 |
| Smt. Maria Teresa Nigli | Assistant Administrative Officer | 31-10-2015 |
| Smt. Farida B Jabbarkhan | Skilled Support Staff | 31-10-2015 |
| Smt. Rukma Naik | Skilled Support Staff | 31-01-2016 |

Transfer

| Name & Designation | Post held | Transfer to | Date of transfer |
|---------------------|---|--------------------------------------|------------------|
| Dr. Samir Kumar Das | Principal Scientist (Livestock Production Management) | ICAR- IVRI Research Station, Pune | 30-11-2015 |
| Dr. K. Muniswamy | Scientist (Animal Bio-technology) | ICAR – CIARI, Port Blair | 19-12-2015 |



Visit of Hon'ble Deputy Chief Minister of Goa



Visit of Deputy Director General (NRM) ICAR



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



Agrisearch with a human touch



ICAR-Central Coastal Agricultural Research Institute



भाकृअनुप-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

