Silver Jubilee Celebration
1989 - 2014

CELEBRATING 25 Years Silver Jubilee Publication

SOUVENIR

भाकृअनुप
ICAR

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

(भारतीय कृषि अनुसंधान परिषद)

ओल्ड गोवा- ४०३ ४०२, गोवा, भारत

ICAR Research Complex for Goa

(Indian Council of Agricultural Research)

Old Goa - 403 402, Goa, India

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MRS. MRIDULA SINHA
Governor of Goa
श्रीमती मृदुला सिन्हा
राज्यपाल, गोवा.

सत्यमेव जयते

Raj Bhavan
Goa - 403 004
राज भवन
गोवा - **403 004**

MESSAGE

I am happy to know that the Indian Council of Agriculture Research's Central Coastal Agricultural Research Institute at Old Goa, is celebrating its silver jubilee. It is a matter of satisfaction that this research organization has recently been upgraded to serve the coastal ecosystem of our country. This recognition brings an added responsibility on them to ensure agricultural research and development on a sustainable basis, without causing harm to the established ecosystem.

Scientific discoveries and technological devices have immensely facilitated in the increase in agricultural production and productivity in our country. While our past achievements in the field of agriculture has been highly impressive, we have to appreciate that there is need to further increase our production and productivity in agriculture and allied sectors, in order to fulfill the food security of the rising population and for greater progress of the nation. At the same time, we have to ensure that our developmental endeavours are in harmony with the environment and ecology. I am confident that the ICAR - CCARI, Old Goa, will, on this historic occasion, rededicate itself to bring out more innovative ideas and practical methods to further increase our agricultural production in harmony with the eco-system. I also hope that Goa will continue to benefit from their expert services, in its efforts to achieve higher production in agriculture and allied sectors.

I extend my best wishes to the scientists and others of this Institute, on this occasion, for success in their continued work.

(Mridula Sinha)
Governor

24th February, 2015

LAXMIKANT PARSEKAR
Chief Minister, Goa

MESSAGE

On behalf of the Government and people of Goa , I take great pride in congratulating ICAR -Central Coastal Agricultural Research Institution, formerly known as ICAR-ICAR Research Complex for Goa on celebrating its silverjubilee year 2014-15. I am indeed happy and pleased to read this souvenir.

The Institute has ser\/ed the farmers of Goa by developing several useful technologies and guided them through its various development activities. The Institute has also played a major role in conserving the highly diverse and unique germplasm of plant and animal species of Goa. It was enlightening to read the souvenir being published on this occasion, which gives an in-depth picture of the work done for Goa in these 25 years . I am sure the Institute in its upgraded capacity will play a major role in the research and development in coastal ecosystem of India of which Goa is also a part, and assure the support of the Government and people of Goa in its future endeavours.

I congratulate staff of the Institute and wish them all the success in the future.

Laxmikant Parsekar
Chief Minister - Goa.

RAMESH B. TAWADKAR
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MESSAGE

It's a matter of great honor to felicitate the ICAR- Central Coastal Agriculture Research Institute which is dear to the farmers of Goa for its painstaking research and development work as ICAR-ICAR Research Complex for Goa on its silver jubilee year celebration. I was very happy to read this souvenir which elaborates all the research Work done by this institute for the farmers of Goa.

I personally acknowledge and applaud the pioneering development work done by the institute for the tribal farmers of Goa under its Tribal Sub Plan projects. I am sure that the good Work done will be continued in a larger scale for the coastal ecosystem of India and assure our continued support to the institute in its future endeavors.

I once again congratulate the entire staff of ICAR-CCARI in this momentous occasion.

Ramesh B. Tawadkar
Minister for Agriculture,
Sports & Youth Affairs, Tribal Welfare,
Animal Husbandry & Veterinary Services

AVERTANO FURTADO
Minister for Labour & Employment, Fisheries & NRI Affairs,
Government of Goa

MESSAGE

It gives immense joy to congratulate ICAR;Central Coastal Agricultural Research Institute, Goa for their Silver Jubilee year celebration and applaud their sincere efforts in publishing this souvenir which throws light on the magnitude of research and development work done by them for the farming community of Goa. Their contribution for the fisher folk of Goa through their Potential Fishing Zone forecasts and marine and brackish water fish germ plasm conservation work is praiseworthy.

Their sincere efforts have resulted in the promotion of the institute to serve for the entire coastal ecosystem and I am sure they will make remarkable contribution for the development of the same through their continued sincere efforts.

I once again congratulate them and wish them the very best in their future endeavors.

Avertano Furtado
Minister for Labour & Employment,
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डॉ. नरेंद्र प्रताप सिंह
निदेशक

Dr. Narendra Pratap Singh
Director

गोवा के लिए भा.कृ.अनु.प. का अनुसंधान परिसर, ओल्ड गोवा.
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PREFACE

ICAR Research Complex (ICAR RC) for Goa is one of the research institutes under Natural Resource Management division of Indian Council of Agricultural Research, New Delhi. ICAR RC Goa conducts multidisciplinary research in agriculture and allied sectors viz. animal sciences and fisheries. This Institute plays a major role in promoting excellence in agriculture and is mainly involved in research activities which are aimed at improving the production and productivity of major crops of this region through various strategies including farming system approach.

This exclusive Souvenir is brought out specially to mark the occasion of the Silver Jubilee celebration of ICAR Research Complex for Goa. As we complete 25 years of research we look back with pride at our humble beginnings.

However with the concerted efforts of all the scientists, administrative, technical, and other supporting staffs much headway has made in agricultural sector in Goa. I offer my congratulations and appreciation to all who have contributed in one way or other to bring out this souvenir. We are deeply indebted to the message received from dignitaries on this occasion. Their good wishes and guidance inspire us to strive harder in our endeavor to fulfill the dreams of the farmers of Goa.

(Narendra Pratap Singh)

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ICAR research Complex for Goa – An Overview

Dr. Narendra Pratap Singh
Director
ICAR Research Complex for Goa
Old Goa - 403402

Historical Background

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

ICAR Research Complex for Goa is one of the research institutes established under Indian Council of Agricultural Research (ICAR), New Delhi. ICAR is an autonomous organization under Department of Agricultural Research and Education (DARE), Ministry of Agriculture, Government of India. ICAR Research Complex for Goa was established in April, 1976 as a regional centre under ICAR Research Complex for Northeast Hill region, Shillong, Meghalaya. Subsequently it became the regional centre under CPCRI, Kasargod. Considering the importance of agriculture in Goa state, ICAR, New Delhi, upgraded the centre into an Independent Institute from April, 1989. This Institute is under the Natural Resource Management (NRM) division of ICAR. In 1983, a Krishi Vigyan Kendra (KVK) was established in this Institute to provide transfer of technology to the farming community of Goa. ICAR Research Complex for Goa is spread over 53 ha in which all the major infrastructure and experimental field for research work are established.

The Institute is situated in Old Goa, the historical capital of Goa during Portuguese times. This Institute provides research and developmental support to the agriculture and allied sector of Goa region. It plays a major role in promoting excellence in agriculture. This Institute is mainly involved in research activities which are aimed at improving the production and productivity of major crops of this region through various strategies including farming system approach. Other important areas of research include livestock and fisheries sector to increase the milk, meat and fish production.

The research activities are carried out under five functional groups namely Natural Resource Management, Crop Science, Horticulture Science, Animal Sciences and Fishery Science. Extension programmes are carried out through both on campus and off campus training and field demonstrations through active participations of KVK.

In addition to the inhouse projects, the Institute has 18 projects funded by various agencies like Bill Gates and Milinda Foundation through IRRI, Department of Science, Technology and Environment, Goa, Government of Goa, World Noni Research Foundation, Department of Biotechnology, National Fisheries Development Board, Ministry of Agriculture, Government of India, ICAR funded projects - AMMAS, AICRP *etc.* Institute also has many projects under Rashtriya Krishi Vikas Yojana, and Tribal Sub-Plan Programme every year.

Mission

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

Mandate

To conduct strategic and applied research on potential agricultural and horticultural crops, livestock and fisheries for improving productivity and post harvest management.

To disseminate improved technology developed

To act as centre for training in updated technologies

To collaborate with national and international institutes/agencies in developing and transferring new technologies

To generate nucleus planting materials

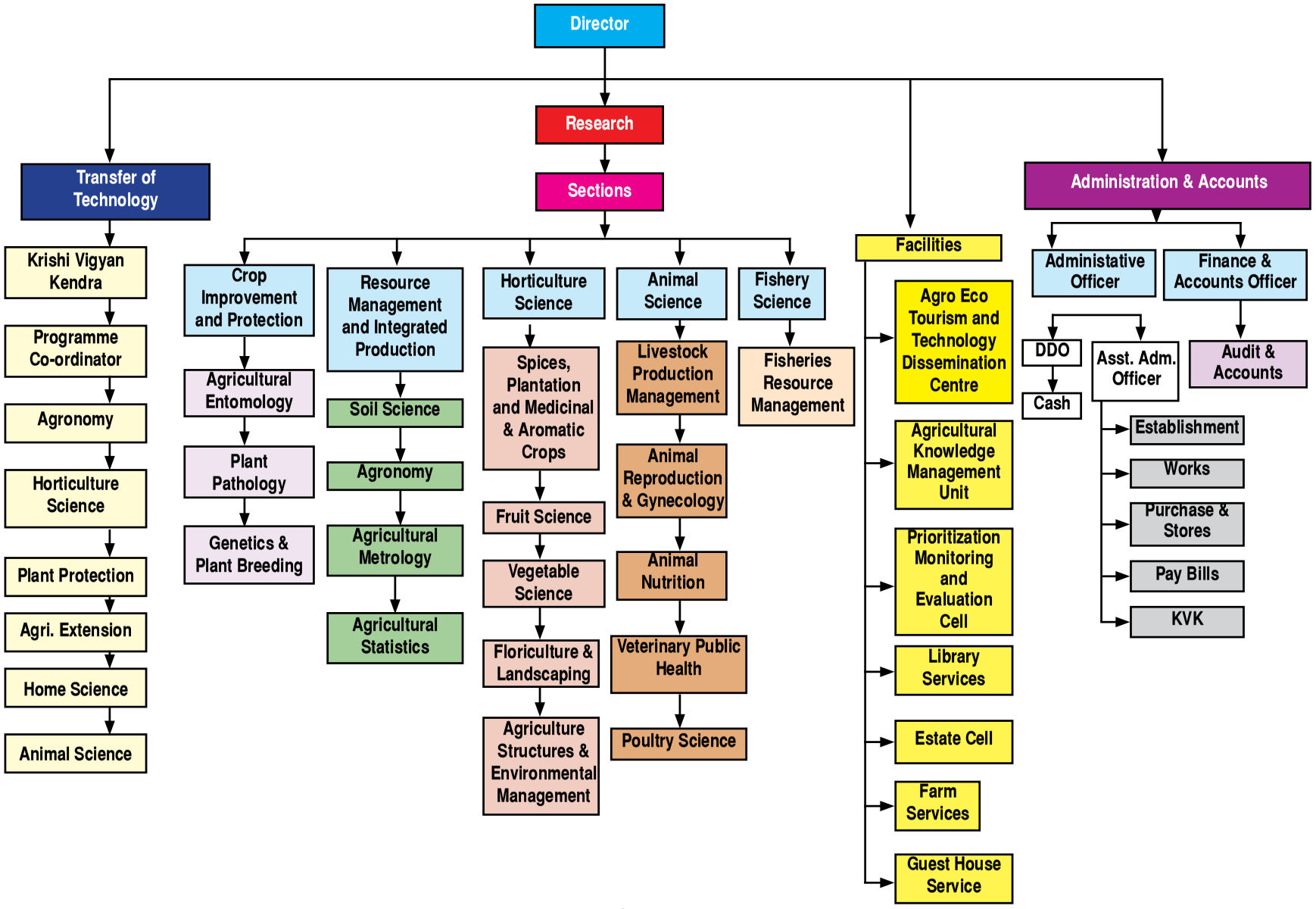
To provide consultancy services and

To act as repository of information on Western Ghat Agricultural System

Staff position

The Institute is headed by the Director. The staff strength of 88 in the Complex comprises of 17 Scientists from different disciplines and 17 technical, 18 administrative and 28 supporting staff.

Organizational Setup



Organogram

Research Achievements

Natural Resource Management

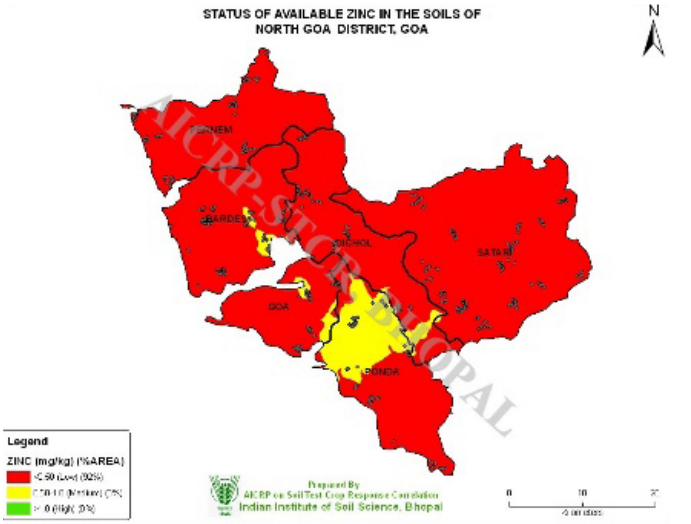
Soil and water conservation and bioengineering measures for coconut and mango crops have been standardized to check soil and water erosion on sloping lands. The best conservation measures were circular trenching coconut and continuous contour trenching + vegetative barrier in mango for conserving soil and water in field.

Continuous Contour Trenching + Vegetative Barrier

A low cost water harvesting structure was designed considering the importance of the conservation of the rainwater and its use during post monsoon season. The water could be utilized to provide protective irrigations to the crops of rabi season or fulfilling the water needs of the agriculture or allied enterprises.

Direct water catchment pit

GIS and GPS based soil fertility mapping of entire State of Goa was completed. Soil fertility maps of different parameters like, soil pH, electrical conductivity, soil organic carbon, soil available nitrogen, phosphorus, potassium and micronutrients have been prepared.



Status of available Zn in the soils of North Goa

Two integrated farming system models for small and marginal farmers viz. upland (plantation crop based) and lowland (rice based) model has been developed and standardized.

Lowland model (rice based farming system)

Crop Improvement and Protection

Korgut – a traditional landrace of Goa has been registered as a unique germplasm for tolerance to salinity stress at seedling stage with NBPGR, New Delhi. The land race has been assigned registration number INGR1405. Phenotyping for salt stress tolerance at seedling stage under hydroponics culture with EC=12 dS m^{-1} showed its tolerance to salinity stress (SES Score=3)

Korgut - rice landrace

Sixteen land races and 18 wild relatives of rice were collected from Goa and adjoining coastal areas and characterized for various agro-morphological traits. Traditional knowledge associated with each of the accession was also recorded.

Wild rice

Varieties Pusa – 44 and Karjat-3, were found most promising for rainfed shallow lowland rice ecology.

Rice variety Karjat - 3

Varieties CSR-23 and CSR-27, were found most promising for coastal salinity situation

Rice variety CSR - 23

Goa Cowpea – 3 A selection from local cowpea collections has been approved for release by the State Variety Release Committee. It is a bold seeded grain cowpea suitable for cultivation under residual moisture condition in rice fallows. It has an average yield is 1.5 t ha^{-1}.

Semi-synthetic diet has been formulated for mass rearing of cashew stem and root borer. This helps in carrying out laboratory studies on CSRB which is most serious pest of cashew.

Pupa

Technology for management of cucurbit fruit fly using border crops (maize, castor) and food baits was developed. This technology is eco-friendly and reduces the use pesticide.

Two types of low cost traps namely Ethanol and light trap were designed collection of ambrosia beetle in cashew plantation. More number of ambrosia beetles was attracted to light trap compared to ethanol trap.

Ethanol trap

Antagonistic bacterial formulation (talc based) reduced the incidence of bacterial wilt (60-70%) and increased the yield (27-30%). Field demonstrations

in vegetable growing villages indicated reduced incidence of bacterial wilt and recorded higher yield in the antagonistic bacteria treated plots compared to untreated control plots.

Three varieties – Surya, Shweta and Utkal Madhuri were identified as highly resistant to bacterial wilt even at high pathogenic population. These could used in breeding programme to develop bacterial wilt resistant varieties.

Wilt in watermelon is caused by *Fusarium oxysporum f.sp.* niveum and is a serious problem rabi cultivation and the economic loss is very high. Seed treatment and seedling drench with biocontrol (Trichoderma) formulation reduced the incidence of wilt and increased the number of fruits. Per cent reduction of wilt was 70-76% and per cent increase in number of fruits was 26-30%.

Bio-PCR was standardized to detect presence of the *Ralstonia solanacearum* from soil, plants and weeds. This method does not require isolation of DNA and the detection threshold is 50 cfu g^{-1} soil. This method includes internal positive control to avoid false negatives.

Pulsed field gel electrophoresis (PFGE) techniques was standardized for *R. solanacearum* typing. This method delineate the isolates based on geographical regions and by host to certain extend, and not by year of isolation or virulence. Since PFGE is a whole genome based method, this could be used to identify the emergence of epidemic or in quarantine.

Standardization of mass production and formulation of fungal (*Trichoderma spp.*) and bacterial (*Pseudomonas spp., Bacillus spp.*) bio-agents was done. The quality of the product is as per the national standards.

Technology for production of vigorous cashew grafts in nursery using microbial consortia for better establishment in the field has been developed. Bio-fortification reduces use of 25-50% nitrogenous and phosphatic fertilizers in the initial stage.

Root knot nematode (*Meliodogyne incognito*) tolerant vegetable amaranth has been selected by the Institute

Horticulture

Casher variety Balli – 2 (Goa -1) released.

Three local bold nut cashew genotypes viz. Valpoi-2, Bardez-9, Ganje-2 and Tiswadi-3 with nut weight of more than 10 g, apple weight of 100 g and higher shelling percentage (more than 28%) were identified as promising genotypes.

Ganje – 2

Out of 268 accessions studied in kokum for flowering and fruiting, there were early, mid and late bearers. Among them, 38 accessions (14.18 per cent) were early bearers, 67 accessions (25.00 per cent) were mid-season

Kokum

bearers and 163 accessions (60.82 per cent) were late bearers. Early maturing germplasm: Acc. No. 149 (Savoi Kamini-1) which was located in Ponda taluk was the earliest among all for flowering and fruiting.

Cardozo Mankurad Selection - a promising germplasm with attractive fruit color, bigger fruit size, bettr shelf life, higher fibreless pulp, higher fruit yield and regular bearer has been registered with NBPGR, New Delhi. (National identity IC0587716 and registration number INGR 11023)

Cardozo Mankurad

Technologies on crop production, plant protection and harvesting and packaging of gerbera, anthurium, lilium and coloured capsicum standardized.

Technologies on crop production, plant protection and harvesting and packaging of heliconia and china aster standardized.

Processes for value addition of the fruits like jackfruit, wax jamboo, rose apple, mango, nutmeg, aonla, kokum, etc.

Coconut based multitier cropping system involving jackfruit, kokum, lemon aonla, papaya, black pepper, etc and arecanut based cropping system involving, black pepper, betel vine, sweet potato had been standardized.

Improved package of practices of pineapple under coconut shade has been standardized.

Microbial consortia have been identified and improved process of fermentation of cashew apple juice has been standardized. It is an efficient process compared to traditional in terms of yield, flavor, appearance and odor.

Animal Sciences

AI in pigs

The Institute has standardized artificial insemination (AI) technology in pigs for cross-bred pig production. The same facility is being provided to the farmers on their field.

Standardization of technology for production and its rearing of crossbred pig (Large white Yorkshire × local)

Agonda Goan – A local pig breed is identified.

Technology for production and feeding of hydroponics fodder introduced and standardized.

Hydroponics unit

A simple indigenous small scale farmer technology for preparation of bypass fat from vegetable (palm) oil, fatty acid and calcium oxide and hydroxide and feeding strategies of the same have been standardized

Agarose Gel Electrophoresis (AGE), a superior, efficient, less laborious and economical method have been standardized for rapid diagnosis of the rotavirus from the fecal samples of human.

An online database, Indian Listeria Culture Database (ILCD), for an online databank of profiles of Listeria has been developed.

A repository of 680 cultures of listeria isolated, collected, submitted from all over India is being maintained at the Institute.

A PCR based diagnostic kit for detection of *Listeria monocytogenes* from clinical and food samples was developed.

A rapid method of Pulsed Field Gel Electrophoresis (PFGE) for typing Listeria based on macro-digestion of the listerial genome was established.

Standardized PCR protocols (Trans-PCR and Real-time PCR) for rapid and reliable detection of Coxiella burnetii and real time PCR for Brucella in clinical samples of humans and animals.

Production technology mostly the nutrition requirement of backyard poultry (Vanaraja and Giriraja) was standardized.

Fisheries

A digitalized database of aquatic and fisheries resources for Goa (FROG) was developed using Open source Relational database system and installed on Linux machine.

The Institute offers Potential Fishing Zone (PFZ) advisory (through electronic display boards (EDBs), telephone, email and website) based on the Chlorophyll, Sea Surface Temperature (SST) and wind based shifting feature data derived on Remote Sensing (RS) and Geographical Information System (GIS) techniques with 2-3 days validity.

Exploration of fish biodiversity in Goa was done

Standardized low cost mussel culture technology in coastal waters of Goa

Low cost ornamental fish feed formulated and also standardized the breeding technologies for many ornamental fishes.

General

Decision Support System - a single window system for agricultural information to the farmers of Goa was developed. This is an online application and provides complete information regarding package of practices and technologies suitbale for Goa.

A web portal – Soil Health Management - Goa has been developed considering the importance of soil fertility, nutrient recommendation and soil health

A software DG-MAP was developed to map the primer sequences on whole genome sequences. The software works well specifically for RAPD and SSR markers and also works out the distance between the priming sites.

Web Based Agricultural Statistics Software Package (WASP) for carrying out statistical analysis of the experimental data is developed.

Agro-eco-tourism cell established at the institute's Agricultural Technology Dissemination Centre.

Soil Science Research at ICAR Research Complex for Goa, A Glance

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ICAR Research Complex for Goa, Old Goa, Goa
[b] Principal Scientist (Agronomy),
Indian Institute of Horticultural Sciences,
Bengaluru, Karnataka

Introduction

Soils, one of the very important natural resources, vary greatly with topography, climate, vegetation, etc. Soils of Goa are diverse and possess several constraints for crop production. In this article, the research work carried out by Central Coastal Agricultural research Institute, Old Goa, Goa India has discussed in brief. This mainly focus on identification of soil related problem and studies on their management.

The soils of Goa are mostly lateritic (81%), which are rich in ferric aluminum oxides and reddish in color. The soil is rich in minerals and humus, thus conducive to plantation crops. Goa lies in the tropical zone and has warm and humid climate. The soils are mostly sandy loam to silt-loam texture, well drained and highly acidic (5.5 to 6 .5 pH). Although soils of Goa are rich in humus and minerals, still it possesses few constraints for crop production. The Institute has carried soil fertility (macro and micro nutrients) mapping of two districts – North Goa and South Goa. Sea water intrusion induced coastal soil salinity is one another constraint for rice production in Goa. Such soils are spread over 18000 ha and rice is a prevalent crops over 12000 ha. The rice productivity is often lower under such situation.

The soil degradation status of Goa shows that 163480 ha representing 44.16% of the total geographical area are affected by various soil degradation problems. The Institute has developed and studied various soil and water conservation measure for crops like cashew, mango and coconut.

The Institute has been playing an important role in understanding and managing one of the important natural resources i.e. soil thorough its various research programmes. The significant outcomes of the same has been discussed here onwards

Conservation of soil, moisture, carbon and nutrient through soil and water conservation measures on sloping lands of coastal western Goa

Different kinds of soil and water conservation measure had been developed and evaluated to arrest soil, water, carbon and nutrient loss through erosion. In mango, the Continuous Contour Trenching + Vegetative Barrier (Vetiveria zizanoides), Staggered Contour Trenching + Veg. Barrier reduced the runoff loss by 38.8%, 24.5% and 12.3% and soil loss by 83.5%, 67.1% and 28.9%, respectively over control. Whereas, in coconut the increasing order of percentage runoff to rainfall was as: circular trenching > Circular terraces > Control. Similar trends of soil conservation efficiency, water conservation efficiency and soil and water conservation efficiency in both coconut and mango was recorded. Relatively higher soil moisture content (20%, 18.3%, and 0.7%) under continuous contour trenching + vegetative barrier over control during November, January and March, respectively was observed. The estimations showed that, control treatment could let 598 and 567 kg/ha soil organic carbon erode along with the soils in mango and coconut, respectively. The most effective SWC measures in mango and coconut

Continuous Contour Trenching + Vegetative Barrier

Staggered Contour Trenching + Vegetative Barrier

Vegetative Barrier alone

Circular Trenching in coconut

were CCT+Vb and Circular trenching which allowed 83.7 and 77.5 kg/ha soil organic carbon. Order of total soil nitrogen, phosphorus and potassium loss was noticed as - Mango: CCT+Vb > SCT+Vb > Vb > Control and coconut: circular trenching > Circular terraces > Control.

Development of low cost water harvesting structure

The Institute has standardized a low cost water harvesting structure considering importance of the conservation of the rainwater and its use during post monsoon season. The water could be utilized to provide protective irrigations or fulfilling the water needs of the agriculture or allied enterprises. The dimensions of the structure is L×W×D = 8×6×1.5 m^3 and it has a capacity to store 72 000 liters of water with ten years of approximate life of silpaulin sheet.

A low cost water harvesting structure - Direct Rain Water Catch Pit

GIS and GPS based soil fertility mapping for State of Goa

The Institute has accomplished GIS and GPS based soil fertility mapping of entire State of Goa. Soil fertility maps of different parameter - soil pH, electrical conductivity, soil organic carbon, soil available nitrogen, phosphorus, potassium and micronutrients have been prepared. There are being used for making soil test based fertilizer recommendations.

GPS based soil sampling locations in State of Goa

The soil fertility analysis has revealed that the soils the soils are acidic in soil reaction and have high in soil organic carbon. With regard to available N, about 81%-90% of the total area was predominantly under low category and only 10%-19% was under medium status. In the case of available P, the status was predominantly under low category (74%-82%) and 18%-26% of the area in medium category. The order of area with respect to soil available K, was as, medium (58%-77%)> high (22%-38%) >low (1%-4%). The soils of both the district are sufficient with respect to soil available iron, manganese and copper, however they are deficient in zinc.

Status of available Zn in the

Status of available Zn in the soils of South Goa

Development of web portal on soil health management and issuing of village level soil test based fertilizer recommendations to important crops of Goa

A web portal – Soil Health Management - Goa has been developed by the Institute considering the importance of soil fertility, nutrient recommendation and soil health. It is an online web application developed using base data of about 20,000 analyzed soil samples. It generates information on village and taluka wise soil fertility status of all sampled village and taluka of Goa for important annual and perennial crops of Goa. The information is given on parameters like soil pH, electrical conductivity, soil organic carbon, soil available nitrogen, phosphorus, potassium and micronutrients. It offers fertilizer based on soil fertility status, targeted yield and area, type of crop, age of crop and number of plants separately for annual and perennial crops. Furthermore, final recommendation are given on the kinds of fertilizer and fertilizer grades that are available in Goan market. The combinations of different complex and straight fertilizers are also suggested along with the approximate cost. The possible users for this application are farmers, students, agricultural officers, zonal agricultural officers of Directorate of Agriculture, researchers, policy makers, etc. Advices on how and when to apply fertilizers are also given.

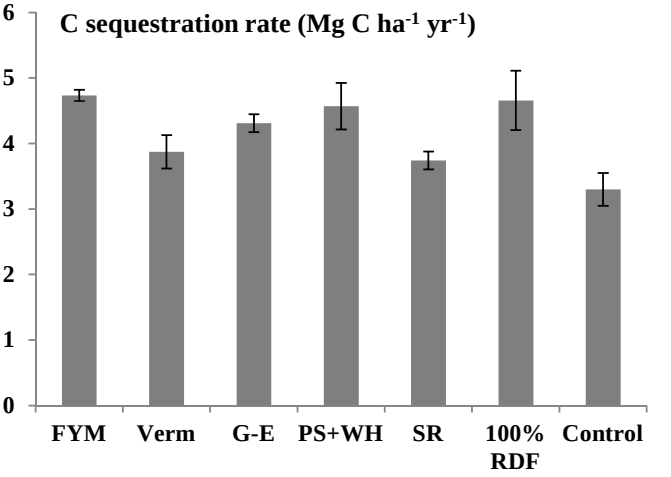
User interface of the Web Portal 'Soil Health Management'

Carbon sequestration through possible organic nutrient sources for rice cultivation in west coast of India

Outcomes of five year field experiment on effect of organic and inorganic nutrient sources on rice revealed a significant carbon sequestration in soil for use of organic sources. Buildup of soil organic carbon over a long run is one of the ways to capture the atmospheric carbon dioxide and this would help to combat climate change by reducing atmospheric carbon dioxide concentration. Highest SOC sequestration was recorded in farmyard manure (23.7 Mg C ha^{-1}) and recommended dose of fertilizer (23.3 Mg C ha^{-1}) treated plots with respective soil organic carbon sequestration rates of 4.7 and 4.6 Mg C ha^{-1} yr^{-1} whereas the least was recorded in untreated control (16.5 Mg C ha^{-1}).

Soil microbial activity

Farmyard manure treated plot had highest soil microbial biomass of 246 µg g^{-1} and it was lowest in untreated (89.5 µg g^{-1} soil) and recommended dose of fertilizer (89.7 µg g^{-1} soil). This inflicts the negative effect of inorganics on microbial activity. Metabolic quotient (MQ) was lowest in farmyard manure treatment and highest in control and 100% RDF, this indicated stress on microorganisms under untreated and inorganic fertilizer treated plots. Improvement in soil enzyme activities – dehydrogenase, phosphatase and urease were observed under organic treatments.



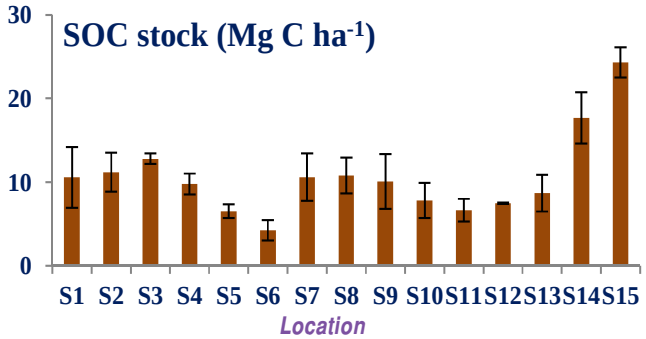
Effect of organic and fertilizer nutrient sources on carbon sequestration rate in rice after 5 years (n=3)

Characterization of unique coastal acid saline soils (Khazan lands) of Goa and its fertility mapping

Soil pH in not real indicator of salinity in these soils. Salinity in these areas exists under low soil pH situations which is one the rare and of its kind only. In general, the coastal saline soils were low in soil available N and P and medium to high with respect to soil available K. The soil available micronutrients - Fe, Cu, Zn and Mn status were recorded in sufficiency ranges. Ex-

changeable Na was the most dominant among all cations. This causes poor physical properties of these soils. These soils had high C storage capacity and had as high as 24.3 Mg C ha^{-1}. Soil salinity inflicts a negative effect of soil biological properties, suggesting environmental salinity stress on microbial activity. Soil organic carbon stocks of acid saline soils - the total soil organic carbon stock of the study sites varied from 4.27 to 24.3 Mg C ha-1. This suggests a brighter side of these soils being a storage house of organic carbon. Relationship between soil chemical and biological properties - Biological properties- dehydrogenase, urease, phosphatase activities, soil microbial biomass carbon and soil respiration were significantly and negatively correlated with EC, exchangeable Na and ESP, and were positively with SOC. The study give platform for deciding the countermeasures to combat coastal soil salinity for crop production.

Global positioning based soil sampling locations in Goa



Soil organic carbon stock of coastal saline of Goa

Integrated nutrient management for rice production in coastal saline soils of Goa

Application of Sesbania rostrata + recommended dose of fertilizer together recorded significantly higher grain yield (3.68 – 4.41 t ha^{-1}) at two different sites affected with coastal soil salinity. Application of Sesbania rostrata + recommended dose of fertilizer is most suitable technology for higher sustainable rice production in coastal saline soils of Goa.

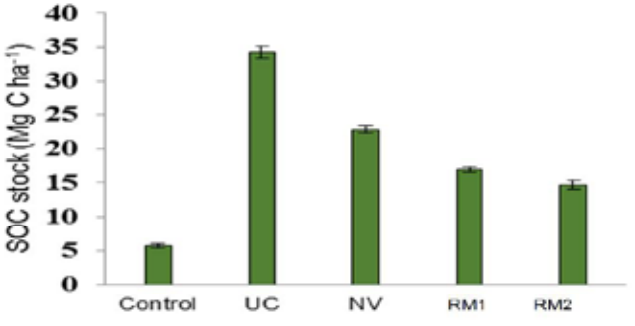
Management of iron ore mine reject soils of Goa

Characterization of mine reject soils of Goa: The iron ore mine reject soils – mine tailing, active mine site and abandoned mine sites are in general low in soil organic carbon, available nitrogen, phosphorus, potassium, sulphur and boron.

These also have very poor biological activity compared to normal soils. Management of iron ore mine reject

Global positioning based selection of the experimental sites

soils: The ectomycorhiza and blend – mine + normal soil + biofertilizer could improve soil available N (by 116%-190%), K (by 73-100%) and S (133%-176%) over the control. Remediation strategies could sequester about 14.7 – 15.3 Mg C ha^{-1} whereas control site had 5.2 Mg C ha^{-1}. Key nutrient mineralization processes – basal soil respiration, microbial biomass carbon and its fraction of SOC could significantly be improved using mentioned remediation strategies.



Improvement in soil organic carbon stock with ectomycorhiza of iron ore mine reject soil using blend – mine + normal soil + biofertilizer (RM1)

Genetic Wealth and Cultivation of Rice in Goa

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Goa state of India has got wide diversity with respect to crop plants. These crops are grown both for domestic and commercial purposes. Main food crops of Goa include rice, ragi, maize, sugarcane and pulses. Rice and fish being the staple diet of the people, paddy becomes the principal crop in the scenario of agriculture in Goa. It is cultivated in both the season *Kharif* or *sorod* and the *rabi* or *vaingan*.

Rice has a long history in Goan agriculture. Though rice area in the State is declining, still it occupies a major area with 45,000 ha under its cultivation. The different rice ecologies prevailing in the state are rainfed shallow lowland, irrigated, coastal saline soils and rainfed upland conditions.

Rainfed shallow lowland ecology

It is the predominant rice ecology occupying 1/3rd of rice area in the state. Jaya, Jyothi, Karjat-3 and few traditional rice landraces are widely grown in this ecology. Farmer prefers medium duration rice variety with semi tall type and having lodging resistance. This ecology is characterised by continuous water stagnation ranging from 30-50 cm throughout the crop period.

Rainfed upland ecology

Upland ecology is prevailing in pernem taluka of North Goa and Canacona taluka of South Goa. The intermittent drought spell for 10-15 days affects the rice yield considerably in these areas. Further, the cultivation of non-drought tolerant rice varieties due to lack of awareness among the farmers resulting in poor yield. Hence, introducing high yielding short drought tolerant rice varieties will help in boosting the productivity.

Coastal wet lands

Coastal saline soils are the low lying areas affected with sea water ingression. Only traditional landraces *viz*., Korgut and Asgo are still cultivated by the large number of farmers. Along with salinity, flash flooding and water stagnation are the frequently occurring problem in these soils. The introductions of high yielding varieties into this ecology are not successful as farmers prefer local varieties due to their specific culinary preferences. Improving the local landraces with respect to grain yield will enhance the productivity in this ecology.

Coastal rice ecology

Rained shallow land ecology

Rainfed upland ecology

Genetic wealth

Both improved and traditional varieties are part of rice farming in Goa. Farmers still cultivate old traditional landraces due to their specific properties. We could find huge diversity in respect local rice germplasm including landraces and wild relatives. Goan farmer's have grown, selected and evolved a series of rice varieties meeting to their specific demands. They are better adapted to the region with high nutritive value having varying levels of resistance to biotic and abiotic stresses.

Rice landraces and their characteristics

Among the traditional rice varieties grown in the state, Korgut, Asgo and Shidde occupy larger areas especially in the coastal saline soils, locally known as *khazan* lands. They are able to with stand high salinity stress and water stagnation. They are preferred over the improved varieties because of their various uses like suitability for parboiled rice, in the preparation of Ganji, and farmer's feel satiation for long time after consuming these varieties.

Landraces *viz*., Damgo, Belo, Walayo, Kalabelo and Mudgo are very popular among the farmer's in the Northern part of Goa in the Pernem Taluka. These are relatively high yielders and are grown mainly for regular consumption.

Saalsi, an aromatic short slender grain type variety popular in South Goa. This variety is cultivated by few farmers in small pockets. Rice from this variety is used preparation of sweet dishes during major festivals.

Other varieties like Kolio and Tambri Patni are cultivated in rainfed upland situation, locally known as *morod* lands. They can withstand water deficit conditions, a situation more common in *morod* lands or rainfed uplands. Similarly, varieties Kendal and Kochri are popular local varieties in sandy areas.

However, due to introduction of high yielding modern rice varieties like Jaya, Jyothi and Karjat-3 and also the lack of encouragement for farmers to grow these traditional varieties, cultivation of these decreased to a larger extent. This has resulted in not only loosing the important germplasm materials, but also the various important genes which could aid in development of new improved varieties.

Efforts are being made by ICAR Goa to collect, conserve and evaluate all the available rice genetic resources from Goa. The survey was conducted in all rice-growing places to collect the traditional landraces. Contributing farmers were approached, and information on personal, location details and special features of each of the landraces was gathered. The vernacular names along with their collection sites were given in Table 1.

Table 1. List of Traditional Rice varieties of Goa and their place of Collection

Sl. No.	Landraces	Source/Site of Collection
1	Belo	Asapur, North Goa
2	Damgo	Anconem, North Goa
3	Mudgo	Anconem, North Goa
4	Kala Belo	Asapur, North Goa
5	Walayo	Torxem, North Goa
6	Kendal	Neura, North Goa
7	Babri	Torxem, North Goa
8	Korgut	Chorao Island, North Goa
9	Shidde	Amona, North Goa
10	Red Kochri	Sangolda, North Goa
11	White Kochri	Sangolda, North Goa
12	Saalsi	Gaodongrim, South Goa
13	Kolyo	Kotigao, South Goa
14	Panyo	Gaodongrim, South Goa
15	Asgo	Loutulim, South Goa
16	Xitto	Awali, South Goa

Characterization and study of genetic diversity among the collected landraces revealed enormous diversity among them. The diversity in panicle size, shape and grain colour is evident from the collected germplasm

Diversity among the landraces with respect to panicle and grain size.

Exploiting this genetic diversity among the landraces and using them in future breeding programme for improving the tolerance to abiotic stresses help in breaking the yield barrier.

An Insight of Major Insect Pests and Their Management in the Crop Plants of Goa

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Introduction

Insects are the most abundant and diversified group of organism on the planet. Goa is having a variety of flora and fauna owing to its location on Western Ghats. The climatic condition in Goa is hot and humid which is favourable for the incidence of insect pests in major crop plants causing severe loss in the production and productivity, sometimes complete crop failure. In recent times, some of the minor pests are attaining major status and sporadic occurrence of insect pests may be due to increasing in climate change. In this article, status of insect pests on economically important crop plants and their management options are discussed. The current status of insect pests in the major crops grown in Goa is given below.

Major insect pests of crop plants in Goa

Crop	Insect pests	Scientific name	Incidence
Paddy	Leaf folder	*Cnaphalocrosis medinalis*	Moderate to severe
	Caseworm	*Nymphula depunctalis*	Low
	Stem borer	*Scirpophaga incertulas*	Traces
	Brown plant hopper	*Nilaparvata lugens*	Moderate
	Gundhi bug,	*Leptocorisa acuta*	Moderate to severe
	Army worm	*Spodoptera mauritia*	Sporadic
	Blue beetle	*Leptispa pygmaea*	Sporadic
	Gall midge	*Orseolia oryzae*	Traces
Groundnut	Pod borer	*Anisolobes stallii*	Severe
	Aphid	*Aphis craccivora*	Low
	Leaf miner	*Aproaerema modicella*	Low
Sweet potato	Sweet potato weevil	*Cylas formicarius*	Severe
	Hornworm	*Agrius convolvuli*	Sporadic
	Armyworms	*Spodoptera litura, S.exigua*	Sporadic
Pulses	Pod borer	*Helicoverpa armigera, Spodoptera litura*	Low
	Pod fly	*Melanagromyza obtuse*	Moderate
	Pod bug	*Clavigrallla gibbosa, Riptortus pedestris*	Low
	Leaf miner	*Aproaerema modicella*	Low
	Blue butterfly	*Lampides boeticus*	Low
	Cowpea Aphid	*Aphis craccivora*	Moderate to severe
	Whitefly	*Bemisia tabaci*	Low
Sugarcane	Wooly Aphid	*Ceratovacuna lanigera*	Sporadic

	Early shoot borer	*Chilo infuscatellus*	Low
	Internode borer	*Chilo sacchariphagus indicus*	Low
	Scale insect	*Melanaspis glomerata*	Sporadic
	Termite	*Odentotermes obesus*	Low
Mango	Mango hopper	*Idioscopus clypealis, I.nitidulus & Amritodus atkinsoni*	Low to moderate
	Stem borer	*Batocera rufomaculata*	Low
	Scale insect	*Chloropulvinaria polygonata, Aspidiotus destructor*	Traces
	Fruit fly	*Bactrocera dorsalis*	Moderate
	Shoot borer	*Chlumetia transversa*	Low
	Leaf webber	*Orthaga exvinacea*	Low
Papaya	Mealy bug	*Paracoccus marginatus*	Low to moderate
Banana	Corm Weevil	*Cosmopolites sordidus*	Low
	Stem Weevil / Pseudostem borer	*Odoiporus longicollis*	Low
Coconut	Red palm weevil	*Rhynchophorus ferrugineus*	Severe
	Rhinoceros beetle	*Oryctes rhinoceros*	Low
	Eriophyid mite	*Aceria guerreronis*	Severe
	Black-headed caterpillar	*Opisina arenosella*	Sporadic
Cashew	Stem and root borer	*Plocaederus ferrugineus*	Severe
	Tea mosquito bug	*Helopeltis spp*	Severe
	Apple and nut borer	*Thylocoptila panrosema*	Low
	Leaf and blossom webber	*Lamida moncusalis*	Low
	Thrips	*Rhynchothrips raoensis*	Low
	Ambrosia beetle	*Euplatypus parallelus*	Traces
	Leaf miner	*Acrocercops syngramma*	Low
	Mealy bug	*Ferrisia virgata, Phenococcus solenopsis*	Sporadic
Brinjal	White fly	*Bemisia tabaci*	Low
	Epilachna Beetle	*Epilachna vigintioctopunctata*	Low
Chilli	Mite	*Polyphagotarsonemus latus*	Moderate
	Thrips	*Scirtothrips dorsalis*	Low
Bhendi	Shoot and fruit borer	*Earias vittella & E. insulana*	Low
	Leafhoppers	*Amrasca biguttula biguttula*	Low
Cucurbits	Fruit fly	*Bactocera cucurbitae*	Severe
	Pumkin Beetle	*Aulacophora foveicollis & A. lewisii*	Moderate
Turmeric	Rhizome scale	*Aspidiella hartii*	Low
	Shoot borer	*Conogethes punctiferalis*	Low

Field crops

Paddy

Rice is an important stable food crop for Goa. Different rice varieties/ lines/ hybrids were screened against major insect pests. Gall midge, case worm, gundhi bug, brown leaf hopper, stem borer and leaf folder are recorded as major insect pests over the years and the incidence is low to moderate. Damage level is well below the economic threshold values and concluded that in general no insecticide spray is required. However, damage level reach above threshold one insecticide spray is essential to manage the problem. In recent times, moderate incidence of gundhi bug has been observed during kharif and rabi season. Sporadic incidence of army worm and blue beetle has also been recorded may be due to increasing in climate change.

Groundnut

Groundnut, sweet potato and pulses like cowpea are cultivated during rabi season in residual soil moisture conditions of rice fallows. Groundnut pod borer/ earwig/ wireworm infestation is a major production constraint of rabi groundnut grown on residual soil moisture in the state. It could be managed through protective irrigation at sowing and pegging stage and insecticides drenching. Minor incidence of aphid and leaf miner has also been observed.

Sweet potato

Sweet potato is an important crop of the rice based cropping system in the state of Goa. This crop is heavily infested by the sweet potato weevil. It is managed by dipping sweet potato cuttings in insecticide solution for 1hr and installation of sex pheromone trap. Sporadic incidence of horn and army worm has been observed.

Sugarcane

Among the insect pests of sugarcane, wooly aphid, early shoot borer, internode borer and termites are major pests and cause yield loss. These insect pests could be managed through use of tolerant sugarcane varieties, conservation of predators, release of *Trichogramma* eggs @ 5 lakh/ha and other cultural practices.

Pulses

Pulse pod borer, leaf miner and spiny pod borer has occurred in severe to moderate intensity. Tur pod fly and pod borer was particularly severe on red gram. High incidence of aphids was recorded on cowpea. In general farmers are not using any spray against the problem. Spraying of systemic insecticide is able to manage aphid menace in cowpea.

Plantation crops

Cashew

Cashew is a major plantation crops grown in Goa. It is infested by different insect pests. Among these, stem and root borer and tea mosquito bugs are major one and causing severe loss to growers. CSRB is an internal tissue borer and infestation was up to 10% in different periods and severely attacked trees die within a period of two years causing substantial tree loss. Farmers are come to know of the infestation only after the tree is dead and they are not practising any plant protection measures against the pest. It could be managed through mechanical removal of grubs and treat the infested trees of the trunk region up to one meter height from the ground level and on exposed roots with Chlorpyriphos @ 10 ml in one litre of water. The tea mosquito bug is another important and most serious pest of cashew in Goa and causes more economic loss to the crop. It is estimated that this pest alone cause 20-60 per cent yield loss. Management options include spraying of Lamda cyhalothrin at 0.003% during new flushing stage (November- December) and conservation of red ants and other predators.

Coconut

Red palm weevil, rhinocerous beetle, eriophyid mite and black headed caterpillar are the major insect pests of coconut and causing major yield loss. The weevil activity was high after the south west monsoon between October and November, while low activity of the pest was noticed during the monsoon between June and July. Red palm weevil and rhinocerous beetle are managed through installation of pheromone trap and the technology has been standardised. Eriophyid mite could be managed by application of fertilizers and root feeding of insecticide. Management of black headed caterpillar include release of larval parasitoids *Goniozus nephantidis.*

Fruit crops

Mango

Among the insect pests of mango, the hoppers are very serious pest and cause severe yield loss. In severe outbreak conditions it causes complete yield loss. Characteristic clicking sound could be heard during higher infestation periods. Hoppers shelter in the cracks and crevices of the bark or underside the

leaves of the trees during the off season. Hoppers are managed with spraying of systemic insecticides. Fruit fly is another serious and quarantine pest of mango. It could be managed by installation pheromone trap and removal of infested fruits from orchard.

Papaya

Moderate incidence papaya mealy bug has been recorded in Goa. The mealy bug could be managed through release of its parasitoids *Acerophagus papayae, Pseudleptomastix Mexicana* and *Anagyrus loecki*.

Vegetables

Local cultivars of vegetables viz., brinjal, chilli, bhendi and amaranthus are cultivated in small land holding in Goa. Sucking pests like white flies, leaf hoppers, thrips, mites and aphids are the major one and causing severe yield loss, sometimes failure of the crop. In general farmers not using any insecticide spray for these insect pests problem. Spraying of systemic insecticides or neem based insecticides is recommended to manage the sucking pests.

Cucurbits

Cucurbitaceous vegetables viz cucumber, ridge gourd, bitter gourd and snake gourd are cultivated mainly during kharif season in hill slopes. Fruit flies and red pumkin beetles are the major insect pests on cucurbitaceous vegetables. Fruit flies cause damage to an extent of 20 percent with cucumber being most susceptible. Fruit flies could be managed through installation of pheromone traps and squirting of locally available food baits. The technology has been standardized and demonstrated to farmers.

Conclusion

Insect pests are causing damage on major crop plants grown in Goa. Some insect pests are inflicting economic damage viz stem and root borer and tea mosquito bug on cashew, red palm weevil and mite on coconut. Most of the farmers are come to know of the infestation only after the crop is lost or damage reach above threshold level. This is mainly due to lack of knowledge on early diagnosis of insect pests and non-adoption of plant protection measures. Insect pests an economically important crop plants in Goa could be managed through adoption of integrated pest management practices.

Prevalence of Diseases and their Management in the Crop Plants of Goa- An Overview

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Introduction

Goa is strategically located in Western Ghats, the region rich in biodiversity. Goa is a state where many crops are grown in a relatively small geographical area. In recent times it is observed that the productivity of these crops reduced and one of the main reasons is, the loss caused by diseases. Because of its geographical topography including coastal, plain and hill regions coupled with high rainfall favour the development of many diseases in crop plants. In this article, status of disease problems and management options available for major and economically important crop plants of Goa is discussed. Occurrence and prevalence of the diseases in the major crops grown in Goa are given below.

Major diseases of crop plants in Goa

Crop	Disease	Causal agent	Incidence
Rice	Sheath rot	*Sarocladium oryzae*	Moderate
	Bacterial leaf blight	*Xanthomonas oryzae pv. oryzae*	Low
	Blast	*Magnaporthe grisea*	Low
	False smut	*Ustilaginoidea virens*	Sporadic
Groundnut	Dry root rot	*Macrophomina phaseolina*	Moderate
	Crown rot	*Aspergillus niger*	Low
	Stem rot	*Sclerotium rolfsii*	Low
	Early leaf spot	*Cercospora arachidicola*	Moderate
	Late leaf spot	*Phaeoisariopsis personata*	Moderate
	Rust	*Puccinia arachidis*	Moderate
Cowpea	Leaf spots	*Cercospora sp., Septoria sp.*	Low
	Rust	*Uromyces appendiculatus*	Low
	Anthracnose	*Colletotrichum lindemuthianum*	Low
	Charcoal rot	*Macrophomina phaseolina*	Low
	Viral diseases	Many viruses	Moderate
Sugarcane	Eye spot	*Drechslera sacchari*	Low
	Sett Rot	*Ceratocystis paradoxa*	Sporadic
	Pokkah boeng	*Gibberella fujikuroi*	Sporadic
	Red rot	*Physalospora tucumanensis*	Low
	Smut	*Ustilago scitaminea*	Sporadic
	Wilt	*Fusarium sacchari*	Sporadic
	Mosaic	Sugarcane mosaic virus	Low
Mango	Seedling mortality	Many fungi	High

	Powderymildew	*Oidium mangiferae*	Moderate
	Anthracnose	*Colletotrichum gloeosporioides*	High
	Dieback	*Botryodiplodia theobromae*	Low
	Red rust	*Cephaleuros sp.*	High
Papaya	Foot rot	*Pythium aphanidermatum*	Low
	Ring Spot Virus	Papaya ring spot virus (PRSV)	High
	Tree mortality	Complex	High
Banana	Sigatoka Leaf Spot	*Mycosphaerella musicola*	Moderate
	Bunchy Top	*Banana Bunchy Top Virus (BBTV)*	Moderate
	Panama wilt	*Fusarium oxysporam f.sp. cubense*	Low
Coconut	Bud rot	*Phytophthora palmivora*	High
	Stem bleeding	*Thielaviopsis paradoxa*	High
	Ganoderma wilt	*Ganoderma lucidum*	Sporadic
	Leaf rot	Many fungi	Moderate
Arecanut	Fruit rot/ koleroga	*Phytophthora meadii*	High
	Foot rot/ anaberoga	*Ganoderma lucidum*	Sporadic
Black pepper	Foot rot/ quick wilt	*Phytophthora capsici*	High
	Slow decline	*Nematodes, Phytophthora capsici*	High
Ginger	Rhizome rot/ soft rot	*Pythium aphanidermatum*	Moderate
	Bacterial wilt	*Ralstonia solanacearum*	Sporadic
Turmeric	Rhizome rot/ soft rot	*Pythium aphanidermatum*	Moderate
	Leaf blotch	*Taphrina maculans*	Low
Brinjal	Bacterial wilt	*Ralstonia solanacearum*	High
Chilli	Bacterial wilt	*Ralstonia solanacearum*	High
	Leaf curl	Leaf curl virus	Moderate
	Fruit rot	*Colletotrichum capsici*	Moderate
	Powderymildew	*Leveillula taurica*	Low
Bhendi	Powderymildew	*Erysiphe cichoracearum*	High
	Yellow vein mosaic	Yellow vein mosaic virus	High
Cucurbits	Blight and fruit rot	*Phytophthora capsici*	High

Field crops

Rice

Rice is the major field crop of Goa grown mostly during kharif and to certain extend rabi season. Different rice varieties/ lines/ hybrids were evaluated during kharif under Goa conditions. Sheath rot and bacterial leaf blight are observed as the major diseases during kharif over the years and the incidence is low to moderate. It is concluded that fungicide spray is not required for rice during kharif. However, if the incidence of sheath rot is observed during grain filling stage coupled with rainfall, one or two sprays with fungicides is recommended to minimize the loss. During rabi , incidence of blast is observed sporadically whenever the weather conditions are conducive. Under such situations, spraying of fungicide is necessary to check the spread of the disease. In recent times, incidence of false smut has been observed both in kharif and rabi. It is recommended to use the certified disease free seeds to control the disease.

Groundnut

In rice based cropping system, groundnut and pulses like cowpea are cultivated during rabi season. Groundnut is grown in residual soil moisture conditions of rice fallows. Dry root is the major disease problem and it could be

easily managed by seed treatment with bio-control agents and the technology was demonstrated in the farmer's field. In some of the fields, crown rot caused loss of crop during rabi and sporadic occurrence of stem rot is recorded during kharif. Foliar diseases viz. early leaf spot, late leaf spot and rust cause considerable damage whenever the conditions are favourable. One or two sprays of fungicides control these foliar diseases. However, the farmers are not taking up any fungicide sprays in groundnut.

Cowpea

In general, cowpea is not affected much by the diseases in Goa conditions. However, incidence of viral diseases could cause severe losses if the management practices are not followed. For the management of viral diseases, the insect vectors are to be controlled by spraying insecticides. Though leaf spots, rust and root rot are reported from the fields, the crop loss is not significant.

Sugarcane

Incidence of leaf spot and red rot diseases in sugarcane are not significant, most of the farmers don't follow any disease control measures. However significant loss of crop foliage was reported due to leaf spot diseases whenever the environmental conditions are favourable. Sporadic incidence of Pokkah boeng, smut and wilt are reported from some of the fields. Since spraying of fungicides on sugarcane foliage is not feasible, the farmers don't follow any control measures.

Fruit crops

Mango

Seedling and graft mortality in the nurseries is very severe and complete loss of planting material was reported. Application of bio-control formulations during nursery operations reduced the incidence and increased the plant stand. Occurrence of powderymildew during flowering stage is quite common and cause severe damage along with leafhopper infestation. Hence it is important to take fungicide sprays during pre-flowering and flowering stage. Anthracnose disease incidence is quite common in the field, however the damage to the fruits are high during postharvest time. Sporadic incidence of die back in the plantation is reported. Red rust incidence is severe in most of the plantations and no control measures are taken by farmers. It is recommended to take pre-harvest fungicide sprays and hot water treatment of harvested fruits to reduce the damage due to anthracnose and stem end rot.

Papaya

Foot rot in papaya is a serious problem due to high and continuous rainfall during southwest monsoon. Soil treatment with bio-control agent and subsequent treatments with bio-control agents or with fungicide reduce the incidence considerably. Papaya ring spot virus (PRSV) incidence is prevalent in each and every tree grown in the state, though the degree of severity varies. Production of disease free seedlings in insect proof net and control of insect vectors through insecticide spray are recommended for managing PRSV. In recent times, tree mortality with mixed types of symptoms is reported. Our studies pointed out the association of various agents like bacteria, PRSV etc with tree mortality. As the problem leads to complete death of the tree and the etiology is quite complex, detailed study is requires.

Banana

Sigatoka leaf spot is quite common in the banana plantations of the State. It causes severe damage to the crop whenever the conditions are favourable and it is recommended to take up one or two fungicide sprays to minimize the incidence. Sporadic incidence of freckle leaf spot and panama wilt were also reported. Bunchy top disease is highly prevalent in the state and awareness to be created to remove and destroy the infected plants regularly. Most of the banana farmers don't follow any disease management practices.

Plantation and spice crops

Goa, situated in the Western Ghats region, is dominated with plantations of coconut, arecanut, cashew and black pepper. Both plantation and spice crops are attacked by a wide range of diseases leading to huge economic loss. Diseases caused by fungi, especially species of Phytophthora are very important production constraints as they destroy the plantations by killing the plants of all ages. Production and productivity of plantation and spice crops in Goa is low and one of the reasons attributed is loss caused due to incidence of diseases. Bud rot in coconut, fruit rot in arecanut and foot rot in black pepper are the important Phytophthora diseases of plantations, which reduce the economy of the household significantly. Continuous and heavy rainfall during south west monsoon predisposes to these problems.

Coconut

Some coconut diseases are lethal to the tree and others reduce the growth and productivity of the palm. Bud

rot disease is economically important as the palm dies when unattended. Bud rot incidence in coconut is moderate to severe throughout the state; sometimes mortality due to the incidence is as high as 25 per cent at any given point of time. Only few farmers take preventive measures and most of the plantations are ignored due to non-availability of skilled personnel in tree climbing and early identification of diseases trees. Generally Bordeaux mixture and copper oxyxhloride are being used in the treatments. Problem of leaf rot in coconut during summer/ thorough out the year was diagnosed and management strategies were designed. This method successfully reduced the incidence in the following years and revived the trees of initial stages of infection.

Arecanut

Among the diseases of arecanut, fruit rot is a serious disease that could lead to great economic losses. The disease may cause fruit drop of 50-100% if timely and proper control measures are not adopted. Fruit rot in arecanut is severe in the state and, most of the farmers follow one or other practice to manage the disease due to better price for arecanut. Management practices include spraying of Bordeaux mixture, copper oxyxhloride and metalaxyl-mancozeb. Some of the farmers use other non-recommended products available from the neighbouring states. Results of various practices vary from complete control to no effect. The much of this variation may be due to the chemicals used and the timing of spray.

Cashew

In general, cashew crop is free from diseases. However, inflorescence blight is reported in recent times, probably due to changes in climate. Though Tea mosquito bug infestation is assumed to be a predisposing factor of this disease, further study is required to know the factors responsible for sudden emergence of this problem.

Black pepper

In black pepper, loss due to the incidence of foot rot disease is severe if not addressed properly at appropriate time. Complete loss of black pepper over a period of time was observed in Goa and it is due to the incidence of foot rot (quick wilt). Even the new plantations are suffered from the problem. The severe incidence and loss of crop is partly due to diseased planting material and non-application of timely management strategies. Lack of drainage contributes to the severity in addition to nematode infestations. Planting of disease free and healthy material, application of bio-control agents and adopting better agronomic practices like improved drainage would help in reviving the black pepper plantations of Goa.

Ginger and turmeric

Ginger and turmeric are affected by rhizome rot especially during south west monsoon season which leads to severe crop loss. Rhizome treatment with fungicides or biocontrol agents and proper drainage are recommended for the management rhizome rot. Sporadic incidence of bacterial wilt in ginger was reported. Planting of disease free planting material and soil solarization are the promising strategies for bacterial wilt control.

Vegetables

Most of the vegetables are grown during rabi season after the harvest of paddy. Vegetables are cultivated mostly by small farmers in clusters. Local cultivars of brinjal, chilli, bhendi and cucurbits highly preferred by people as they fetch higher prices compared to others. Seeds of these cultivars are maintained by generations. Damping off is one of the important nursery diseases and technology for the management of damping off in vegetable nursery using bio-control agents was developed.

Brinjal

Bacterial wilt in brinjal is a serious disease and losses due to the incidence of bacterial wilt ranges from 30 to 100 per cent. Other than chemical fumigants, there is no commercial pesticide available for the control of bacterial wilt. Conventional management strategies like crop rotation, date of planting, other cultural methods and soil treatment are not very effective. Stable resistance varieties are few but are not generally preferred by the growers. However, the locally preferred cultivars viz. Agassaim and Taligao are highly susceptible to bacterial wilt. Since most of the management strategies have limited success in the control of this disease, we explored the possibility of employing biological control using bacterial antagonists. Our research efforts demonstrated the effectiveness of bacterial antagonists in the management of bacterial wilt in brinjal.

Chilli

Bacterial wilt disease also affects chilli and the management strategies should be same as mentioned

for brinjal. Occurrence of powderymildew was reported during high humid conditions. Fruit rot/ anthracnose is quite common during fruiting stage. Both the diseases reduce the yield significantly if not controlled. Fungicide sprays at appropriate stage is necessary to manage powderymildew and fruit rot. Leaf curl and other viral diseases can be managed by controlling the insect vectors by using traps and insecticide sprays.

Bhendi

In Goa, bhendi is grown throughout the year. Powderymildew and yellow vein mosaic virus (YVMV) are the major diseases. Majority of the local cultivars grown are susceptible to both diseases. Powderymildew affects the plants of all ages and could be controlled by spraying sulphur fungicides. Resistant varieties are the only option in the management of YVMV. But growers continue to cultivate the local susceptible cultivars as they fetch better price.

Cucurbits

Cucurbitaceous vegetables are mostly grown during kharif in the hill slopes. Incidence of blight and rot is reported during heavy rainfall period coupled with high humidity. Though spray of fungicides is recommended, it would be practically difficult to spray the fungicide during the rainy season. Planting a resistant variety, selecting a disease free field and proper drainage are important in managing this disease.

Conclusion and future scope

The major crop plants grown in Goa are affected by diseases, which cause significant crop and yield loss. Though management practices can reduce the crop loss, lack of knowledge on early diagnosis and awareness makes management a difficult task. In this scenario, ICAR Research Complex for Goa identified creating awareness on the early diagnosis of diseases is an important area that improves the efficiency of management practices. Timely availability of chemicals and quality bio-control agents is also an issue in plant disease management. Overall consumption of pesticides in Goa is very less and hence by default the cultivation of major fruit, plantation and spice crops is pesticide free. Hence, economically important crop diseases in Goa could be managed by integrated and eco-friendly methods to sustain the system in a long run.

Genomic Resources for Horticultural Plants

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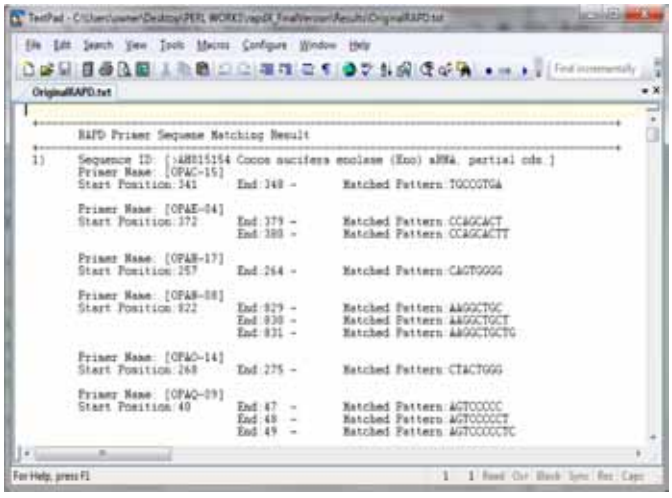
Introduction

In the post genomic era, most of the horticultural plant genomes are decoded. Complete genomes of major fruit vegetable and ornamental genomes are sequenced. Genetic improvement of the horticultural crops is aided by increasing genomic resources, molecular markers and QTL maps and databases. In this short report we list the current developments at our laboratory on the bioinformatics tools and resources to harness genomics science for horticultural plants.

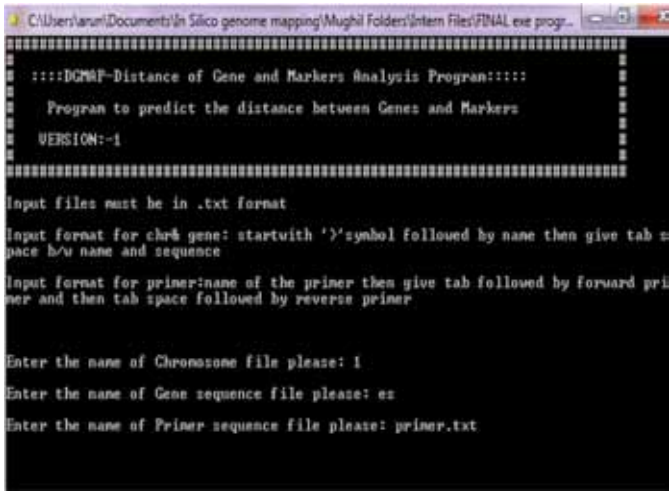
Softwares

Marker express 1.0 a software (Plate 1) was developed for detection of RAPD priming sites in a given sequences and design iSCAR primers. The software works by following simple steps: searches for priming sites of the given primer(s) in allthe target sequences, calculates priming sites of sequence(s), measures distance between priming sites, and converts best amplified primersinto iSCAR primers.It requires two input text files a primer sequencefile (*.txt) and a target nucleotide sequence file (*.fasta) from the user. It generates five sets of output files. We validated software with a case study on oilpalm covering 1.4 % genome where 92 % of polymorphic published primers were predicted. The software has won the award as top 45 innovations of DST-Lockheed Martin India Innovations growth program 2014.

DGMAP 1.0 a software (Plate 2) was developed for calculating the distance between primers and genes in a given set of genome sequence and hence useful for in silico mapping of genes and markers in a given genomic region. Gynoecy in cucumber is controlled by the Female (F) locus that can be modified by other sex determining genes, environmental conditions and plant hormones. Using bioinformatics approaches we identified closely linked RAPD and SSR markers to the F locus on the cucumber genome. F locus-linked ACC synthase is found to be presented at a position of 24Mbp on cucumber chromosome6. The markers that are presented near to the F locus-linked ACC SYNTHASE are represented in figureB. The distance from the F locus-linked ACC synthase gene is represented in bp. SSR markers SSR12555, SSR15293, SSR12603, and SSR12645 are found very close to F locus-linked ACC synthase gene with the distance of below 50 kb. The mapping was done manually and the markers location was done based on the distance from the F locus linked ACC synthase gene.



Output of marker express software



Snapshot of DGMAP software

Database

(FV-iSCARdb) A database (plate 3) of predicted SCAR (Sequence Characterized amplified region) markers based on RAPD/ISSR priming sites in genome, expressed sequences and core nucleotides was developed. The database currently holds nearly 47,000 predicted SCAR marker primers for horticultural plant species. The crops covered are apple, banana, cacao, melon, papaya, potato, straw berry, tomato was developed. URL: http://www.bioinfoindia.org/fv-iscardb.

Snapshot view of FViSCARdb database

Salient Research Achievements in Mango, Cashew and Spices

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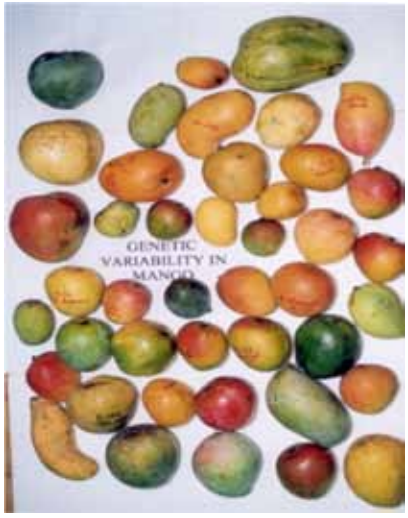
Mango Germplasm collection, conservation, characterization and evaluation

Wealth of mango varieties

Mango, the major fruit crop of Goa is highly esteemed crop, covering the highest area under fruit crops (4771 ha.). Nevertheless, systematically planted commercial orchards are rarely seen in the state. In fact, the state has a large number of mango varieties existing under different locations like in homestead gardens, around bungalows, among coconut and arecanut palms, on bunds of fields, around playgrounds, on road sides, in parks, in office premises, in temple and church premises, etc. Portuguese rulers, the Jesuit Priests in particular, are credited to have introduced a number varieties along with grafting technique, into the state during the 16th century it is believed. Many trees of these varieties are very old, senile and ravaged by neglect and heavy infestation of loranthus parasite. Virtually, these are under great threat due to rapid urbanization activities. Under this historical perspectives, Goa state has a wealth of mango varieties of unique kind necessitating its conservation for the posterity. Considering the need for preserving the valuable mango wealth of Goa, Central Coastal Agricultural Research Institute (formerly ICAR Research complex for Goa) has collected 67 local mango varieties and is conserving this local mango Germplasm in its farm located at Old Goa. Following is the long list of these varieties maintained in the Germplasm bank.



Variability in fruits of Goan mango varieties

Mango varieties maintained in germplasm bank

1. Afonsa	18.Colaco Branca	35.Karel	52. Oval Appus
2. Akno Malgesh	19.Costa	36.Kala Alphonso	53.Papel
3. Ananas	20.Cota	37.Koita	54.Papel Branco
4. Araujo	21.Cruz Fernandes	38.Madame	55.Rebello
5. Aqua rosea	22.D'Silva	39.Mankurad	56.Reynold
6. Babio	23.Dosi Ambo	40.Malgesh	57.Rotto
7. Black Culas	24.Dourada	41.Malgoa	58.Sakri
8. Barreto	25.Elavayangan	42.Manga Rosa	59.Salgadin
9. Bemcorada Type I	26.Fernandin	43.Maxima	60.Sacradin
10.Bemcorada Type II	27.Furtad	44.Matekin	61.Secretin
11.Bishop	28.Godgo	45.Miranda	62.St. Anthony
12.Ball	29.Hilario	46.Monteiro	63.Timoz
13.Brindao	30.Irmao Xavier	47.Mozambique	64.Tokio
14.Carreira	31.Japao	48.Mussarat Bardez	65.Toranja
15.Chimut	32.Jeronimo	49.Mussarat Salcette	66.Udgo
16.Carreira Branca	33.Jesuit	50.Nicalau afonsa	67.Xavier
17.Culas	34.Jose	51.Oliveira	

Among the above varieties, commercially the most important varieties, in the order of popularity, are Mankurad, Hilario, Mussarrat (Bardez and Salcette), Fernandin, Culas, Sakri and Karel (Pickling type). Mankurad being the most liked variety in earlier times, stone propagation was resorted for growing this variety. As a result of this, there exists lot of variation in fruit quality and bearing tendency in Mankurad variety. So also is the case with Hilario variety. In view of this, fruits of Mankurad mango variety suffer for lack of uniform quality as each Mankurad tree differs with respect to fruit quality and bearing tendency. Therefore, collection and evaluation was initiated with a view to select the Mankurad types having the desired commercial traits like fruits with attractive skin and pulp colour, less or no fibre contents in pulp with good sugar-acid blend coupled with excellent flavor and aroma, besides higher fruit yield and regular bearing tendency.

Registration of Cardozo Mankurad Variety

This selection is registered with NBPGR, New Delhi (IC 0587384; Reg. No. INGR 11023) for its unique features like -fruits with attractive skin colour, fibreless higher pulp contents, better shelf life and regular bearing habit.

As mentioned above, due to continuous stone-propagation of Mankurad variety for several decades, there exists tremendous variability having desired traits within the population of this variety. Cardozo Mankurad is one such chance seedling selected for several superior characters over the parental variety. This important germplasm was located in a homestead garden of Cardozo family in Mapusa city of Bardez Taluka in North Goa and selected for its regular bearing tendency, attractively coloured fruits with higher contents of fibreless pulp and better storage quality. Clonal progeny was developed from the mother tree and evaluated at ICAR Research Complex for Goa, for validating the desired traits. Progeny orchard of this new selection is developed at ICAR Research Complex for Goa, Old Goa. The salient characteristics of the new selection are presented here in the table.

The soft wood grafting is a suitable propagation method for multiplication of grafts of this promising selection. One to one and half-year old grafts can be used for planting in the main field. The pits of one cubic metre size spaced at 10m x 10m distance are to be filled with top soil mixed with 15 kg FYM, 1.0 kg mussorie phosphate and 1.0 kg neem cake well before planting and kept ready for planting with onset of monsoon.

After one year, first year fertilizer dose of 150:50:50 g of N, P_2O_5 and K_2O along with 10 kg per graft of FYM has to be applied to each young graft. Doubled quantity of nutrients should be applied for two year old grafts and from third year onwards, the first year dose be added to the previous year's dose till 9th year. For ten year old trees, nutrients comprising of 1500 g N, 500 g

S. No.	Trait Description	Mankurad (Parent)	Cardozo Mankurad (Selection)
1.	Bearing	Alternate to irregular	Regular
2.	Yield	Medium	Heavy
3.	Fruit Size	Small to medium (278.0g)	Medium to large (320.0 g)
4.	Fruit Skin Colour	Yellowish orange with pink blush, seen mostly on ventral shoulder	Yellowish orange with Deep pink seen on both shoulders or throughout.
5.	Fruit pulp		
a	Texture	Melting	Firm, Melting
b	Aroma	Strong Aromatic	Aromatic (Rose)
c	Colour	Yellowish orange	Deep Orange
d	Fibre	Scanty	None
e	Flesh	75.98 %	78.29 %
f	TSS	21.0 ° Brix	22.0 – 25.0 ° Brix
6	Quality	Excellent	Excellent
7	Shelf life	Poor (3days)	Better (About one week)
8	Stone weight	28.5 g	22.67 g

P_2O_5 and 500g of K_2O along with 50 kg per tree of FYM need to be applied for better performance. Full dose of recommended nutrients has to be given in circular rings, 0.5-2.0 m away from the trunk, in the month of August for rainfed gardens and incorporated into soil. The trees of Cardozo Mankurad commence flowering during November-December and fruits become ready for harvesting during March-April. About 1500-2000 fruits may be harvested from each tree at tenth year and onwards. The grafts of this new selection are in great demand in the state, especially for taking up new commercial plantations.

Attractively coloured fruits of Cardozo Mankurad Mango Variety

Collection and evaluation of variants in Mankurad mango variety

Further, screening of different Mankurad types is initiated for identifying the better clones to conserve the true Mankurad variety. Fruits of 18 variants of Mankurad variety are analysed for quality attributes and the grafts prepared from their mother trees are planted in the field for further validation of the attributes.

Introduction of mango varieties from other Research Centres

Considering the scope for commercial cultivation of mango in Goa state, a number of important mango varieties from other research centres have been introduced and evaluated under agro-climatic conditions of Goa. Kesar, Amrapali, Ratna, Neelum and Kalapady are found to perform better for commercial cultivation in Goa. These varieties showed regular bearing with excellent fruit quality.

Amrapali mango variety.

From IARI, Pusa, New Delhi, four varieties viz. Pusa Lalima, Pusa Arunima, Pusa Shreshta and Pusa Pitambar have been introduced recently for their evaluation under coastal conditions in Goa. At the same time, the quality planting material of these varieties is propagated and supplied to the farmers by the Institute.

Cashew germplasm collection, conservation, characterization and evaluation

Field Germplasm Bank of cashew

In all, 89 local accessions are maintained in the field Germplasm bank under AICRP (cashew) programme at this Institute. These accessions comprise of genotypes having jumbo nut size, cluster bearing habit, bold nut and higher nut yield higher shelling percentage, bigger apples and dwarf statured canopy types.

New Cashew Selections from ICAR Research Complex for Goa

Cashew is major commercial plantation crop of the state of Goa. Central Coastal Agricultural Research Institute (formerly ICAR Research Complex for Goa) has been actively engaged in research programmes on cashew, with special emphasis on collection, conservation and cataloguing of local cashew genetic resources of this state with a view to explore the enormous variability existing in this region from the time of its introduction by the Portuguese. In the process, a decade of research on evaluation of cashew genotypes has resulted in the release of one improved variety, Goa-1 (Balli-2) and further results culminated into the three promising selections of cashew viz. Tiswadi – 3 (Goa Cashew -2),

Ganje-2 (Goa Cashew -3) , KN-2/98 (Goa Cashew -4), which are suitable for commercial cultivation in the state of Goa. Following are the salient features of Goa-1 cashew variety and three promising new selections of cashew submitted to the State Variety re Committee for recommendation for commercial cultivation in the state of Goa.

Goa-1 (Balli-2)

'Goa-1' is a selection derived by clonal evaluation of a local accession 'Balli-2', based on superior performance of a promising tree located in village called Balli of Quepem Taluka in South Goa. The original mother tree was identified for its higher yielding ability of 31.5 kg of nuts at the age of 30 years, besides good quality nut and apple. Medium to bold nut size (7.41 - 7.92 g) and excellent kernel recovery (29.82 -30.05 %) of export grade (W210 -W240) coupled with higher nut yield are the important features of this variety. The high yielding feature of this selection is attributed to higher number of flowering laterals M-2 canopy (15.93), male to bisexual sex ratio of 10.02 : 1 and bunch bearing habit (5–6 fruits per panicle) whereas the single largest panicle recorded as high as 26 number of nuts per panicle during the last season.

The apple characteristics of this selection are far superior compared to the present commercial varieties grown in Goa which is distinctly advantageous for feni-making industries of the state. The yellow coloured apples are bigger in size (about 70 g) with higher juice contents (66 – 70 %) of 12^0 Brix.

Bearing, Cluster of apples, raw nuts and kernel of Goa-1 cashew variety

The mean yield of the for the last four years was observed to be about 7.510 kg of nuts per tree per year at the age of ten years, while the highest yield of a single tree was observed to be 9.44 kg/tree.

Tiswadi – (Goa Cashew -2)

Considering the nut yield performance (10.02 kg/tree) during the last 10 years and its jumbo nut size (9.2 - 10.6 g) and bigger (100.5 – 110 g) and juicy apple characteristics, a proposal for releasing the accession Tiswadi-3 as a commercial variety for cultivation in the state of Goa under the name Goa-2 was approved in the in the AICRP Biennial workshop. Bold nuts yield jumbo sized kernels with exportable grade of W180 – W210 counts. Bigger apples are very juicy (76.5% juice contents). This is early variety and thus yield starts right from first week of March and continues through May.

Tiswadi – 3 (Goa Cashew -2) apples, jumbo nuts and jumbo kernels

Ganje-2 (Goa Cashew-3)

The Promising mother tree of this selection was spotted in Ganje Village of Ponda Taluka in North Goa District during the survey and the clonal progeny of this plus tree was evaluated under the accession name – Ganje-2, during last decade. This is a mid-season vigorous variety with extensive canopy growth habit.

This promising selection has higher nut yield potential (15-18 Kg/tree at 10th year), Bold Nut Size (8.2 g), Higher no. of bisexual flowers (26-30), bunch bearing habit (5.6 nuts/bunch), Bigger yellow Apples (>90 g) with higher juice content. Nuts yield higher shelling of 29.3% having kernel count of W210- 240 grade.

Bearing, cashew apple and bold nuts and kernels of Ganj-2 (Goa Cashew -3)

Bearing, nuts and cashew apple of KN2 / 98 (Goa Cashew - 4)

KN-2/98 (Goa Cashew-4)

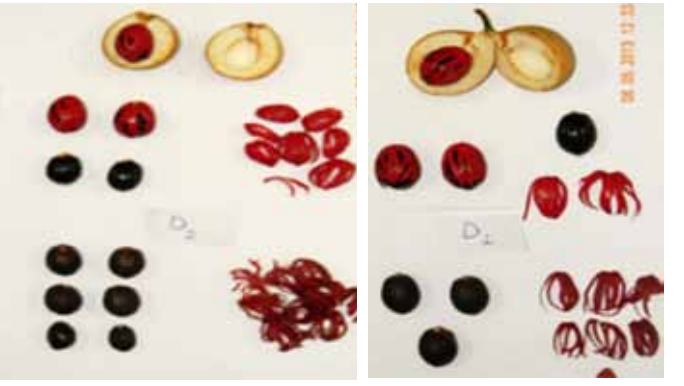
The mother tree of this selection was spotted in Balli Village of Quepem Taluka in South Goa District during the survey in 1997 under an Ad-hoc Project. Clonal progeny of this plus tree was evaluated under the accession name –KN2/98, during1999-2012. This selection has compact canopy with vigourous and upright growth habit. Flowering starts from December with fruits maturing from mid of February continues up to May end. Thus it has long fruiting season from mid of February to end of May. This selection yields about 14 – 16 kg /tree of nuts having mean nut weight of 8.2 g with 29.5% kernel out turn having W210-240 kernel counts. This has bunch bearing habit. Red coloured bigger apples (107 g) are very juicy (71.14%) with 11-12^0 Brix.

Hybridization in cashew

Hybridization programme involving promising local cashew Germplasm is also initiated during the last decade for developing improved cashew varieties for the state of Goa. Of the first set of 12 hybrids under evaluation, one hybrid – H-21/05 is consistently showing higher nut yield (6.7 kg/tree at 4th harvest) trend. This has bold nut size (8.2-8.6 g) with shelling percentage of 29.15 and mean apple weight of 90.5 g.

Nutmeg germplasm collection, conservation, characterization and evaluation

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 IISR, Calicut)), and one wild species (*Knema orientalis*) collected from Cancona streaks, are maintained in Institute's Farm. The accessions viz. NMD-1, NMD-2 and NME-4 are showing the higher nut yield trend in the range of 243 to 515 fruits per tree.



Nutmeg germplasm

Nutmeg Pericarp Candy

Nutmeg Pericarp Syrup

Nutmeg Pericarp Jam

Besides the above, three new promising local genotypes viz. Sakhli-1, Khandola-1 and Mulgao-1 are identified for their higher nut and mace yield and desired quality attributes.

Processing of nutmeg pericarp for value added products

Nutmeg (*Myristica fragrans*) is an important tree spice cultivated as intercrop in coconut/arecanut gardens, for two types of expensive spices, the nutmeg seed and mace. However, a large quantity of the pericarp biomass covering the seed nut and mace generally is left to rot in the field after collecting the economic parts. Considering the nutritive quality and spicy flavor of the pericarp, value added products are processed by using the nutmeg pericarp for additional income from the nutmeg tree. Protocols for value added products such as pericarp candy, pericarp jam and nutmeg syrup and ready to serve beverages have been standardized. This technology while deriving additional income from 'the otherwise waste fruit part' the rind / pericarp, generates employment opportunities through cottage industries to the rural mass. Cost of production of nutmeg pericarp candy comes to about Rs. 160 per kg, while, it will be about Rs.140/- per kg for jam and Rs. 70/-per litre of syrup. Candy has a shelf life of 12 months, while pericarp jam and syrup have shelf life for 6 months under normal open cool conditions.

Introduction and evaluation of turmeric varieties

Improved varieties of turmeric (like Prabha, Pratibha, Meghalaya selection-1, and Sudarshan) are found promising under agro-climatic conditions of Goa for commercial production both as inter crops in cashew and coconut plantations and also as pure crop in open fields. On an average 22-25 tons of fresh rhizome yield of turmeric can be expected from one hectare of planted area.

Total production cost will be about Rs. 80-85 thousand, major cost being that of the seed rhizomes. Helps derive additional income during the gestation period in cashew/mango/plantations. The improved varieties can also be taken up as intercrop in coconut gardens. One can expect a net returns of about Rs. 1.5-2 lakhs per ha.

Technology is successfully transferred to the progressive farmers, namely, Shri Shrihari Kurade, Cuncolim, Goa; Shr Krishna Prasad Gadgil. Sakhli, Bicholim, Goa and Fr. Inacio Almeida, Pilar Society, Goa.

Turmeric cultivation

Foliar spray of nutrients for enhancing nut yield in cashew

Critical stages like flowering, fruit set and growth and development of fruits, mostly coincide with dry spell in Konkan and Goa region, during which soil moisture is limiting factor for uptake of nutrients through root system. Although cashew is considered as hardy species, it surely suffers for want of nutrients during its critical stages due to which yielding performance gets affected. Supplementing the nutrients through Foliar spray is an improved method of nutrient supply under critical stages. Such a technology for cashew involves spraying of water soluble nutrients (N,P,K and micronutrients) on tree canopy for their absorption through foliage when nutrient absorption through root system would be limited/hampered due to poor soil moisture status during the critical stages (new flushing, flowering and fruit development).

Following is Spray Schedule which will cost about Rs. 16.0 per tree.

1st spray: 12 g/l of 19:19:19 water soluble fertilizer during flushing (Nov.)

2nd Spray: 8 g/l of 0:52:34 plus 0.2% Boron during flowering (Dec)

3rd Spray: 8 g/l of 13:0:45 during fruit development

Additional Net income: Rs. 150.0-200.0 /tree. Adoption of this will increase the nut yield and apple yield per tree by at least 20-25 per cent, thereby realising higher income per unit area. The water soluble fertilizers are compatible with plant protection agrochemicals and hence can be applied with plant protection sprays.

This technology is being popularized through Field demonstrations and training programmes, being conducted through Tribal Special plan programmes and also in collaboration with Directorate of Agriculture and Zuari Industries Ltd., Goa.

Coconut based multi-species cropping system

A study to enhance the economic feasibility of the coconut garden with multiple intercropping options revealed that incorporation of components viz. spice crops like nutmeg, black pepper, cinnamon and betel leaf vines; fruits like banana, papaya in the periphery, elephant foot yam in the inter space of coconut garden of about 0.5 ha, of having 63 palms, could be economically feasible production system. A total of 3675 nuts were harvested from bearing palms (49 nos) with average of 75 nuts per palm. In all, 2755 fruits having nut and mace in them, were harvested from 16 yielding nutmeg trees which in turn yielded about 2.5 kg of nutmeg nuts and 0.45 kg of nutmeg mace from the system. Maximum yield of 1386 fruits was harvested in the month of July. Nine varieties of banana (Saldatti, Myndoli, Sakri, Savarboni, Amti, Velchi, Rasabali, Red poovan, and Nendran) yielded 1118 kg of banana hands. The banana yield was almost continuous throughout the year with a peak in the month of September. This trend helps in getting the continuous income from the system. About 108 kg tuber yield of elephant foot yam (Var. Gajendra) was harvested from the intercrop. A total of 108 vines of black pepper and 28 vines of betel leaf planted in the system will further boost economic feasibility of the system. The system support s the foraging of Honey bees from which additional benefits could be derived.

The production system also generated considerable biomass. Each Glyricidia plant of 167 stumps generated 12 kg fresh leaf biomass/yr/stump (@4.09 kg biomass/plant (fresh wt basis: generated in four months). A total of 167 stumps X 12 kg = 2004 kg leaf biomass was generated from the system which was incorporated into coconut, banana and nutmeg basins. One ton of this biomass is reported to replenish 21 kg N, 2.5 kg P, 18kg K, 85 g Zn, 164 g Mn & 364 g Cu upon incorporation in to the soil. Similarly, about 600 coconut fronds collected from the system generated about 1704 kg of dry biomass per year, which can be either converted into vermicompost or utilized for various purposes. Banana pseudo stem and leaf Biomass, dropped coconut biomass also contribute to the biomass generated from the coconut based production unit.

Status and Prospects of Under-utilized fruit crops of Goa

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Introduction

Goa state houses several horticultural crops comprising of fruit crops, vegetables, plantation crops and spices, medicinal & aromatic crops and flower crops covering about 63% (1,02,715 ha.) of the cultivable area (1,62,505 ha.) of the state. Each group of these crops is bestowed with rich genetic diversity. Major fruit crops like mango, banana, pineapple, etc, cover about 11,163 ha., while other fruit crops a number of under utilized/ lesser known fruit crops including Jack fruit, citrus, sapota, bilimbi, hog plum, kokum, etc., cover about 3815 ha with an estimated production of about 40,000 tons and productivity level of 10,000 kg/ha. The basic details of these crops, the diversity and utility are discussed in this paper.

Area (ha) under production of fruit crops in Goa

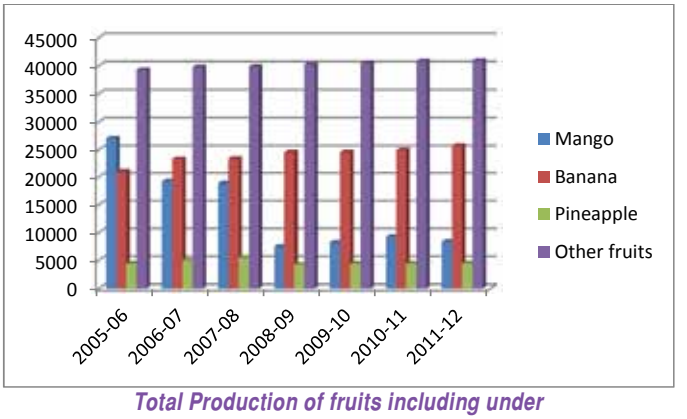
Crop	Year						
	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12
Mango	4339	4414	4494	4514	4716	4750	4760
Banana	2225	2342	2398	2302	2219	2250	2293
Pineapple	318	336	341	262	273	271	275
Other fruits	3645	3695	3699	3737	3750	3776	3807

Productivity (kg/ha) of fruit crops in Goa

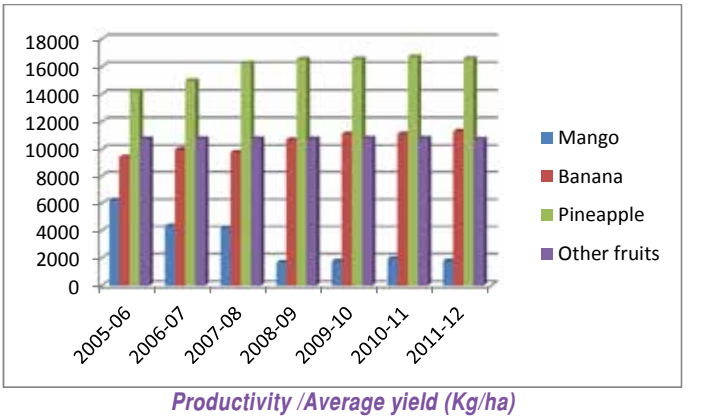
Crop	Year						
	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12
Mango	6240	4368	4204	1674	1767	1954	1793
Banana	9450	10000	9791	10709	11114	11113	11311
Pineapple	14200	15000	16258	16546	16557	16715	16589
Other fruits	10783	10772	10783	10784	10805	10818	10750

Total production (t) of fruit crops in Goa

Crop	Year						
	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12
Mango	27075	19280	18894	7558	8334	9284	8536
Banana	21026	23420	23480	24651	24662	25006	25824
Pineapple	4515	5040	5544	4335	4520	4530	4562
Other fruits	39304	39804	39890	40300	40520	40850	40925



Total Production of fruits including under utilized fruits (t) in Goa



Productivity /Average yield (Kg/ha) of fruit crops in Goa

Brief description on the under-utilized fruits

The under-utilized fruits of Goa re found as inevitable components in plantaion based cropping systems. And also naturally found in secondary forest regions of the state. They also exist in homestead farms and roadsides and farm bunds. A glimpse on these fruits are furnished here under:

Information on indigenous fruits of Goa, their seasons of flowering and fruiting

Common name of fruit	Botanical name	Family	Season of flowering	Season of Fruiting
Adam's fruit	*Mimusops kauki*	Sapotaceae	Nov-Dec	Feb-April
Ambada	*Spondias pinnata*	Anacardiaceae	Apr-Jun	Aug-Nov
Bimbla	*Averrhoa bilimbi*	Oxalidaceae	Jul-Sep, Nov-Dec	Sep-Nov
Bread fruit	*Artocarpus ultilis*	Moraceae	Jan-Feb, Jul-Aug	Mar-Apr, Jul-Sep
Churna	*Zizyphus rugosa*	Rhamnaceae	Feb-Mar	Apr-May
Carambola	*Averrhoa carambola*	Oxalidaceae	Apr-Aug, Sep-Oct	Jan-Feb, May-Jul
Chivra	*Grewia micrococcus*	Meliaceae	Mar-Apr	Apr-May
Jack	*Artocarpus heterophyllus*	Moraceae	Apr-May	May- Jul
Jagomas	*Flacourtia jangomas*	Flacourtiaceae	Jun-Jul	Oct-Dec
Jamun	*Syzigium cumini*	Myrtaceae	Mar-April	Apr-May
Karonda	*Carrisa carandas*	Apocynaceae	Feb-Mar	Apr-May
Kokum	*Garcinia indica*	Guttiferae	Feb-Apr	Apr-Jun
Rose apple Wax jambu Malay rose apple	*Syzygium jambos* *S samarangense* *S malaccanse*	Myrtaceae	Mar-Apr	Jan-Feb, Mar-Apr
Mattom	*Parinari curatellifolia*	Chrysobalanaceae	Sep-Oct	Dec-Jan

Kokum (*Garcinia indica Choisy*)

This tree species belongs to family Guttiferae and naturally exists in farms, forest regions, stream banks etc. It has got multifaceted usages such as fruit, spice, medicinal crop etc. The fresh fruits are used as such for preparation of squash, juice, RTS etc, whereas the dried rind is used as a spice ie. souring agent in Goan cuisine especially in Goan fish curry. Besides these domestic uses Kokum is presently in limelight in global pharmaceuticals trade because of its virtue of containing alpha Hydroxy citric acid in its rind which has the chemical property to inhibit accumulation of fatty acids. Therefore HCA extracted from kokum rind would form the vital component of products like anti-obesity drugs, slimming agents etc. While the fruit rind contains, anti-obesity factor, ironically, the seeds of kokum are rich sources of fat content. Traditionally a product named kokum butter is extracted from the seeds and is used domestically. Further this butter forms an important base in cosmetic product like lipstick, face pack etc.

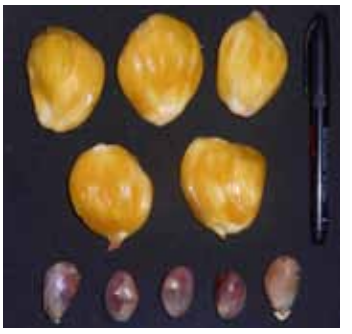
Mashem-1

Kokum trees that naturally exist due to their seedling origin, diocious nature and cross pollination, exhibit wide variation in morphological and physico-chemical characters.

Variability found in Kokum in Goa

Variables	Range of variables	Remarks
Canopy shape	Conical, Pyramidal, Dome shaped, Spreading type	Affects the ease of harvesting
Leaf	Narrowly to broadly lanceolate, rarely ovate	----
Fruiting season	Early (Feb-mid April), Mid season (Mar end – mid May), Late (mid Apr- June)	Early &mid season bearers are choice of growers
Fruit colour	Yellow to dark maroon	Rich source of anthocyanins
Fruit weight	10-50 g	Good rind and juice recovery in bigger fruits
Fruit shape	Spherical, Oblong, Oval, fruits with pointed tips	---
Rind thickness	0.14 – 0.48 cm	Higher rind recovery is profitable
No. of segments	4 – 8 segments /fruit	Depends on sex of tree
Dry seed weight	0.09 to 0.52 g	Source of natural fat
Juice percentage	19.18 - 90.76.	Juicy types preferred for syrup, agal etc.,
TSS of juice	1.95-22.40 o Brix	Advantage of selection for different value added products
Acidity	1.1 – 6.8%	Advantage of selection for different value added products
HCA	19.32 to 37.39%	Anti-obesity compound
Kokum fat in dry seeds	11.54 – 43.18%	Industrial and Pharma applications

Jack fruit (*Artocarpus heterophyllus*)



Belongs to family Moraceae and is occurring in abundance in nature. Basically there are two ecotypes viz., firm fleshed and soft fleshed ones. The former is used for dessert purpose and the latter both for dessert as well as different forms of processed foods like leather, papad etc. Immature fruits of both types are used for culinary purposes. This tree species is also heterozygous in nature and shows variation in traits.

Fruit characteristics of jack fruit accessions

Characteristics	Range
Fruit Shape	Ellipsoid/Oblong/ Clavate/Irregular
Stalk length (cm)	2.3-9.8
Stalk girth (cm)	6.9-10.3
Stalk attachment to fruit	Depressed /Flattened
Fruit length(cm)	33.9 – 68.2
Fruit girth (cm)	59.80 - 90.80
Fruit weight(kg)	5.57-16.10
Shape of spine	Sharp /Intermediate
Spine density	Sparse /Dense
Fruit shelf life (days)	2-5
Fruit quality	Poor/Moderate/Good
Fruit attractiveness	Poor/Moderate/Good
Fruit surface	Spiny/Smooth
Rind thickness	Thin/Medium
Fruit rind colour	Green/Greenish Yellow
Rachis length(cm)	15.8 - 38.2
Rachis Diameter	5.8-11.1
Number of flakes(bulbs)/ fruit	83-271
Weight of flakes per fruit (g)	1.680 - 6.042
Weight of fresh flake with seed(g)	15- 44
Weight of fresh flake without seed(g)	10 - 34
Flake length (cm)	3.63-7.55
Flake width(cm)	2.20- 4.05
Flake thickness	Thin/Medium.Thick
Flake fibre content	Low/Medium/
Flake shape	Spheroid/Oblong with curved tip/Twisted/ Rectangular/ Irregular
Flake texture	Soft/Firm
Flake/ Fruit ratio	0.71-0.82
Pulp taste	Insipid /Sweet
Pulp consistency	Firm/Medium/Soft
Pulp flavour	Intermediate/Strong
Pulp juiciness	Juicy/Not juicy
Pulp colour	Deep yellow/ Yellow/ Light yellow
Seed length(cm)	2.79-3.74
Seed width(cm)	1.47-2.74
Number of seeds per fruit	83-271
Seed weight/fruit (g)	735-1588
Seed shape	Oblong/Reniform. Irregular
Seed surface sliminess(ripe fruits)	Slightly slimy / Intermediate
Seed coat thickness	Thin /Intermediate
Seed surface pattern	Regular striations
Seed coat colour	Off white/Creamish
Adherence of seed coat to kernel	Easily separable/ Difficult to separate
Flake without seed /seed ratio	3.0- 4.4

Bread fruit (*Artocarpus altilis*)

This is a perennial tree species (family- Moraceae); produces fruit that is used as a vegetable. The tree bears fruits almost throughout the year, but the two peak seasons of availability are March-April and July-Sept. Bread fruit trees are found in almost every back yard. As the propagation is by root suckers/root cuttings, there is less variation noticed. But still slight variation in terms of size and shape of fruits is observed. This being a starchy fruit finds its own place in the Goan cuisine. The mature fruits are sliced, deep fried and relished tantamount to fish fry especially by vegetarians and also by non-vegetarian populace during off season for availability of fish. The starch powder extracted from bread fruit forms a component of baby food etc.

Carambola (*Averrhoa carambola*)

This species belongs to family Oxalidaceae. This is an ever green medium sized perennial tree that bears star-shaped fruits. As the species can be propagated both by seeds as well as grafts, there is variability in fruit of carambola from sour to sweet. A distinct difference is observed in fruit quality between sour and sweet type of fruits. The sour fruits are greener and smaller in size, rich in acids whereas the sweet ones are bigger, yellowish green, fleshier and with appealing sugar: acid ratio. Dried flakes of sour carambola are used as souring agents and fresh fruits are used in curries / pickles whereas fresh fruits of sweet type are used for dessert purpose and preparation of juice/squash etc.

Bilimbi (*Averrhoa bilimbi*)

This is a close relative of carambola, an evergreen medium stature perennial tree, bearing green, cylindrical, fleshy fruits directly on trunk / older branches (cauliflorous flowering). They are very common in Goan backyards. The fruits are used as souring agents and more often in pickles. There is less variation observed in this species.

Ambada/Hogplum (*Spondias pinnata*)

This species belongs to family Anacardiaceae, a tall stately, semi-deciduous type of tree, bearing greenish oval fruits. The trees exist in road sides, backyards, farm bunds etc. There are two distinct types of fruits available viz., sour and sweet, the former with a relatively large sized seed and the latter with thin seed. Ambada fruits are used for preparation of curry, chutney etc. The fruits are relished for the sour taste.

Jagoma (*Flacourtia jangomas*)

This belongs to family Flacourtiaceae. This is an evergreen perennial tree species found mostly in coastal regions and dioecious in nature. There are spines present over trunk and older branches. The fruits are available during Oct-Dec; dark red/maroon in colour, smaller, containing numerous small edible seeds. The ripe and fresh fruit is consumed as such after softening the pulp by gently pressing it between the fingers. The pulp tastes sweet to acidic. There is variation observed in terms of fruit size and quality.

Adams furit (*Mimosops Kauki*)

This belongs to family Sapotaceae. This is a medium- huge perennial tree bearing brown fruits containing 1-3 light brownish seeds that look like those of Sapota. The pulp is not very fleshy but sweet; the fruits consumed as dessert and except for fruit size, not much variation exists in this fruit species.

Roseapples (*Syzygium species*)

Syzygiums belong to family Myrtaceae. These are medium – large sized perennials bearing fruits twice a year ie. During Jan-Feb and Apr- May. There are three species found in Goa viz S. jambos (globose, creamish yellow fruits, seedless), S. malaccense (ovaid-pear shaped red fruits, seedless) and S. samarangense (pear shaped, greenish yellow, seeded). All types are crispy and watery, acid – sweet in taste and consumed fresh. Not much variation is observed within a species.

Karonda (*Carissa carandas*)

This species belongs to family Apocynaceae. This is an evergreen perennial thorny shrub bearing purplish black fruits during Apr-May. As it is native to India, variation is observed in fruit size and earliness. The mature unripe fruits are used for pickling and chutney making and the ripe fruits for dessert purpose. Products like squash, juice, wine are also made out of ripe- fruits.

Jamun (*Syzygium cumini*)

This is a perennial tree species (family-Myrtaceae) bearing dark purple fruits during Apr-May. As it is believed to be native to India, vide variation is exhibited in terms of fruit size, shape, colour, bearing habit, biochemical traits etc. The trees are found widely distributed in Goa. But bearing is observed to be not regular but alternate/irregular in Goa. The fruits are consumed fresh and also in form of squash/juice/wine. Due to its anti-diabetic property, it is valued in ayurvedic pharmaceutical industries.

Strengths and weakness

- There is rich biodiversity and there is lot of scope for value addition
- But there is no commercial cultivation.
- And also there is lack of awareness about the significance of these crops
- There is huge loss of such nutritional fruits in the state

How to improve the status

- Creation of awareness about the significance of these fruits in terms of nutritional value, scope for fresh consumption and value addition , processing
- Trainings and campaigns need to be conducted in the village level.
- Farmers co-operatives have to be formed so as to effectively market these fruits and their products.
- Capacity building for the small and marginal farmers for value addition and marketing.

Future thrust

- Though currently, there is appreciable research impetus on these neglected fruits, further strengthening of R&D is required in the following lines.
- Systematic data on area, production and consumption pattern
- Crop Improvement for yield and processing traits
- Thrust on non-traditional products besides traditional ones
- Indian processing and pharmaceutical industries to play a key role
- Wide-spread advertisements to popularise and capture market-initially in neighbouring states
- Indian based clinical studies to be conducted to validate the traditional knowledge and beliefs.

Physico-chemical traits of few under-exploited fruits of Goa

Name of Fruit	Type/Source	Fruit wt.(g)	Length (cm)	Girth (cm)	Pulp (%)	Seed (%)	TSS (Brix)	Acidity (%)
Rose Apple i).Malayan Apple ii) Wax Jambu	Light Pink Big Size Light green Seedless	55.94 60.4 40.8	5.66 8.46 4.56	4.82 5.08 3.98	81.59 83.44 100	18.41 16.56 --	5.6 3.8 4.8	0.47 0.36 0.12
Carambola	Sweet	96.6	11.94	2.78	99.1	0.9	6.6	0.29
Carambola	Sour	75.6	9.28	2.38	99.0	1.0	3.8	2.40
Bimbla	Soft Ridged	12.12	5.3	1.80	100	--	3.8	2.80
Jagoma	Small,round	5.94	22	1.80	92.58	7.42	18.2	0.56
Chara	Small, round purple	1.22	1.88	1.56	66.21	33.79	21.4	0.48
Adam's fruit	Brown,Oval	12.6	4.72	8.18	60.55	39.45	23.0	0.13
Karonda	Round,purple	2.75	1.3	1.2	95.21	4.79	14.4	1.15

Status and Prospects of Vegetable cultivation in Goa

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India has made substantial growth in production and productivity of vegetable crops with a total annual production of over 88.6 million tonnes next only to China. India's share in world production of vegetables is 11.4 per cent. The average productivity of vegetables is 14.4 tonnes a hectare. With the advent of hybrid technology coupled with greater concern for nutritional security among the people, the vegetable production in the country is progressing in the right direction. Although the national productivity is around 15 tonnes per hectare, production and productivity of vegetables in some of the states are static around 10 tonnes/ha only. In these states, there is an urgent need to reorient the vegetable production strategy so that vegetable production gets impetus.

Goa state being an internationally renowned tourist destination with huge influx of tourists from both domestic and international throughout the year, the requirement of fresh fruits and vegetables is always high. In Goa, the area under vegetable crops during 2008-08 was 8,213 ha with the annual production of about 84,290 tonnes. The average productivity works out to be around 10 tonnes per hectare which is very low compared to national average. The present magnitude of vegetable cultivation is very low and disproportional to the Goan and floating population. Hence, bulk of vegetable requirement is met from the neighbouring states like Karnataka and Maharashtra.

ICAR Research Complex in Goa has initiated efforts since its inception to demonstrate the feasibility of cultivation by introduction and evaluation of new vegetable crops under prevailing condition. Apart from this, attempts have been made to collect, conserve and evaluate the available vegetable germplasm in important crops of Goa.

State of Goa

Goa has a total geographical area of 3, 61,113 hectares which lies between $14^0$16" North latitude and $73^0$75" East longitude bound by the Arabian sea on the West, State of Maharashtra on the North and Karnataka on East and South. The climate is hot and humid with the temperature ranging from 18 to 35^0C through out the year. The annual rainfall ranging from 2500 to 3500 mm is received in about 100-120 days between June and October. The soils are predominantly red lateritic (73.40%) followed by alluvial and marshy soils (11.70%), sandy coastal soils (10.11%) and saline soils (4.79%).Majority soil series are coarse to medium textured with good drainage and poor water holding capacity. The pH of soil is 4.5-6.5 with medium available N and deficient available P and K.

Area and production of vegetable crops

It is estimated that around 60% of the total cultivated area is under horticultural crops. But the area under vegetable crops is less i.e. only 5% of the total cultivable area. The data for the past one decade shows that the area under vegetable cultivation hardly increased from 7550 ha in 1997-98 to 8213 in 2006-07, but later it reduced to 6,498 in 2011-12.

Major vegetable crops of Goa

S.No	Season of cultivation	Major vegetable crops
1.	Kharif or rainy season (June-September)	Cucurbits (Cucumber, Ridge gourd, Snake gourd, Bitter gourd, Pumpkin, Ivy gourd etc.), Okra, Chilli,
2.	Rabi or Winter season (October-February)	Sweet potato, Brinjal, Amaranthus, Vegetable cowpea, Radish, Knol khol, Okra, Pumpkin, Chilli, Onion, Cluster bean etc.
3.	Rabi extended summer (February-May)	Amaranthus, Okra, Onion, Vegetable cowpea, Chilli

Major vegetable crops of Goa

Area and production of vegetable crops in Goa

Year	Area (Hectares)	Production (tonnes)	Productivity (t/ha)
2002-2003	7,600	70,467	9.27
2003-2004	7,800	70,467	9.03
2004-2005	7,800	74,725	9.58
2005-2006	8,144	82,580	10.14
2006-2007	8,213	84,290	10.26
2007-2008	5,547	56,027	10.10
2008-2009	5,703	57,603	10.10
2009-2010	5,671	58,130	10.25
2010-2011	5,880	60,472	10.28
2011-2012	6,498	78,201	12.03

The productivity is also very low when compared to the national average of 18 t/ha. Presently, more than 85% of requirement of vegetables in the state is met from the neighbouring states like Karnataka and Maharashtra.

There are three main seasons of vegetable production in Goa

Rainy or Kharif season : June to September
Winter or Rabi season : October to February
Summer season : March to May

Methods of vegetable cultivation

The cultivation of any crop depends on many biotic and abiotic factors viz., season, location, type of vegetable, rainfall pattern, climate etc. These factors are very vital incase of vegetable cultivation, as vegetables are more sensitive to these factors than any other field crops.

Being situated on western ghat of Konkan tract, available aerable land is divided in to three types viz., sandy coastal belts, lateritic plateaus and hilly slopes. The soil and topography of Goa is not uniform, unlike other states, which makes the farmers to develop their own indigenous methods and systems of cultivation.

Cultivation on the hill slopes

The vegetable cultivation on hill slopes is purely rainfed, the major crops cultivated being cucurbits (cucumber, ridge gourd, pumpkin, coccinea, musk melon etc.), okra, chillies etc. The method of cultivation is same as that of shifting cultivation in the states of north eastern region. The slopes that are originally covered with forest trees, shrubs and other plants, are selected, cleared and ridges and furrows are made along the slopes. This operation is completed before the onset of monsoon (May). Immediately after the onset of monsoon, seeds are dibbled directly on the ridges in case of okra and cucurbits and seedlings are planted in case of chillies.

The rainfall pattern is in such a way that, the 90 per cent of rainfall is received in four months (June-September) which will take care of the short duration vegetable crops. It is almost purely a organic type of cultivation. The farmers are using the same piece of land for 2-3 years, after which, a new area is cleared and taken up for vegetable cultivation.

In case of cucurbits, pandals are erected for the support of vines. The vines are trained to a straight stick initially, which later on trails on the pandals erected.

The okra seeds are sown on the ridges immediately after the onset of monsoon (last week of May to first week or June). The local land races/types are named after the node at which first bearing starts. These local types are very vigorous growing ones with big, deeply lobed leaves. The fruits are invariably glabrous, light green in colour and long but still tender in quality. The only problem in this type is its susceptibility to yellow vein mosaic virus.

In chilli, majority of them are local types grown exclusively on the hill slopes of Goa. A local type by name "Kholla chilli" which fetches premium price is cultivated extensively on the hill slopes. The seedlings that are kept ready are planted on the ridges immediately after the onset of monsoon. This crop comes up very well under rainfed condition.

In an overall view, though this method of cultivation

Cultivation of cucurbits in hill slopes during kharif season

gives reasonable income to farmers, it has its own adverse effect on the natural resources viz., soil and water. The main drawback in this method is soil erosion because the ridges are formed along the slopes instead of across. In addition, indiscriminate clearing of forest slopes shall ultimately lead to loss of some valuable biodiversity. To overcome this problem, creating awareness on the management and sustainable utilization of natural resources is the need of the hour.

Cultivation on the plain sandy loam soils

This is one of the intensive methods of vegetable cultivation practiced during December-January extending up to March-April in Goa. The major vegetables, which are grown in this method, are brinjal, vegetable cowpea, pumpkin, snake gourd, bottle gourd, cluster bean, chilli, sweet potato, onion, okra, amaranthus etc. In majority of the vegetable grown here, local types are used instead of improved varieties as local ones fetches premium price in the market.

This is basically sandy loam soil belt of low-lying areas with the advantage of high water table, farmers dig out shallow pits of about 3-4 m and water available is manually carried for irrigating the fields. As this method is laborious, the plots are maintained in small size, but still very intensive system of cropping pattern is followed to get more income.

The dig out pit area is also utilized for cultivation of cucurbits. Either pumpkin or snake gourd seeds are sown over the bund of this pond. When the crop attains 2 m height, it is trained on a pandal in such way that, the entire water surface is covered by vines and

protected from open sunlight, which will reduce the evaporative loss of water and aid in efficient utilization of soil and water resources.

Besides all the above-mentioned vegetable crops, cool season vegetables like capsicum, radish, turnip, beetroot, knolkhol etc. are also cultivated in the plain land with assured irrigation facility.

The scope to improve this method of cultivation is by introduction of improved varieties to this method, which will in turn increase the productivity per unit area. The major problem faced by the farmers is wilt and shoot and fruit borer in brinjal, fruit fly and epilachna beetle attack in cucurbits etc. If this lacuna is taken care of, then this method will be a good example for intensive vegetable cultivation.

Cultivation on the paddy fallow

This is also one of the important methods practiced where, the water resource is very efficiently utilized. Goa, being a high rainfall area, the low-lying areas is full of water during the monsoon period. This type of area is very well utilized by the farmers for paddy cultivation. The transplanting of paddy crop starts by June and the final crop will be harvested during October. After the harvest of paddy crop, the stubbles are incorporated into the soil by repeated in situ ploughing.

Crops like cowpea, brinjal, sweet potato, groundnuts are grown by using the residual moisture of paddy fallow.

Local cowpea by name "Waali" is sown and the crop will be raised with the available residual moisture in the substrata of soil for 2-3 months after the monsoon. There are two types of cowpea grown in this method. One is grown as pulse crop, locally referred as "Alsando". This pulse crop has good market demand. Another type is raised exclusively for vegetable purpose. The former one is bush type and the latter is pole type.

There is tremendous variability in the local cowpea germplasm, which has to be tapped with the breeder's point of view. Selection in case of both pole and bush types may yield valuable germplasm for the future. Besides, introducing improved varieties of cowpea will increase the productivity status in this crop.

Another important crop, which is grown on the residual moisture, is sweet potato. The planting of sweet potato vines starts well before the sowing of cowpea. The cuttings are planted on the plain field. After the initial establishment of cutting, mounds are formed for individual plants and earthing up is carried out. The major problem in this crop is sweet potato weevil incidence. This can be overcome by effective utilization of sex pheromone traps apart from introduction of new improved pest and disease resistant varieties from same agro climatic zones of neighbouring states.

Collection of under utilized vegetable crops from its natural habitat

The first and foremost among this group is edible mushroom. As many as 12 edible mushrooms have been identified in the past years. Among the local mushrooms identified, Termatomyces spp fetches premium price in the local market. This edible mushroom is available from July onwards and continues for another two months. This species is being collected from the forest areas and sold in market on number basis by local vendors. So far, since no systematic work has been initiated to commercialize this mushroom, this area needs to be exploited.

The other minor vegetable which are available in the nature during and after the monsoon are, Elephant foot yam, Colacasia, Xanthosoma, Bamboo shoot, Dioscorea spp etc. Systematic study on these vegetable crops may provide valuable germplasm for future breeding programme besides sustainable production of horticultural produce.

Cultivation of vegetables in plains

Protected cultivation of high value vegetable crops

Protected cultivation of vegetable crops viz., coloured capsicum, seedless cucumber, tomato etc. are also taken up on a limited scale under naturally ventilated polyhouse in Goa. Most of the protected cultivation in Goa is supported through NHM programmes by Department of Agriculture, Govt of Goa. The demand for high value vegetable crops is very high, but all the crops cannot be cultivated in Goa. Hence it is limited to few crops during September to May.

Prospects of vegetable cultivation in Goa

Vegetables are cultivated generally on hill slopes during monsoon and coastal sandy soils during rabi season starting from November to March. Although local varieties of vegetables are cultivated in Goa, improved varieties and hybrids are not adopted at a commercial scale in farmers field. The improved high yielding varieties and hybrids developed in the neighbouring states are better in their yield performance under Goa condition. The information in the following table gives the salient features of varieties tested under Goa condition and its suitability. It is apparent that local types of vegetables are highly preferred by the consumer due to its specific quality traits and taste, but its yield levels are less. Hence, apart from cultivation local vegetables for consumer preference, adoption of new varieties and technologies is need of the hour to increase the production and productivity of vegetables in the state of Goa.

Future thrust

The table indicates the suitability of different vegetable crops for Goa state. The results also indicated the potentiality of new crops for cultivation to meet the ever growing demand of tourism industry. But the production and productivity of vegetable crops over the year is stagnant in comparison to growing demand. The major constraint in agriculture in Goa is labour availability. The statistics shows that only 17% of the total population is dependent on agriculture as a primary source of income compared to 60% during

Coloured capsicum cultivation under naturally ventilated polyhouse in Goa

Cucumber cultivation under naturally ventilated polyhouse in Goa

1960. The area under cultivable fallow land is also increasing year by year thus posing serious threat to availability of vegetable and other agricultural produces from Goa in the coming days. It is high time to devise a sustainable policy to improve the vegetable area and production to meet the requirement of local population and tourists. The priority area of improvement would be to introduce large scale cultivation of hybrid vegetables in major crops. The local vegetable types cultivated fetch premium price apart from its demand among the local population. But the productivity levels of these types of vegetables are low compared to national varieties and the yield gap from hybrid vegetables is wide. Hence introduction of improved varieties/hybrids in major vegetable crops followed by large scale cultivation of vegetable crops with improved production technologies may increase the production and productivity of these high value crops. Thus, the immediate goal would be to raise the present productivity level of 12 tonnes/hectare to national average of 18 tonnes/hectare, which will add almost 50 per cent more production of vegetables per year.

Suitable varieties of different vegetable crops for Goa region

Vegetable crops	Variety suitable	Season	Potential Yield (t/ha)	Remarks
Brinjal	Arka Neelkanth ,Arka Nidhi, Surya, Swetha Agassim and Taleigao Agassim and Taleigao	Rabi and Summer	20-35 30-40 3-6	Resistant to bacterial wilt As intercrop in coconut
Okra	Arka Anamika and Parbhani Kranti Salkeerthi and local types	Rabi and Summer Kharif	8-10 8-10	Resistant to YVM Susceptible to YVM
Cluster bean	Pusa Navbahar	Summer	4-5	
Radish	Arka Nishant and Japanese White	Rabi	15-20	
Vegetable cowpea	Local types	Rabi	2-3	Local preference
Amaranthus	Red and green type	Rabi	5-6	
Chilli	Pusa Jwala, Arka Meghana, KA-2, PC-7 Local types	Rabi Kharif	1.5-2 6-8 1-1.5	Dry chilli Green chilli Dry chilli
Knol khol	Local types	Rabi	12	Rice fallow
Sweet potato	Local types	Rabi	15	

Scope and Prospects of Floriculture in Goa

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Ela, Old Goa, Goa

Flowers, the crowning beauty of God's creation, are closely associated with mankind from the dawn of civilization. Flowers are intricately entwined in the social fabric of our nation and no function is complete without flowers. Flowers are inseparable part of human joy and sorrow. It is said that man is born with flowers, lives with flowers and finally dies with flowers. The scope of utility and importance of flowers have been realized throughout the world. India has a long tradition of floriculture. However, the social and economic aspects of flower growing were recognized only later. It is only in the last three decades with changing life styles and under increased urban affluence; floriculture has assumed a definite commercial status. Floriculture has tremendous potential for export besides domestic consumption. Floriculture has become a source of gainful employment in our country. In India, Floriculture industry comprises flower trade, production of nursery plants and potted plants, seed and bulb production, micro propagation and extraction of essential oils. Floriculture includes cultivation of flowering and ornamental plants for sales or for use as raw materials in cosmetic and perfume industry and the pharmaceutical sector. India has a blooming future as far as floriculture is concerned. Enormous genetic diversity, varied agro climatic conditions, versatile human resources etc offer India a unique scope for judicious employment of existing resources and exploration of avenues yet untouched.

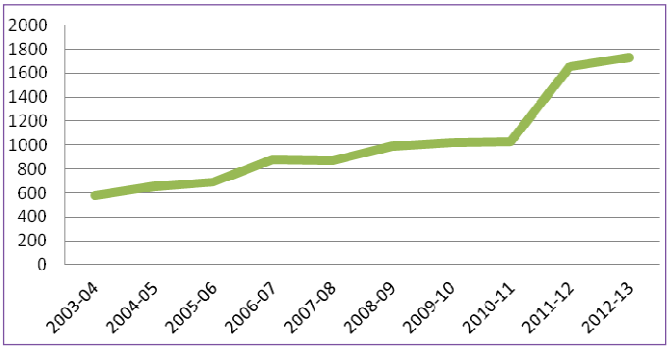
Government of India has identified floriculture as a sunrise industry and accorded it 100% export oriented status. Owing to steady increase in demand of flower, floriculture has become one of the important commercial trades in Agriculture. Floriculture products mainly consist of cut flowers, pot plants, cut foliage, seeds bulbs, tubers, rooted cuttings and dried flowers or leaves. The important floricultural crops in the international cut flower trade are rose, carnation, chrysanthemum, gerbera, gladiolus, gypsophila, liatris, nerine, orchids, achilea, anthurium, tulip and lilies. Floriculture crops like gerberas, carnation, lily etc. are grown in green houses. The open field crops are gladiolus, chrysanthemum, roses, gaillardia, marigold, aster, tuberose etc. Floriculture is increasingly regarded as a viable diversification from the traditional field crops because of higher returns per unit area and the increasing habit of "Saying it with flowers" during

All India production trends in floriculture

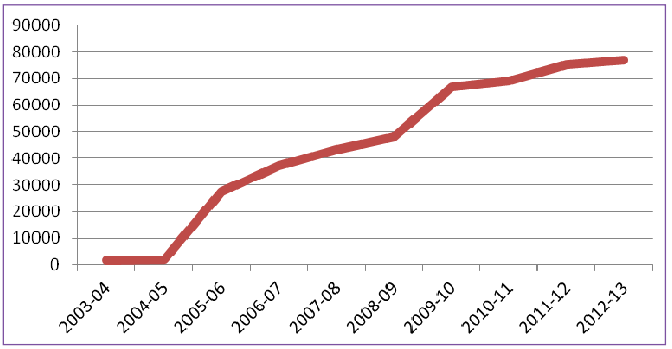
Sl. No.	Year	Area ('000ha)	Production	
			Loose flowers (000 MT)	Cut Flowers (million no's)
1	2003-04	101.18	579.48	1792.6
2	2004-05	115.92	654.83	1951.5
3	2005-06	126.23	693.40	27618
4	2006-07	144.01	880.43	37156.29
5	2007-08	160.72	870.37	43417.46
6	2008-09	166.5	987.4	47942
7	2009-10	182.9	1020.6	66671
8	2010-11	190.9	1031.3	69027.4
9	2011-12	253.7	1651.62	75066.0
10	2012-13	232.74	1729.21	76731.85

all the occasions. Though the art of growing flowers is not new to India, but large-scale commercial cultivation, protected cultivation is relatively new in India. Enormous genetic diversity, varied agro climatic conditions, versatile human resources offer India a unique scope for diversification in new avenues which were not explored to a greater extent. With the opening up of international market in the WTO regime there is a free movement of floriculture products worldwide. In this context each and every country is having equal opportunity for trade in each other's territory. Globally, more than 140 countries are involved in cultivation of floricultural crops. Among various countries Germany continues to be the highest consumer followed by Japan. India is having a better scope in the future as there is a shift in trend towards flowers and this can be gainfully exploited by country like India with high amount of diversity in indigenous flora. The domestic industry is growing at annual rate of 7-8% per annum. As per National Horticulture Database published by National Horticulture Board, during 2012-13 ,about 232.74 thousand hectares area was under cultivation in floriculture in 2012-13. Production of flowers is estimated to be 1.729 million tonnes loose flowers and 76.73 million tonnes cut flowers in 2012-13. Thus the area under flowers has crossed to 2.32 lakh hectares during 2012-13 which is concentrated mostly in Tamil Nadu, Andhra Pradesh, Maharashtra, West Bengal, Karnataka, Kerala, Himachal Pradesh and Uttarakhand.

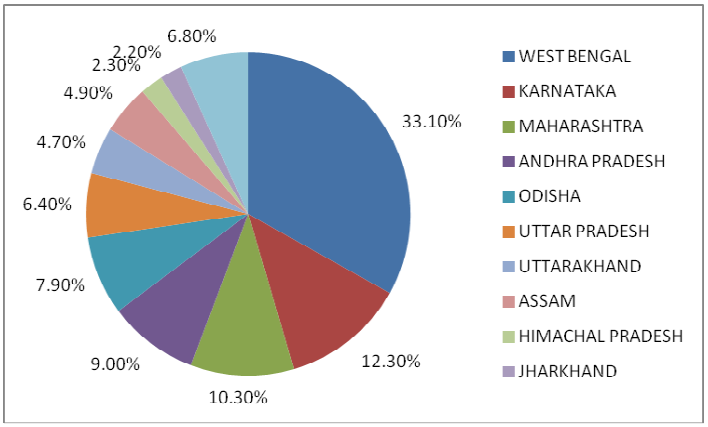
India is bestowed with several agro - climatic zones conducive for production of ornamental crops. During the decade after liberalization floriculture industries took giant steps in the export arena. This era has seen a dynamic shift from sustenance production to commercial production. Indian floriculture industry comprises of flowers such as Rose, Tuberose, Gladiolus, Anthurium, Carnations, Marigold etc. Cultivation is undertaken in both open farm conditions as well as state-of-the-art poly and greenhouses. There are more than 300 export-oriented units in India. More than 50% of the floriculture units are based in Karnataka, Andhra Pradesh and Tamil Nadu. With the technical collaborations from foreign companies, the Indian floriculture industry is poised to increase its share in world trade. Floriculture is now commercially cultivated in several states with West Bengal (33.1%), Karnataka (12.30%) Maharashtra (10.30%), having gone ahead of other producing states like Madhya Pradesh, Gujarat, Punjab, Haryana, Andhra Pradesh, Orissa, Jharkhand, Uttar Pradesh and Chhattisgarh.



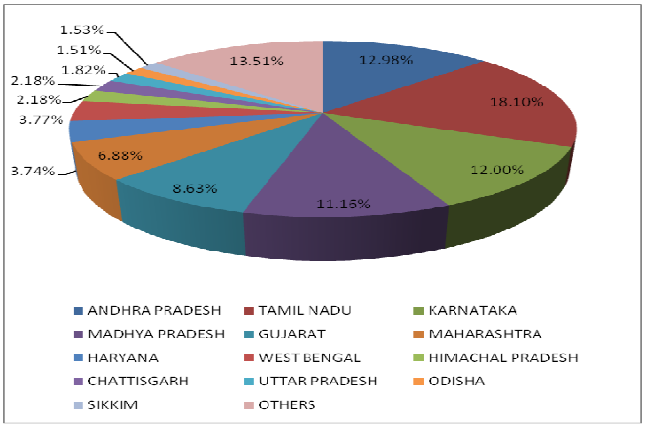
Loose flowers production ('000MT)



Cut flowers Production (Million No's)

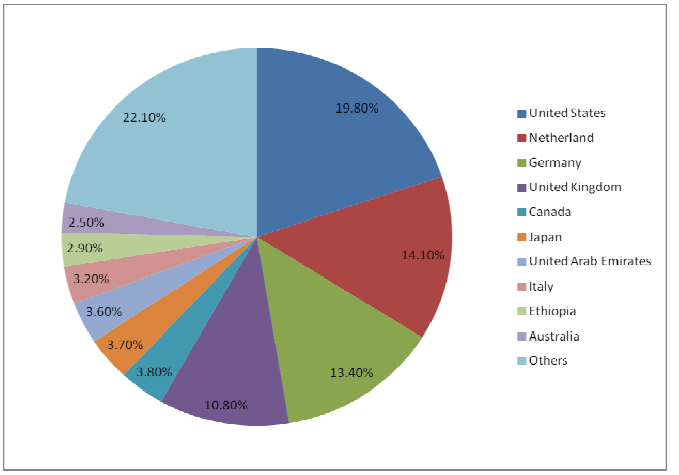


Leading cut flower producing states (2012-'13)



Leading loose flower producing states (2012-'13)

A glance of the export statement of APEDA shows that total exports from floriculture products in terms of quantity was 22,485.21 MT of floriculture products valued at Rs. 455.90 crores in 2013-14. Major Export Destinations during the year 2013-14 are United States, Netherlands, Germany, United Kingdom, United Arab Emirates, Japan and Canada were major importing countries of Indian floriculture during the same period.



Share of exports of flowers from India: 2012-'13

India's share in world floriculture trade has been negligible compared to some other countries. It has not been possible for India to record significance presence in the world market, the reasons being

- Inadequate and improper quality control mechanism: Quality parameters are high internationally, like output free from diseases, proper handling at various stages of transport etc. Indian exporters are unable to meet the stringent quality norms that most of the European countries demand.
- Availability of dedicated cold storage facility at airports, farms are very low, airlines too prefer less volume cargo making things more difficult for exporters.
- Size of farms in India is quite small as compared to some countries thereby there is no economics of scale.
- Inability of Indian exporters to produce quality value-added products which are in high demand in most of the European countries.
- Absence of proper and adequate infrastructure
- Lack of proper technical knowledge
- Lack of sale and export promotion activities etc.

Status of floriculture in Goa

Goa, a beautiful small state, with an annual average minimum and maximum temperature ranging between 18^{0}C to 35^{0}C with an average annual rainfall of 3000 mm makes it more suitable for cultivation of cut flowers, loose flowers and cut foliage. Traditional flowers like Marigold, Jasmine and Crossandra are commonly grown on a smaller area mostly for local consumption. Though Goa is lagging behind in production of flower crops, it is leading in consumption of all types of flowers and cut foliage throughout the year and the demand for these crops reaches peak during tourist season starting from October to May coupled with many religions functions like Ganesh Chathurthi,

Export of flowers from India (Value in Lakh and Quantity in 'MT)

Country	2010-'11		2011-'12		2012-'13	
	Qty	Value	Qty	Value	Qty	Value
United States	7430	5799	7559	7129	6697	8381
Netherland	3149	4527	3924	5413	3099	5970
Germany	4474	4332	5257	5752	3715	5675
United Kingdom	4299	3530	3456	3856	3192	4568
Canada	524	811	868	1203	986	1619
Japan	640	1234	737	1472	801	1567
United Arab Emirates	823	996	817	1126	1029	1545
Italy	1255	893	1267	1119	821	1350
Ethiopia	132	695	415	822	163	1232
Australia	336	679	356	991	353	1074
Others	5845	6109	6270	7649	6266	9364
Total	28907	29604	30926	36532	27122	42345

Dussehra, Diwali, Christmas etc. Rose, Golden rod and Marigold are top most flowers in cut flowers, fillers and loose flowers respectively imported in to Goa markets. Cut flowers comprising of Rose, Aster, Gladiolus, Carnation, Gerbera, Chrysanthemum, Tuberose, Alostromeria, Lillium, Orchids, Anthurium, Bird of Paradise, Heliconia and ginger lily followed by loose flowers viz., Marigold, Chrysanthemum, China aster, Tuberose, Jasmine, Rose and Gaillardia are commonly imported from other places. The cut foliage and greens which are commonly imported are palm leaf, cypress, asparagus, aralias, thuja, ferns, cycas, leaves of Heliconia and Bird of paradise, philodendron, dracaena, cordyline, pleomele etc.

The economy of Goa is based on tourism and mining and these sectors generate income for livelihood of most of the people. However, agriculture can complement and supplement above activities and also help in increasing income and employment of marginal farmers and rural youth. Annually Goa has recorded a tourist inflow of more than 20 lakhs domestic and over five lakhs foreign tourists which demands for more and more floriculture products. In addition, Goa is conveniently located with very good transport linkage with metros like Mumbai, Delhi, Kolkata, Chennai, Bangalore and Hyderabad. Nearly 81 per cent of land holdings are below the size of one hectare and about 11 per cent holdings are between 1-2 hectares. Thus, small and marginal farmers constitute bulk of the land holders for whom Floriculture is a viable option. Major flower growing is carried out mainly on small holdings and few export oriented units. Major production is traditional flowers (loose flowers like marigold, jasmine, crossandra, tuberose, aster etc.) and cut flowers (rose, gladiolus, tuberose, carnation, orchids, anthuriums, liliums, gerbera, chrysanthemum, gypsophila etc.).

Three important factors for a successful floriculture venture viz., favourable climatic conditions for growing of wide range of flower and foliage plants, sustained domestic as well as export demand for flower crops with good transport facility and ready support from the Government and policy makers to make Floriculture a profitable venture are very much available in the state of Goa. In addition to this, of late, Goa is being the venue for many national and international conferences, seminars, meetings including International Film Festival of India which actually requires huge quantity of flowers for hotels, meetings etc.

Strategy to promote floriculture in Goa

Floriculture is a lucrative enterprise having an edge over other horticulture and field crops. The flower business is growing at the rate of 7-8% per annum in India even when there is a fall in other agriculture production. India is comparatively well place with regard to floriculture business because being a large tropical country and able to produce variety of flowers all round the year recently. Due to favourable climatic condition, India can supply fresh flowers. At the beginning, hi-tech cultivation of flowers was confined to corporate houses and big farmers with huge land and capital, but, of late it has been successfully taken up by other sections of society like unemployed youth, women and small farmers.

The important steps favouring for successful floriculture are to be taken by the policy makers and Government of Goa. The major problem faced by the existing farmer who is producing the cut flowers is marketing. Though the quality of flower produced locally is at par with the imported ones from neighbouring states and even some time valued more because of extended shelf life, stiff competition from the established florists is a major constraint. This can be addressed by establishing a co-operative venture like mechanism or buy-back arrangement by the florists especially for high value crops like cut flowers. The second problem is transport of flowers from different areas. Since most of the polyhouse or open fields are established by small and medium farmers, procuring flowers from different areas would be practically difficult. Instead, co-operative ventures can have their own refrigerated transport vehicle. Secondly for big players and export oriented production, an area has to be identified exclusively for cultivation of flowers such as floriculture parks or special agri export zones. This will facilitate easy and efficient handling of inputs, flowers, transport etc. The most important problem faced by the florists is irregular supply. What the export market requires is continuous supply of required quantity and quality at an appropriate time. This can be achieved only when an exclusive area is earmarked for floriculture purpose with necessary support from the Government.

Hence, the strategy to promote floriculture should be on the line of

- Commercial cultivation of Cut flowers like Gerbera, Liliums, Anthurium and Orchids by clusters of small and medium farmers under naturally ventilated polyhouse.
- More focus should be given on flower crops which are tolerant to coastal humid ecosystem like Orchids, Anthurium, Tuberose etc.
- Germplasm collection and conservation in important traditional flower crops of Goa viz., Jasmine, Marigold , Crossandra, orchids etc and its utilization in future crop improvement programmes
- Introduction and evaluation of improved varieties in flower crops under open field as well as under protected condition
- Introduction and evaluation of exotic flower crops like heliconia, red ginger, bird of paradise etc. as intercrops in plantations like coconut, cashew and arecanut for supplementary income generation
- Introduction and evaluation of ornamental foliage plants like coleus, crotons, philodendrons etc and filler plants like asparagus, ferns, golden rod etc.
- Promotion of shade loving cut foliage plants and exotic flower crops in the interspaces of coconut and other plantation crops.
- Setting up of co-operatives to address the issues related to Hi-tech horticulture in general and Floriculture in particular in the state of Goa.
- Promotion of Ornamental nurseries which will serve as the most important avenue for the distribution of planting materials of ornamental crops to the landscape industry, garden enthusiasts, farmers and also help to improve biodiversity in the urban setting.
- Development of suitable models for Vertical and Indoor gardening , Landscaping etc for coastal humid ecosystem
- Development of efficient post harvest technologies for enhancing the vase life of different flower crops
- Diversification in floriculture through value addition like standardizing technologies for dry flower production, pigment and essential oil extraction from flower crops etc
- Increase in production value added products like dry flowers, seeds, potted plants, micro propagated plants etc.
- Establishment of appropriate marketing and distribution channels etc

Conclusions

India has a long history in Floriculture and flower growing is an age old enterprise. What it has lacked is its commercialization. Floriculture is a viable and profitable alternative for the farmers. The growing demands of flowers in the domestic as well as the export market will require a concerted effort on the part of the government as well as the private entrepreneurs to develop floriculture on scientific lines. By recognizing its full potential, India has a fair chance of attaining a strong position on the World floriculture platform. For boosting floriculture industry, lot of measures are to be undertaken by both the Government as well as the private agencies involved in production of floricultural products. It is necessary to emphasize that cooperation and commitment, in terms of education, research and funding from government is necessary for flower industry to succeed in commercial floriculture worldwide. Paying attention to the input needs, better resource management and making various policies entrepreneur friendly would lead to a balanced growth of the floriculture industry.

Looking back on Research at ICAR, Goa: An Agricultural Engineer's Perspective

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Abstract
Agricultural Engineering brings a multi-disciplinary problem solving approach to agriculture and allied sciences. Research at ICAR-ICAR research Complex for Goa was concentrated in development of in-situ soil conservation measures on the slopes of Goa for sustainable Cashew production, rehabilitation of mine reject soils, estimation of post harvest losses of paddy and cowpea, design of suitable structures for western region. A development project funded by Tribal Sub Plan, GOI for Mechanization of Small and Marginal Tribal Farmers of Goa has been in operation. Agricultural Engineering will have a special role in the future of research and development at ICAR- Central Coastal Agricultural Research Institute, realigning its research with the new mandate of the institute to assess and solve the problems of farmers of the coastal eco-systems.

Introduction
The small beautiful state of Goa has a geographical area of approximately 3,702 sq.m. area and a net sown area around 40% and cultivable wasteland is around 12% of the cultivated land1. Farming in Goa is losing its charm with the increasing cost, non-availability of labour and the decreasing production due to subsistence farming practiced where minimum inputs are given to the crops. The percentage of workers in this sector has declined from 60% in 1960 to 27.5% in 1991 and to 16.6% in 2001 population census2. Small and fragmented holdings, varying land topography viz. morod lands (lateritic uplands), midlands or khar lands and the khazan land3 make mechanization a big challenge in Goa.

Agricultural Engineering is an applied science which brings an inter-disciplinary approach to tackle problems in agricultural and allied sciences in real time and real-life situations keeping in view the biological nature of the systems being handled. It uses holistic systems based management approaches and engineering to simplify the problem and solve it but with an underlying sensitivity to the volatile /delicate entities being handled like environment, living things viz. human beings, animals, plants, fishes etc.

The research and development in the field of agricultural Engineering have been concentrated in three key areas viz. soil and water conservation engineering, farm machinery and power and agricultural structures and Environment management. This paper reviews the work done at ICAR-ICAR Research Complex for Goa since its inception, analyses the present scenario with special reference to the problems associated with coastal ecosystems envisaging its future role in ICAR-Central Coastal Agricultural Research Institute.

Research at the Institute
Cashew is a main cashew crop of Goa covering grown in around 26 ha mostly on sloping terrain. But, still the cashew production in Goa is still lower than the national average i.e. around 473 kg/ha. This low productivity has been attributed to high moisture stress due to heavy losses of rainwater, soil and nutrients through runoff on these slopes after the south west monsoon between June to September. Hence a study on various effect of bioengineering measures viz. Half-Moon Terraces + Vetiveria zizanioides + Stylosanthes scabra, continuous contour trench + Vetiveria zizanioides + Stylosanthes scabra, graded trench + Vetiveria zizanioides + Stylosanthes scabra, staggered contour trench + Vetiveria zizanioides + Stylosanthes scabra and semi elliptical trench + Vetiveria zizanioides + Stylosanthes scabra on runoff, soil and nutrient loss and growth of cashew.

The study revealed that the bioengineering measures influenced the runoff, soil and nutrient losses and growth parameters of cashew. The reduction of runoff varied from 3.2 to 7.6% of the annual rainfall under different conservation treatments. Minimum runoff (3.5%) and soil loss (3.7 t/ha/year) were recorded

under the treatment viz. continuous contour trench + Vetiveria zizanioides + Stylosanthes scabra. Minimum Nitrogen (13.95 kg/ha) and phosphorous (16.53 kg/ha) losses were recorded ill the treatment of continuous contour trenches with Stylosanthes scabra and Vetiveria zizanioides. Growth performance of cashew was better under the combination of vegetative barriers with continuous contour trenches, graded trenches and staggered contour trenches. Overall, continuous contour trenches with Stylosanthes scabra and Vetiveria zizanioides was found to be the best soil and water conservation treatment among all other bioengineering measures for cashew plantations in Western Ghat region. Based on these studies in-situ Soil and Water Conservation practices for soil moisture conservation to improve the Cashew productivity on the upland slopes were standardized and the recommendations given to the farmers.

For water conservation research on microscale water harvesting structures were conducted. These structures have been adopted by state Agriculture Department under its subsidy program.

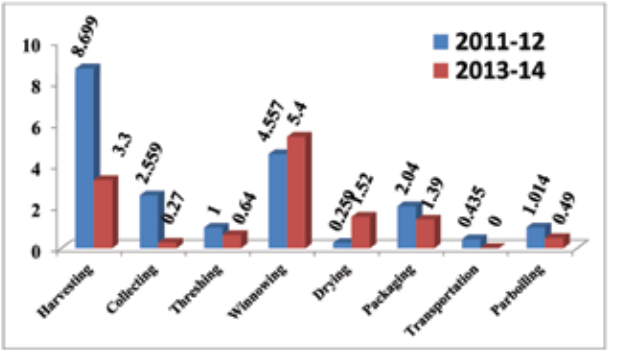
Agricultural Processing

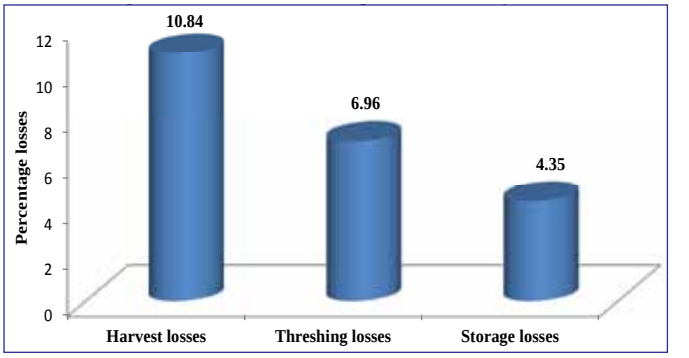
The harvest and post-harvest losses in Paddy and Cowpea were estimated based on both primary data collected on farm and secondary data collected from the concerned stakeholders. A total of ten villages, five each from the two districts of Goa i.e., North and South were taken for the study. From each village five(2011-12) and ten (2013-14) farmers were chosen randomly totaling 50 in 2011-12 and 100 in 2013-14 for Paddy and 50 for Cowpea in 2012-13. A total of 17 rice mills and 6 godowns (Paddy) and 9 godowns (Cowpea) were also surveyed. The primary and secondary data have been pooled for estimation of state level postharvest losses.

Post-harvest losses estimated on secondary data co collected from farmers

Though Paddy is the main field crop in Goa there is a waning interest in farmers for Paddy farming due to the dwindling profits due to high cost of labour, lack of timely operations due to scarcity of labour, non-availability of modern rice mills, which has resulted in high losses which eat into the profit margins of farmers. Farmers are leaving their fields fallow and uncultivated over the years. There has been a concentrated effort by ICAR Research Complex for Goa and the Directorate of Agriculture, Government of Goa to resuscitate the dying profession of Paddy farming through introduction of high yielding varieties, mechanization initiatives like provision of power tillers, custom hiring of combine harvesters and other machinery through Government subsidies or through Tribal sub plan. Introduction of machinery suitable for the small and fragmented land holdings, lowland and undulating upland is very important to ensure timely operations and hence reduce losses in paddy. Modern rice mills are mandatory to reduce milling losses and proper milling of hybrid paddy varieties. Training and sensitization on good management practices like drying, parboiling, storage etc is necessary to enable farmers to overcome the losses. Metal bins of 200-500 kg capacity can be a boon for on-farm storage. Proper plant geometry suitable for inter-cultivation and harvesting using machines should also be introduced and emphasized upon. Also the sensitization of farmers has to go hand in hand with proper infrastructure such as roads for transporting cut Paddy, threshing and drying yards and storage structures to ensure better management of paddy in Goa.

Cowpea, popularly known as Alsando in Goa is popular for its local appeal. It is cropped using only the residual moisture in the rice fields. It is a very high





Operationwise losses in cowpea from primary data

value crop selling for Rs 80-100 per Kg in the local market. But the crop has high borer problem in storage and hence not stored beyond the month of May in the godowns and maximum upto September at household level. The crop is grown only in small area , 34 of the 50 farmers surveyed grew it under less than 1 acre, due to the high labor intensiveness in its operations like harvesting, threshing and winnowing etc. due to lack of mechanization. Other varieties of cowpeas which do not need multiple picking i.e. which mature at the same time if introduced can be harvested using suitable harvesters and threshed and cleaned using multi-crop threshers.

Agricultural Structures

Goa is a tourist hotspot with tourism as its primary industry. Agriculture finds a third place in the state as occupation after mining and tourism. Since land holdings in Goa are fragmented with more than 60% of land holdings are under small and marginal, to make agriculture profitable integrated farming systems and secondary agriculture is being greatly promoted. There is a large demand of high value flowers, fruits, vegetables which cannot be met by domestic produce and come from neighbouring states. During the monsoons open field cultivation of only Paddy is possible. Use of protected cultivation structures, year round can enhance the productivity in the state especially for exotic vegetables, flowers etc., in demand in the hotel industry. At present shade net houses and multi-span naturally ventilated poly houses are being used in the state. The designs of Pune and Bangalore have been adopted which are not specific to the climate of Goa. An attempt is being made to design a protected cultivation structure suitable for Goa was initiated in July 2011 through the project on Design of Protected Cultivation Structures for Year Round received Rs. 44.5 lakhs funding from Rashtriya Krishi Vikas Yojana through the Directorate of Agriculture in Goa.

Studies on microclimate viz. temperature, relative humidity, solar radiation, air flow patterns have been in progress with and without crops for existing old structures and newly constructed structures. The studies have clearly indicated that for vegetable cultivation the present design of naturally ventilated greenhouses are not suitable for Goa as they result in high humidity and hence major incidence of pest and diseases. The structure itself has to be modified to suit interventions such as air mixing fans and if needed ventilating fans. The new design of greenhouse has also incorporated modifications for location specific problems such as high rainfall and changing directions of prevailing winds. The modified design will be finalized after studies on effect of mixing fans on microclimate. The new design will be constructed and tested before the final recommendations are given to the state.

Studies on development of low-cost structures for hydroponic fodder production

A cost-effective structure for hydroponic fodder production has been designed and constructed. The structure will now be tested for hydroponic fodder production and its operation will be standardized.

Studies on Greenhouse-type solar dryer for Drying Arecanut

Work on standardization of the greenhouse-type solar dryer for drying of arecanut in Goa was initiated in collaboration with Agricultural Product marketing Board, Goa. Two designs of the dryer: 1) Modified for roof top and 2) Platform type for waterlogged sites was constructed on the farmers field and tested for drying of arecanut.

It was found that:

- Average initial moisture content of arecanut = 61.09%
- Average final moisture content of arecanut =12.75%
- Drying time outside 27-28 days
- Drying time in dryer 12 days

Roof-top greenhouse-type solar

Platform type dryer

Agricultural Mechanization program for Small and Marginal Tribal Farmers of Goa

Based on preliminary study of the agricultural situation in Goa12,13, a need for systematic approach to the mechanization process with proper sensitization through training and demonstration was felt among the farmers of Goa. Hence, a program on Mechanization of small and marginal tribal farmers of Goa was initiated at ICAR research complex for Goa under its Tribal Sub Plan in 2011 and is in progress till date.

Technological Interventions

So far 40 groups comprising of farmers groups and women self help groups have been provided with power tillers, mini rotary tillers, self-propelled paddy reapers, brush cutters with paddy reaping attachment, pedal operated winnowing fans, drum type threshers (PTO and electricity operated). The groups were given hands on training on the operation and maintenance of these equipment.

Glimpses of farm machinery distribution to beneficiaries

Impact

Studies on the beneficiary groups have indicated a social bonding and significant socio-economic upliftment of the groups. Where previously animal draft power was mainly used, now the farmers not only use the machinery for their agricultural operations but also have extra income through custom hiring of the machinery. An increase of 50 percent in field capacity and 55 percent reduction in cost of agricultural operations due to the use of power tillers alone was observed. This was only for the direct beneficiaries and not the indirect beneficiaries. Also due to timely completion of agricultural operations the intensity of agriculture has improved as all are growing rabi vegetables under larger area. This year the project will be continued with a financial layout of Rs. 60 lakhs.

Conclusions

Goa is a small scale representation of the coastal eco-systems of India and the problems of the same have been systematically studied and enumerated from the agricultural engineering point of view at ICAR-ICAR research Complex for Goa. Keeping in view the broadening of the mandate of the institute to address the coastal ecosystems at large, the same problems can be now up-scaled and addressed from the agricultural engineering point of view. But the proposed or developed technologies need to be sensitive to the delicate make-up of the coastal eco-system and hence be more holistic and sustainable in nature. Development of location specific soil and water management technologies along with the environmental monitoring and budgeting, location and site specific mechanization, post harvest processing, value addition and management, development of sustainable structures for agriculture, horticulture and allied fields would be some the areas in which agricultural engineering will play a major role. It will also play a supportive role in the multi-disciplinary approach to address the various other problems of coastal eco-system of India.

Glimpses of Impact Analysis Data Collection, Sensitization and Hands on Training

Future Role of Agricultural Engineering in ICAR-CCARI

S. No.	Problem	Solution	Role of Agricultural Engineering
	• Decreasing interest in agriculture as a profession • Lack of manpower for agriculture	• Need and situation based ag. Mechanization • Improving the financial and social status of agricultural profession. • Sustainable and hi-tech agriculture to attract rural youth	• Development/adoption of suitable agriculture machines and technologies, sensitization and training.
2.	• Reducing land for agriculture	• Improving status of ag. Profession • Product diversification • More production per unit area/soilless production technology	• Development of co-operative processing plants for diversified products. • Development of a compete package-design, production package etc. of small and hi-tech protected cultuivation structures and their demonstration. • Development and standardization of hydroponic/aeroponic/soilless technology and their demonstration

3.	• Post harvest losses • Various animal and fish products and by-products	• Integrated farming systems • Systems approach to harness potential of animal and fish products and by-products.	• Development of water and soil conservation measures, resource management, mechanization and sustainable structures for integrated farming systems. • Development/adoption and demonstration of suitable machineries for harvesting, trimming/ pruning, intercropping in plantation crops. • Design, development /adoption and sensitization /extension on post harvest management machinery and technologies. • Development/ adopting of suitable hybrid dryers and other technologies and their demonstration. • Product diversification in agriculture and allied fields, Development of HACCP based production and market systems for ethnic and new animal and fish products.
4.	• Monsoon based farming and lack of water resources fro rabi farming	• Micro irrigation • Precision farming • Water conservation and management • Use of brackish water/sea water • Use of solar stills for water recycling.	• Development of location and situation specific water harvesting and management technologies, consultation and demonstration on the same. • Demonstration of micro irrigation technology using harvested water wherever possible. • Development of sea/brackish water dependent agricultural technologies for open field/ protected cultivation. • Distillation of sea/brackish water using solar still technology. • Development and demonstration of sea water greenhouse technology.
5.	• Underutilized fruits with economic and nutraceutical potential 14,15	• Development / popularization of suitable fruit harvesters • Timely harvest and post harvest management • Development of suitable processing machinery • Design & development of co-operative multi-product processing plants	• Enumeration and estimation of their GPS based production potential • Development of suitable multi-fruit and multi-product based processing systems and since number of trees are less promoting community or cooperative based processing systems. • Development of suitable harvesting machines and systems
6.	• Coastal agro-ecosystem	• Risk analysis • Disaster management • Environment management • Vulnerability analysis	• Risk assessment, sensitivity mapping & feedback, environmental impact assessment, development & testing of environmental monitoring & budgeting system and its performance. • Design, development and use of GIS based monitoring systems.

Status of dairy production and management in Goa

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Introduction

The State of Goa lies between 15^{0}48" and 14^{0}53" North latitude and between 74^{0}20' and 73^{0}40' East longitudes. It is located on the slopes of the Western Ghats and stretches out to a length of 105 km from north to the south and is about 60 km wide from east to west. The maximum temperature is 35^0 C and minimum temperature is 18^{0}C. The total average rainfall is 3750 mm. The soil is laterite and some areas in Coastal region have sandy soils. The state of Goa has two districts with 12 talukas. The human population as per last census stands of 13.44 lakhs and being an important tourist spot in the Indian Subcontinent on an average every year 15.0 lakhs tourist visit the state. The state covers partly Western Ghats providing green fodder and natural resources.

Though mining and tourism contribute to the income of the state, the agriculture sector continues to play a major role in the Goan economy. Agriculture in Goa is not much advanced as there is land fragmentation, traditional way of farming, unavailability of labour, high cost of labour, low returns from the sector cause a great concern over the future of agriculture in the state However, as a subsidiary occupation many farmers are rearing cows and buffaloes for income generation. Hence there is lot of scope for dairy production as a secondary source of income as well as household consumption of milk to fulfill the nutritional requirement of family members. In Goa mostly paddy is cultivated and a considerable amount of paddy straw, rice bran, rice husk, cashew apple waste, is available as agro industrial byproduct for feeding the dairy animals. Natural resources like Karad grass, tree leaves and pine apple waste are also available as feed resources for the animals. The number of unemployed educated youth is increasing in the state and most of them are from farming community / rural areas. This all congenial atmosphere gives a good scope for dairy industry in the state.

Present Scenario

As per basic animal husbandry Statistics (2010) the bovine livestock population of Goa is 1,08,000 out of which cattle population is 71,000 and buffaloes population is 37,000. The breed able cattle population is Cross breed cows – 11,153, Non-descript cows – 22,265. The breed able buffalo population is 21,800. There is no recognized breed of cattle from the state of Goa. Majority of the cattle population of this state is non-descript and indigenous. Major cattle breeds reared in the Goa are Sahiwal, Red Sindhi and Gir. Major crossbreds reared in Goa are Jersey cross and Holstein cross. Milk yield of Sahiwal under village condition is 1550 kg and in commercial farms is 1800 kg in a lactation period of 250 days. Age at first calving is 32 -33 months and calving interval of Sahiwal is 15 month. Milk yield of Red Sindhi cattle under village condition is 1100 kg and in commercial farms is 1600 kg. Milk yield of Gir cattle under village condition is 1300 kg whereas under commercial condition is 1500 kg. As such majority of the bovine population is indigenous and nondescript, which is smaller in size, low yielding, having long inter calving period and irregular breeding habits. Thus these animals are uneconomical and most of the owners leave them stray on the roadside. Presently crossbred cattle, which are good yielder and regular breeders, contribute to a great extent. Cross breed cows purchased from neighboring states are also not performing well under local conditions due to problem of adaptability. Considering the above facts and constrains the proper breeding policy is followed for achieving the milk production goal of the state of Goa. Cattle are bred both naturally and by artificial insemination (A I). At present crossbreeding and upgrading policy for non-descript cattle and buffaloes is being followed.

Major buffalo breeds reared in Goa are Murrah, Surti, Pandharpuri, non descript (local) and Crossbred. Buffaloes are maintained under stall-fed and semi intensive system. The average birth weights of calves

in Surti and Murrah buffaloes are 23-24 kg and 30-31 kg respectively. Age at maturity under stall fed conditions ranges from 30-32 m whereas in semi - intensive conditions it is 35 - 36 m. The average milk production of Surti under stall fed condition ranges from 6-8 litres / day with 5.5% fat and 6.9% SNF. Average lactation yield of Surti breed is 1500 - 1800 litres. In case of Murrah under stall fed and semi-intensive rearing average daily milk yield is 9 -10 litres and 7-8 litres, respectively, containing 6.9% fat and 7.0% SNF. Average lactation yield is 2500 - 2700 litres under stall fed condition and 2000 – 2200 litres under semi-intensive rearing. Buffaloes are bred both naturally as well as by artificial insemination (A I).

Cattles are maintained under stall-fed and semi intensive system. Dairy cows in the village are kept in semi open housing with concrete / brick floor and GI sheet / asbestos roof. But proper floor space, orientation and cross ventilation are lacking. In a survey it was revealed that 76.66% farmers are rearing cattle in the intensive system of management. However, 23.34% farmers are rearing cattle in semi intensive system of management ie they allow their animal for grazing for 2-3 hours daily as they have fallow and forest land. Most common type of dairy house was concrete semi open (86.67%). In 56.66% shed floors were of concrete having rough surface with proper slope.

In North Goa roof of the shed was mostly made of asbestos with proper height and proper inclination (40.00%). However, in South Goa roof of the shed was made of GI sheet mostly with proper height and proper inclination (33.33%). So considering both the districts asbestos roof was found to be most common in Goa (25.00%). Most common orientation of dairy house was east - west (53.34%) which is most scientific as this house provides most comfort to animal due to lesser entry of solar radiation inside the house. 65.00% farmers followed standard floor space provision ie minimum 5 m^2 of floor space per cow, required for optimum production and comfort of cows. Ventilation system in 50.00% cattle house was good ie they are

CB Cattle (HF Cross) in farmer house

CB Cattle (Jarsey Cross) in farmer house

Sahiwal cattle at institute farm

Murrah Cross buffalo at institute farm

RCC semi open cattle shed of a farmer at Pernem, Goa

RCC semi open cattle house of a farmer at Cuncolim, Goa

maintaining proper height and inclination of roof as well as proper height of the side wall which provides sufficient air flow inside the shed. Most common cooling system was manually by splashing cold water on the body surface of cow two times (63.33%). 23.34% farmers arranged electric fans besides manual cooling. In 46.66% dairy house hygienic condition of cattle shed was good. Arrangement of cattle inside shed was mostly in tail to tail (63.33%) system which is most scientific as in this system animal get sufficient air and sunlight. However a good number of farmers followed face to face system of arrangement of cattle inside the shed where feed was given on the floor in an area separated by two bamboos. However, this system was not at all suitable because of wastage of feed as well as there was more chance of disease occurrence.

In a study it was revealed that in North Goa farmers preferred to feed cattle kadwa kutty (43.33%) in contrast to paddy straw (83.33%) in South Goa. This might be due to more availability of paddy straw in South Goa. So, overall preference was for paddy straw (41.67%) for feeding to cattle as dry roughage in Goa. 11.66% farmers reported that they provide all the three dry fodders as per availability in different seasons. 45.00% farmers were providing animals Hybrid Napier (CO_3 variety) and few farmers in Ponda are producing and feeding CO_4 variety. 21.67% are not feeding any green fodder due to unavailability of fodder. Most common type of concentrate fed to cattle in Goa was High Energy Pellet (HEP) marketed by Goa Dairy. Few farmers are feeding mash feed consisting of different ingredients such as maize, rice bran, cottonseed cake and soya cake as per availability.

Study revealed that daily total milk yield was in the range of 51-75 lit/day (30.00%) in North Goa in contrast to upto 25 lit / day in South Goa (40.00%). But when data of both the districts was combined it was observed that equal percent (26.66%) of farmer produced milk upto 25 lit/day and 26-50 lit/day. Only 16.67% farmers produced more than 100 lit milk per day. Average daily milk yield was 7.6 -10.0 lit / day (31.66%). Considering the local population and visiting tourists the total milk requirement of the state is about 4.50 lakh liters per day. The Goa dairy

In Canacona, Goa paddy straw is used for feeding cattle

In Ponda, Goa hybrid napier CO4 variety is produced for feeding cows

produces and supplies 1.00 lakh liters of milk per day and there is supply from other sources of about 2.00 lakhs liters. Thus there is a shortfall of about 1.50 lakhs liters of milk. Considering the present scenario, dairy production has got a good potential in this state as a potential source of earning.

Cattle Improvement

To maintain pure germplasam of indigenous breed such as Sahiwal, Red Sindhi, Gir selective breeding should be continued for 50% population and for rest population to increase milk production indigenous cow should be bred with the semen of elite Jersey bull or Holstein Friesian bull from a reputed farm. Jersey breed is preferred over Holstein Friesian due to the reasons, Jersey animal are small in size, need less concentrate feed and green fodder, more adaptable to high temperature and high humid climate of Goa, less susceptible to disease, lesser chances of dystokia due to smaller size. In view of the above Jersey breed is suggested for cross breeding and upgrading the indigenous cows. Inheritance of exotic blood may be preferred to 50% level. Regarding nondescript local cattle, improvement should be done by breeding with the semen of Sahiwal or Red Sindhi from reputed farm. It is not possible to have rigid policy for choice of breed as some of the farmers are having facilities for rearing heavy yielder. Hence option may also be kept to use Holstein Friesian semen from reputed farm for crossbreeding and up gradation also.

Buffalo Improvement

As buffaloes in state of Goa are mostly non-descript, they can be upgraded with elite Murrah or Surati breed semen from reputed semen banks. As Surti and Murrah are both Indian breeds, well suited to Goan climatic conditions, hence the non-descript buffalo may be bred with the improved breed of Murrah or Surti for upgrading. At the same time pure germpasam of Murrah or Surti would be maintained through selective breeding.

Another most important aspect is health management. It includes routine deworming and vaccination for disease control and prevention, consultation to reduce metabolic and other disease, mastitis control, pregnancy examinations and infertility diagnoses, along with proper treatment to eliminate drug residues in animal products. Most common reproductive disorders were repeat breeding (33.34%). followed by dystocia and abortion. 44.98% farmers did not report any reproductive disorders. Most common disease in Goa was reported to be mastitis (31.67%). However, 3.33% farmers reported bloat and 3.33% farmers reported parasitic infection of cattle. 56.66% farmers did not report any disease incidence in their herd. This may be due to regular deworming and vaccination done by Goa Dairy and State Animal Husbandry Department. Vaccination of cattle and buffalo is done against few diseases ie FMD, HS and BQ.

There is a distinct relationship between good genetic make up and environment for efficient dairy production. For this emphasis must be given to provide properly designed housing facilities, necessary dairy equipment, manure management, balanced nutrition, total management efforts and a clean, dry comfortable environment.

Future Line of Action

1. To increase awareness of the farmers regarding latest technological know-how's and schemes linkages between the officials of state department, ICAR institutes, NGOs, financial organizations and dairy farmers should be strengthened.

2. Training has to be imparted to the officers, artificial inseminators to update the knowledge in the implementation of animal breeding program. The livestock supervisors/ veterinary field assistants need to be provided with refresher course on artificial insemination, heat detection and pregnancy diagnosis to improve the skills.

3. To mitigate the detrimental effect of climate change on growth, milk production of cow and buffalo scientific housing should be provided considering proper floor space provision, orientation, height and ventilation of house, provision of manger and drainage in the house. Roof and floor type should be given due importance to reduce heat and cold stress on the animal. Necessary training needs to be given on housing, management to reduce the adverse effect of climate change on production.

4. Fodder seeds should be ensured for the production of green fodder round the year to produce milk sufficiently. In case of scarcity of land, fallow land, forest area and interspaces of plantation crops may be used for fodder production. Balanced nutrition, vitamin and mineral mixture

in optimum level should be ensured for higher production of milk. Necessary training needs to be given to the farmers on balanced feeding and nutrition to increase milk yield. Farmers should be aware of using different unconventional feed and agro industrial by product to reduce cost of milk production.

5. Artificial Insemination programme would be strengthened by providing vehicles, cryocans and other equipments required for all the establishments. Bulls used for breeding programme needs to be examined for important reproductive and infectious diseases periodically. Semen may be procured from reputed source. Care may be taken while selecting semen source to avoid inbreeding. Cooling chain for semen is to be maintained for ensuring higher fertility.

6. Regular deworming and vaccination is very important to reduce mortality and morbidity of animal. To increase awareness of farmers, training on health care of animals, disease diagnosis, control measures etc should be imparted to the farmers. Simultaneously availability of veterinary medicines and vaccines should be ensured to farmers by state department to control transmission of viral and bacterial diseases.

Pig Production Status, Scope and Technologies for Improvement

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Role of pig in human Life

Meat has become an integral part of human food to meet the essential nutrients, as proteins. For a balanced diet a good biological availability meat is preferred in modern day era. The per capita consumption of meat in India is only 14 g per day as against actual requirement of 125 g. Non availability of quality meat and its exorbitant prices have restricted meat consumption. Increasing the meat production through intensive rearing of various meat animals will help to meet the ever growing demand of balanced human diet.

Pig production status of India and scope

India contributes to 12 per cent of the world livestock population with an alarming increase of livestock population at the rate of 2 million per annum. (Mujumdhar 2004) The availability of land for fodder production is restricted due to cultivation of commercial crops and rapid industrialization. In addition, lack of grazing land and ever increasing demand for green fodder is another constrain for rearing large animals such as cattle and sheep, goat etc. In this scenario small animal such as pigs, rabbit, poultry can support to meet the demand for animal protein requirements of the population.

Pigs have a rapid growth rate, high reproductive efficacy, require comparatively less space, and can be reared small scale in backyards or as commercial units. A major advantage of pig farming is that they can be fed on fibrous low quality agro byproducts and material that are not suitable for human consumption leading to low production cost. Hence pig rearing can be a lucrative source of income for rural farmers in India.

In India pig raising and pork industry are in the hands of traditional pig keepers belonging to the lowest socio-economic strata with no means to undertake intensive pig farming with good foundation stock, proper housing, feeding and management. They are compelled to follow old and traditional methods with common village pigs, which could be designated as scrub animals. These animals usually produce litter of small size and inferior quality meat. The poor farmer is unable to provide any attention to their managerial practices and most of the times these animals are left loose to pick up feed stuffs from waste areas of neighboring localities.

Scope

However, in spite of these drawbacks, the consumption of pork in the country has greatly increased in recent years. A number of piggeries have come up where pigs are reared on scientific lines and the manufacturing of pork products is carried out under modern conditions. The pig population has increased from 13.29 million in 1997 to 14.14 million in 2002-03 with an annual growth rate of 1.25 per cent (17^{th} Livestock census, 2003). As per 2012 census the growth of crossbred pigs population is the indicating adoption of advances for better production.

Important aspects of pig production

In spite of above facts regarding pig rearing in India many youth from different states are coming forward to establish modern commercial pig units. These units are of tow type one is breeding unit which maintain parent stock produce the piglets and sale for fattening. Another group is majority where piglets are purchased and fattened for pork. To increase productivity and profitability there is a need of improved pig husbandry like suitable breed, feeding practices, advance technologies like breeding through Artificial Insemination sound diseases control and hygienic production can improve pig production of state as well as profit of individual farmer.

Among all the domestic animals pigs are the most prolific animals with shorter generation interval. A sow can be bred as early as 8-9 months of age and can

farrow twice in a year. They produce 6-12 piglets in each farrowing. Pig products such as pork, bacon, ham, sausages, lard, etc. are increasingly in demand both for local consumption and for the export. Pig industry has a special significance as an enterprise in developing countries which raise pigs mainly by scavenging as traditional occupation in the rural areas. Looking to the meager availability and tremendous demand of animal protein diet in India, it is felt that such demand could substantially be met by improving and multiplying pigs, mainly because of their prolificacy, faster growth, efficiency of feed conversion and shorter generation intervals. Efficiency and cost of production for a swine enterprise are directly associated with reproductive efficiency of the breeding herd.

Breeds Recommended for Goa and Coastal region

Large White Yorkshire Climate in Goa state and other coastal areas is hot and humid. Breeds to eb reared in these areas need to have acclimatization capacity to this hot and humid climate. As it is known that Large White Yorkshire is a pig breed well adopted throughout the world can also perform well in Goa and other coastal areas. Therefore Large White Yorkshire breed can be recommended.

Agonda Goan There are local pig breeds which are well acclimatized for this climate as example Agonda Goan. Agonda Goan Breed popular in Goa State and adjoining areas. It is reared in both North Goa and South Goa district of the Goa State. This pig is densely populated in Tiswadi, Brdez and Pednem talukas of North Goa and Margaon, Salcet,Quepem and Cancona Talukas of South Goa. This is well adopted to the hot and humid climate of Goa. Agonda Goan Breed of the pig plays major role in the profitability of pig rearing in Goa region. Better adoption, sustain on scavenging. Early maturity and good mothering ability are the important characters of this breed. This breed is better for crossbreeding with exotic breed so as to get better adoptability and disease resistance. Meat (pork) of this animal is preferred by local sausage industry which is a popular pork dish liked by local population. This pig is mostly black colored some time white patches on legs and face are found. It has rough bristles black and gray in color. Male animals are little wild in nature weighing 15-60 kgs and get sexually mature early *i.e.* 78 to 120 days. Females of this breed are good mothers, weighing 30-100 kgs having on an average 12 teats. Pork of this breed is of good quality having 70-72% dressing percent and 4.5 to 5 cm back fat. Therefore this can be recommended for the coastal areas.

Crossbred pig These are the pigs produced by crossing Agonda Goan female pig with Large White Yorkshire male. These crossbred pigs have better growth rate and feed conversion efficiency. They do not require intensive care like pure exotic breed like pure exotic breed like large white Yorkshire.

Feeding and watering management

The success of the pig farming are dependent upon the efficient scientific feeding practices. In India, pigs are usually slaughtered at about 70 kg body weight, which is generally achieved in six months of age. To meet the intensified pork production, properly balanced high quality ration must be provided to the pigs. Three types of rations are fed to the pigs before they reach the market weight i.e. creeper/ starter, grower and finisher rations. The creeper/ starter feed is generally fed up to the attainment of 15-20 kg body weight , which is followed by grower feed up to the attainment of 50 kg body weight, and then followed by finisher feed up to the attainment of 70 kg body weight. However, in Goa most farmers feed their pigs with freely available food materials like hotel/kitchen waste, bakery waste, garbage from vegetable market, broiler offal *etc.* it is suggested that these unconventional feeds should be fed as the partial replacement for the ingredients in standard ration to economize the pig production.

Water should be available for pigs of all ages 24 hours for normal physiology. Clean drinking water when available for all the times it helps to maintain all body activities optimum. Watering nipples should be fixed in pigpens for this purpose.

Health management

Like other livestock pigs also get sicknesses due to bacterial infections, viral infection and parasitic infestation. Many times stresses due to climate change or sudden change of feed or faulty food material causes illness in pigs. Vaccination all the newly born piglets should be vaccinated at least against Swine fever at the age 2 months. Vaccine against Pasturellosis (Haemorrhagic septicaemia HS) and Foot and Mouth Disease vaccine like cattle is also preferred in pigs. Deworming In young pigs, infection with roundworms can cause diarrhea, weight loss, ling problems and

death. Hence, the piglets should be dewormed regularly once three months.

Important technologies that can increase pig production

Artificial Insemination (AI)

Artificial Insemination is a biotechnology where breeding is done without direct physical contact of male and female and semen is deposited in female eproductive tract using catheter.

Need and advantages of AI

Saving space and maintenance costs as we can decreases of number o boars , quick genetic progress in swine farm by using boars of higher genetic value through AI, production of same age and performance animal groups to slaughter is possible due to AI. Increase accuracy in genetic value evolution as, a) A.I. boars generate more offspring, b)Information measured by offspring and included in a selection index increases precision in the evaluation of measured characters and increase in the selection intensity, in order to obtain a higher number of births per boar by means of A.I., in comparison to natural mating. This leads to less selected boars. Control of sperm quality of boars, which are subject to various effect such as environment management and sanitary condition .

Advantages from management point of view

Saving time, money and effort avoiding natural mating and movement of breeding animals. The use of animals with very different body weight in breeding.

Advantages in health

The risk of sexually-transmitted infectious diseases is reduced as wel as entrance of diseases-carrying animals is also reduced because there is no direct contact.

Boar Semen collection procedure

The Boar is considered to reach puberty when spermatozoa appear in the seminiferous tubules and are stored in the epididymis, that is, towards 4-5 months of the age. The boar ejaculate starts Laving acceptable parameters for A.I. when the boar reaches approx. 8 months of age. Semen quality, both in volume and concentration increases ur-til 2-3 years of age. From 3-4 years ago on, production and sperm quality decreases. productive life of a breeding boar is for 2-3 years. At ejaculation the penis is completely outstretched. It is of fibro elastic nature and its apparent size increase is due to relaxation of the muscle which regulates the sigmoidal curvature, allowing erection.

Boar Training

Boar needs to be trained for semen collection. For this a sow in oestrous can be used as dummy sow or a artificial dummy sow. For a semen centre semen collection with artificial dummy sow is better as every time oestrous sow may not be available. Once the boar mounts the dummy, which is the most difficult part, the boar must get use to the dummy for 2 weeks, resting 3-4 days between collections.

Routine seminal assessment

Once the fresh semen reaches the laboratory, the parameters to evaluate are the following

Colour

The clean milky white color of the semen must be clearly observed in case it is mixed with colors such as brown, red or yellow. When other colors or not normal odors appear, it is a signal of pathologic changes in the genital tract or due to the mixture of semen with urine during ejaculation.

Ejaculate volume (rich fraction)

It is quantified in cc or in ml and measured by a graduated cylinder The normal volume of the ejaculate rich fraction ranges from 50 to 125 cc, approximately. It varies according to age, testis size, breed and physiological status of each boar.

Motility Sperm motility is evaluated placing an ejaculate drop on a tempered slide at 37°C and a cover slip over it. In order to obtain the desired temperature a slide warmer is needed. The sample is observed in the microscope at 100 - 200 magnification, evaluating general movement (evaluation in percent) and the type of individual movement (scoring 0 - 5).

According to the concentration and the ejaculate volume, we can estimate the number of doses to prepare.

Extender preparation

Measure the volume of distilled water at 37°C (with a graduated flask or in a scale) according to the extender and introduce it in a container Add the necessary content per liter of bidistilled water. There are many

commercial semen extenders available and commonly used are BTS, safe cell from IMV, MRA, MRA-3v from KUBUS. In India Dr. M. K. Tamuli has developed an extender in 1984 but not commercially available. Attempts are in progress at ICAR ICAR Research Complex for developing indigenous boar semen extenders. All above extenders are made to store boar semen at 16-18 degree celcious temperature. Attempts are in progress at ICAR Research Complex for Goa to develop extender suitable to store boar semen at refrigeration temperature.

Seminal doses preparation

After semen quality has been assessed and according to its concentration per mrrr' considered suitable for A.I., the number of doses per ejaculate can be calculated. The recommended minimum doses has a concentration of 2 x 10^9 spermatozoa, nevertheless the concentration most commonly used is 3 x 10^9 for a good sperm quality.

AI Procedure

The sow The sow compared to other species is characterized for having long uterine horns, winding and mobile which implies the need of great volume of ejaculate to assure the spermatozoa arrival. The situation of the external urethral orifice is in the floor of the vagina and has to be considered during insemination;

This is the reason for introducing catheter at 300 in the direction of the top of vagina. The neck of uterus or cervix has some pleats where the penis of the boar fits, due to its screw shape. The term puberty is used to define when their reproductive life estrus. In female puberty is generally associated with the appearance of the first estrus and ovulation. In sows, this coincides with the beginning of the reproductive capacity, since the first ovulation is accompanied with sexual receptiveness.

Heat detection In order to insure success in artificial insemination one of the most important factors is the detection of heat. According to onset of heat, we will determine the right timing to perform the artificial insemination. To detect sows heat, various methods exist which differ in their accuracy.

1. External signs to observe Vulvar edema and hyperemia (swollen vulva). Nervous attitude Characteristics grunts and growls. Vaginal mucus (heat discharge). Loss of appetite.

2. sexual behavior Searching for boar. Jumping on other females.

3. standing reflex By the boar , Walking a boar by the pens, Walking a boar in the park areas Walking the sow by the male stalls. By the man. Pressing the sows back By simulating boar stimulus Aerosol with pheromones, Pressure on the back.Pulling of the flank area.

It is recommended to detect heat twice a day in order to determine the correct onset of heat and consequently the suitable timing to do the artificial insemination. It is recommended that there is a time leg between the first and second, for example one early in the morning and the other one is the late afternoon. Special attention should be given to the heat period, from the beginning to the end, since it is a helpful device to detect a decrease in fertility and overall in litter size.

Insemination timing to establish the most suitable timing to inseminate one must be aware and capable of adjusting two distinct phases, ovulation and the first day of standing oestrus or "heat

The adequate timing to inseminate is generally near the last fourth part of the heat period; this is the nearest moment of ovulation. If heat is detected twice a day, the 1st A.I. can be delayed to the following morning or afternoon (depending on the moment when heat is detected) after heat detection, and following insemination every 12 hours.

The urethral plica is located at the vagina base. When inseminating we must introduce the catheter with 30° inclination pointing to the upper part of the vagina to avoid introducing it in the urethra, in this case urine would come out and the catheter would have to be replaced. After the plica is passed we place it with twisting movements in the counter clockwise direction until it is locked in the uterus neck (we can check this by slightly pulling in out). Once the catheter is locked we introduce the seminal dose slowly, this must take approximately 3-5 minutes.

By keeping these things in view ICAR Research Complex for Goa has established facilities like semen collection, preservation and artificial insemination at the institute. Centre has facilities like dummy sow, Accucell photometer, computer assisted sperm class

analyser and BOD incubator. Exotic Boars like Large White Yorkshire, Duroc and crossbreds of LWY X Goa local, Duroc X Goa local are maintained and trained for donating semen. AI facility for farmers is available at this centre. Artificial Insemination technology was demonstrated and actual breeding of farmers pigs was undertaken. Estrous detection proper timing of insemination and advantages of AI was explained to farmers. Role of AI for crossbred piglet production was also explained. Now, it has become regular practice for many pig owners in Goa State and adjoining part of Maharashtra state that pig owners give a call for insemination whenever female pig exhibits estrous. Conception rate is satisfactory as well as litter size is also good.

Synchronization of estrous

To get furrowing in a season when there is demand for the piglets is important from economic point of view in pig industry. Foe r a commercial farm to get regular piglet production estrous synchronization as well as AI is required. For mass AI program in fielsd also estrus synchronization is verymuch essential.This can be achieved with technique of synchronization of estrous. To study the response of local non-descript sows and Large White Yorkshire sows for synchronization, an experiment was designed. Prostaglandin F2 alpha analogue (Dianoprest) was used for the synchronization of estrus in the sows at the dose of 7.5 mg/animal and 10mg /animal. The results indicated that synchronization of estrous was better in group where 7.5 mg Dianoprost was given. Exhibition of estrous was as better as natural estrous cycle. There was about 80 induction of estrous with single dose schedule when sows were subjected for treatment in 10 days after weaning. In gilts it was about 60 percent with single injection schedule. Conception rate after synchronization and AI was observed up to 70 percent.

Pregnancy diagnosis

Early and accurate identification of pregnant and non-pregnant sows and gilts improves reproductive efficiency in commercial swine farms. Numerous instruments and procedures are currently available for routine pregnancy diagnosis in sows like detection of return to estrus after mating, ultrasound and other laboratory methods and each method has its own advantages and disadvantages. Also, most tests which are available at present are unable to estimate litter size reliably in individual sows.

For these reasons considerable effort are expended in developing a simple, accurate and inexpensive method of determining pregnancy soon after conception. The ideal method to diagnose gestation should allow a quick confirmation of pregnancy and should also be highly specific, sensitive and economic.

Ultrasonography Out of the various pregnancy diagnostic methods available in sows, trans-abdominal ultrasonography is being used commonly in Western countries.

Fodder vis-à-vis Goa

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Goa, a small state of the country has geographical area of $37^{0}2$ km^2 (3.61 lakh ha) with population size of about 15 lakhs. However, being an important tourist destination of the country, it has floating population of about 15 lakhs. Out of the total area of 3.61 lakh ha, about 1.25, 0.37, 0.57, 1.41, 0.29 and 1.71 lakh ha is forest area, land not available for cultivation, other not cultivable area, net sown area, area sown more than once and gross cropped area, respectively. About 43% of the total area of Goa is under field crops and 57% area is under commercial and horticultural crops. Almost no land is earmarked for fodder cultivation or pasture for livestock feeding. Further, about 80% population has land holding size of below 1ha.

The climate of Goa is hot and humid. The temperature ranges from 18-35^{0}C with annual rainfall of about 2500-4000 mm mostly during June-September in uni-modal pattern. The soil is predominantly laterite (73.4%) with organic matter content of 0.5-1.5% and poor in nitrogen and phosphorus.

Goa produces approximately one fourth to one third of its daily milk requirement of about four lakhs litres and for the rest totally dependent upon the neighbouring states. Dairying has been secondary occupation for majority of the farmers of the state.

Primary occupation of dairy farmers of Goa

Occupational Pattern	Percentage
Dairying	08
Agriculture and/or horticulture + dairying	74
Business or service + dairying	18

Based on the number of milch animals; about 51.5, 27.3, 16.7 and 4.5, per cent farmers are marginal, small, medium and large, respectively. The wet average and herd average of the state are approximately 7.62 kg/ day and 5.79 kg/ day.

Status of dairy farmers

Parameters	Percentage
Division of dairy farmers based on number of milch animals	
Marginal	51.5
Small	27.3
Medium	16.7
Large	4.5
Division of dairy farmers based on land holding size	
Marginal	37.9
Small	18.2
Medium	16.7
Large	27.3
Farm Infrastructure	
Concrete housing	90.9
Mud housing	09.1
Chaff cutter	24.2
Milking machine	21.2
Generator set	4.6
Biogas plant	40.9

Table. Status of dairy animals

Parameters	Percentage
Composition of dairy animals	
Total cows as percentage of total animals	52.5
Indigenous cows as percentage of total cows	03.9
Crossbred cows as percentage of total cows	96.1
She buffaloes as percentage of total animals	07.9
Total milch animals as percentage of total animals	43.9
Ratio of milch and dry animals	2.66: 1

Milk production status	
Wet average (lit./ day)	07.6
Herd average (lit./day)	05.8
Reproductive parameters	
Age at 1st calving of cows (months)	32.6
Calving interval of cows (months)	16.0
Age at 1st calving of buffaloes (months)	37.6
Calving interval of buffaloes (months)	19.0
Anoestrus (%)	04.0
Repeat breeders (%)	10.0

The major issue with dairy farming in Goa is low productivity due to non-availability of feeds and fodders. The annual requirement of concentrate, green fodder and dry roughages is about 1.23, 10.08 and 1.67 lakhs tons, respectively. In terms of supply, the deficiency percentage is highest in concentrate at 93%, followed by 49% in green fodder and 50% in dry roughages.

Feeding practices for dairy animals in Goa

The feeding traditions practiced by the dairy farmers were either stall feeding or grazing or both. Exclusive stall feeding was practiced by 68.2% of dairy farmers, while other allowed their animals to graze for 5-8 hours/ day. The concentrate feeds were either purchased (ready-made) or home-made. Only 24.2% of dairy farmers were using exclusively purchased concentrate feed, which were in pellet form and 1.5% of the dairy farmers were using exclusively home-made concentrate feeds. The physical composition of home-made concentrate feeds varied among the dairy farmers, which was generally 2-3 ingredients based. The home made concentrate feed consisted of either exclusive ground maize or ground maize + rice bran/ wheat bran or ground maize + cotton seed cake or rice bran/ wheat bran + cotton seed cake or ground maize + cotton seed cake + rice bran/ wheat bran; in approximately equal ratio. However, majority of dairy farmers (74.3%) were using both purchased and home-made concentrate feeds mixed in the ratio of 1:1-4:1. Among the ingredients of home-made concentrate feeds, ground maize and cotton seed cake were most preferred for supplementation with the purchased concentrate pellets. There was an impression among the farmers that supplementation of home-made concentrate feeds with purchased concentrate feeds should be must to maintain the milk yield. The major reasons behind this were inadequate quantity and quality of the purchased concentrate feeds offered to the dairy animals. Farmers of Goa preferred to feed their dairy animals cotton seed cake with the perception that it was nutritionally better than the other cakes. However, as the protein content of cotton seed cake is lower than the other cakes like ground nut cake or soybean meal, scientific feed formulation is necessary to achieve the optimum result. Some farmers soaked the home-made concentrate feed for few hours (4-8 hours) before feeding to dairy animals with the impression that it would increase the palatability and digestibility and reduces the dustiness of the feed. Only 47% of the dairy farmers were cultivating green fodders for feeding of dairy animals round the year, while 53% of the dairy farmers were feeding only naturally grown grasses during rainy season. During rainy season, the naturally grown grasses fed to the dairy animals are green karad grass and mixed grasses, which include road side grasses, tree leaves and edible weeds. The cultivated fodders were mostly non-leguminous (Hybrid Bajra Napier). However, seasonal non-leguminous crops like maize and Jowar were occasionally grown by some selected farmers for grain consumption and after harvesting the crop residues were used for animal feeding as dry roughages. Very few farmers were using subabul tree leaves for animal feeding, grown on the bonds of their fodder plots. The traditional feeding of dairy animals was dependent upon the cropping pattern of the particular area. As rice is the staple food of Goans, paddy cultivation is very common and after harvesting

Status of feed resources in Goa

Attribute	Requirement	Availability	Deficient	Deficient%
Total bovine (cattle + buffalo) population	1,13, 184 (75775 + 37409)			
Concentrate (lakhs tonnes/ year)	1.23	0.09	1.14	93
Green fodder (lakhs tonnes/ Year)	10.08	5.14	4.94	49
Dry roughages (lakhs tonnes/ year)	1.67	0.84	0.83	50

the crop residues (straw) is used for the animal feeding. Besides, karad grasses are naturally grown during the onset of monsoon, which gradually become dry after rainy season and became available as dry roughages during the month of December- February. The dry roughages used for feeding of the dairy animals were paddy straw, dry karad grass and jowar straw. The paddy straw and dry karad grass were stacked outside in a dome shape, keeping a bamboo in the middle as a support. However, some farmers were storing paddy straw and dry karad grass under polythene cover or under roof. One of the interesting finding was that although Jowar is not grown here, farmers purchase jowar straw from the neighbouring state (Karnataka) and prefer to feed their animals. The dry roughages were fed either exclusively or in combination of two. Paddy straw, dry karad grass and jowar straw were fed exclusively by 25.8%, 22.7%, and 21.2% dairy farmers, respectively. About 13.6%, 10.6% and 6.1% of the dairy farmers fed their dairy animals dry karad grass + jowar straw, paddy straw + jowar straw and dry karad grass + paddy straw, respectively. Some farmers claimed that the animals did not prefer paddy straw, still they had no choice as it was grown by themselves. Further, due to the use of mechanical thrasher, paddy straw was not relished by the animals. Very few dairy farmers were feeding their dairy animals maize stover and guar stovers, which were grown in their own fields. Uses of un-conventional feeds are a part of the traditional feeding system to reduce the cost of production. In the present study, 16.7% of the dairy farmers were feeding un-conventional feeds to their dairy animals. Among farmers using un-conventional feeds viz. spent brewers' grain, arecanut sheath (stalk), banana leaves and banana stems. Maximum farmers (63.6%) were using spent brewers' grain (fresh or dry) and the rest farmers (36.4%) were using arecanut sheath (stalk) or banana leaves or both. The most probable reason behind this was that Goa has many distilleries units for the preparation of cereal malt beverages and the spent brewers' grains; the by-product obtained during the preparation of cereal malt beverages is generally discarded. The dairy farmers had their own feeding schedule for the dairy animals based on the traditional knowledge. In morning, during milking the dairy animals were provided with concentrate feeds followed by grazing or green fodder and dry roughages. Similarly in afternoon, concentrate feed was offered during milking followed by green fodder and then dry roughages. The feeds offered to the milking animals were higher than the dry animals. The concentrate feed offered varied from 2-8 kg/ animal/ day for milch animals and 0-2 kg/ animal/ day for dry animals. Dairy farmers were adjusting the supply of green fodders as per the seasonal availability. The quantity of green fodder offered to the dairy animals was more during rainy season as compared to other seasons, which might be due to the abundant availability of green fodder during the rainy season. During rainy season, both milch and dry animals were offered 5-20 kg green karad grass or mixed grass/ animal/ day. Less quantity of dry fodder and more green fodder was offered to the dairy animals during rainy season due to surplus availability of green fodder. Other than rainy season, the amount of cultivated green fodder offered varied from 0-10 kg/ milch animal/ day and 0-5 kg/ dry animal/ day. During scarcity period, the first preference of feeding fodders was the milking animals only. The dry roughages (paddy straw, dry karad grass or jowar straw) available to both the milch and dry animals varied from 2-10 kg/ animal/ day. Paddy straw contains high silica and oxalates and should be chaffed and soaked in water before feeding to increase the palatability and digestibility. However, the paddy straw and dry karad grass were not chaffed and soaked in water by the dairy farmers before offering to their animals, which need immediate interventions. Few farmers were offering spent brewers' grain, areca nut sheath (stalk) and banana leaves 2-10 kg, 0.5-1.0 kg and 0.5-2.0 kg per animal per day, respectively.

Nutrient content of locally available feeds and fodder

In the present study, the CP content of the purchased concentrate feeds (17.3-20.8%) were lower than the BIS specifications (20-22%), however, the other parameters viz. EE, CF and AIA were towards close proximity to the BIS specifications. The composition of home-made concentrate feeds was highly variable, imbalanced and was not fulfilling the BIS specifications because of lacking in scientific blending in proper proportions with all type of feed ingredients. However, similar to the findings of the earlier workers, the TA contents of the commercial feeds were higher than the home-made concentrate feeds resulting in low organic matter content in the former than the later. The variation in the CP and CF contents of cultivated green fodder might be due to the differences in varieties, harvesting stage and soil characteristics. The nutritive values of the dry roughages are very poor (low CP and high CF) and provide only bulk to the dairy animals. Among the dry roughages, the CP% of the guar stover was lowest (1.3-2.5%). However, among the predominantly

Nutrient content of locally available feeds and fodder

Sl No	Ingredient	On % DM Basis					
		CP	EE	CF	NFE	TA	AIA
Concentrate feeds							
1	Purchased	17.3-20.8	1.4-4.8	8.1-12.1	53.2-62.8	9.2-14.2	1.4-2.9
2	Home-made	8.6-23.1	1.3-15.3	2.5-30.3	35.6-84.2	1.8-8.5	0.2-1.4
Green fodders							
1	Cultivated	6.7-19.6	1.3-4.3	21.1-41.4	35.6-67.5	7.8-19.9	0.1-6.7
2	Green Karad	4.5-5.4	1.0-1.6	41.3-41.8	50.7-51.7	4.4-4.9	1.4-1.6
3	Mixed grass	6.0-9.4	1.1-3.7	27.1-35.1	48.3-58.7	7.7-11.7	1.9-4.9
4	Subabul leaves	26.0-26.6	7.7-9.5	16.3-17.0	66.6-67.2	6.6-6.8	0.7-1.2
Dry roughages							
1	Paddy Straw	2.4-3.1	1.4-2.3	30.8-36.6	38.2-41.9	13.7-15.4	9.2-9.9
2	Dry Karad	2.4-3.1	0.8-1.0	42.7-46.3	48.2-50.0	3.4-4.5	1.1-2.0
3	Jowar straw	3.3-4.4	1.0-1.5	33.3-34.6	50.3-51.8	8.5-9.0	4.9-5.3
4	Maize stover	2.3-3.7	2.4-3.2	41.6-43.5	42.6-43.8	7.3-7.4	4.0-4.2
5	Guar Stover	1.3-2.5	0.5-1.0	34.7-36.8	46.7-48.2	9.9-10.0	5.6-6.1
Un-conventional feeds							
1	Brewers' grains	17.8-25.2	2.6-5.7	18.1-19.4	48.3-51.0	3.2-9.2	1.3-1.8
2	Arecanut stalk	1.7-5.3	0.2-1.2	33.8-43.0	46.2-55.5	7.0-8.1	1.8-2.4
3	Banana Leaves	16.6-20.1	1.9-5.8	17.1-26.9	55.7-67.6	10.5-12.0	1.1-2.2
4	Banana Stem	3.1-4.8	1.9-2.1	25.6-32.0	49.7-56.9	12.2-13.0	3.3-3.4

used dry roughages, jowar straw contained highest CP (3.3-4.4%) and lowest CF (33.3-34.6%) than the paddy straw (2.4-3.1%; 30.8-36.6%) and dry karad grass (2.4-3.1%; 42.7-46.3%), which might be the reason of its good palatability to the animals as claimed by the farmers.

Importance of feeding green fodder

- Fulfills bulk of the animal easily and quickly
- Good palatability and digestibility
- Good source of water as they contain 75-85% water depending upon the type of fodder and stage of harvesting
- Main sources of fibrous carbohydrate, which are well utilized by the animals (the non-legume fodders are rich in carbohydrate)
- Major sources of vegetable protein (legume fodders are rich in protein content)
- Good sources of important minerals like calcium and iron.
- Rich source of carotene (vitamin A) and vitamin E, required to maintain optimum fertility of the animals.
- The milk and milk products of the dairy animals fed on green fodders are rich conjugated linoleic acid (CLA), which has major health benefits in human beings.

Strategies for round the year fodder availability

The strategies for round the year fodder availability for the dairy animals can be chalked out as follows.

Developing liaison among farmers

For successful dairy farming, the farmer having dairy unit but no land or inadequate land for fodder production needs more attention. Arrangements have to be made to make liaison between him and other neighbour farmers producing surplus green fodder or farmer who will produce green fodder for him on contract basis. As the year round supply of green

Yield and nutrient content of fodder crops in Goa

Name of Fodder	Yield in (ton)/ha	FDM	CP	CF
Anajn Grass	0.18		12.47-13.44	29.88 - 30.67
Broom Grass	2.46	21.40 -21.77	12.47 -12.93	30.44 - 31.87
Blue Panicum	0.59	17.74 - 18.55	10.74-12.93	30.65 - 31.42
Bundal Guinea-1	15.07-17.62	15.50 - 16.25	12.87-12.91	35.16 -37.58
Bundal Guinea-2	10.18-17.66	16.10 - 16.65	9.08-10.76	33.03 - 36.68
Guinea (Grazing) Grass	6.17	19.25 - 20.10	8.28 – 8.66	36.86 - 38.27
Signal (Palisade) Grass	25.96	18.27 -18.53	8.49-9.09	32.34 -32.86
IGFRI-3	88.48	16.07 - 16.69	9.73-10.06	31.72 - 36.37
PTH	58.10	15.85 - 16.72	6.65-6.93	38.85 - 40.88
Sain grass	12.1	21.58 - 21.47	7.11 - 8.32	34.90 - 35.87
Rhodes Grass	9.99	14.25 - 14.95	8.20-9.67	39.91 - 40.11
DHN-6	25.33	15.17-15.56	7.66-8.79	24.67-24.98
CO-3	63.95		9.82-10.58	29.64-29.92
Signal Congo Grass	3.92	15.00-15.40	10.77-11.93	29.38-30.01
Signal Grass	28.13	18.92-21.59	9.75-9.97	33.34-33.39

fodder is indispensable for the dairy animals, no scheme on dairy farming should be made without the arrangement for fodder availability.

Development of awareness for fodder cultivation

The popularization of intensive fodder production technologies for dairy animals through organization of frequent training, workshops and demonstration is needed to create awareness among the grass root level workers and farmers. The package of practices should include introduction and popularization of cultivation of nutritious high yielding fodder varieties along with the fodder tree for the availability of quality green fodder and its feeding schedule round the year for the dairy animals. In the horticulture based farming system, fodder crops can be cultivated through intercropping approach with cashew and coconut etc.

Improvement in the land utilization pattern and crop production system

The land utilization pattern and crop production system must be improved for more forage availability. An average of 4% of the GCA of the state should be used for fodder production. Grazing based animal husbandry plays a significant role for the small farmers having indigenous low productive animals. During monsoon, the animals can be primarily thrived on the grazing resources. The area under permanent pasture and miscellaneous tree crops form very less area in this state. Further, due to the soil erosion, the pasture land is at its lower ebb of production. The grass land needs to be improved through re-seeding and introduction of some legumes. A systematic and integrated approach needs to be emphasized on mixed herd grazing which will take care of shrubs, bushes and other herbages. The forest covering area is the valuable grazing resources for the livestock population. The livestock graze the forest area mostly during rainy season. During lean period, the tree leaves and shrubs from the forest area are the potential feed resources for the livestock. The silvi-pastoral system integrating pasture and tree is likely to reduce the grazing pressure. The utilization of crop-residues can be improved by the catalytic supplementation of top feeds like Leucaena leucocephala, Sesbania and Glyricedia etc. The lands, which are unfit for conventional agricultural farming, may be put to alternate land use system such as agro-forestry, silvi-pastoral or horti-pastoral. The degraded lands should be rehabilitated and the eroded waste land should be harnessed for edible biomass production. Specific attention is needed for the control and over exploitation of grazing areas by uncontrolled and over grazing especially by the non-descript cattle.

Establishment of local fodder market or fodder bank

Fodder is most nutritious, when grazed standing in the field or feeding fresh. Local fodder market or fodder bank for fresh green fodder has to be established at each

Taluka of Goa, so that the large land holding farmers will be encouraged for more fodder production and their fodder will be sold on appropriate price on daily basis.

Judicious feeding of green fodder

The green fodder should be fed very judiciously to avoid wastage and making profitable. The dairy animals should be categorized as per the milk production and stage of lactation. For feeding the dairy animals, the green fodder should be harvested at the optimum stage i.e. when both the yield and quality of forages are reasonably high. The optimum stage of harvesting of commonly grown fodder crops like maize, cow pea, guar and napier bajra hybrid are milk stage, before flowering, full flowering to pod initiation and about one meter height, respectively. If sufficient good quality cultivated green fodder is available, then daily feeding of 45-55 kg good quality green fodder along with ad lib. (free choice) straw will take care of the bulk, maintenance and production requirement of a lactating animal (cow producing up to 7 liters milk with 4% fat content and buffalo producing up to five liters milk with 7% fat content per day). Thereafter, one kg concentrate mixture can be added for every 2.5 kg and 2.0 kg additional milk produced by the cow and buffalo, respectively. If the dairy animal is pregnant, besides the maintenance and production requirement, one kg concentrate mixture as pregnancy allowance should be offered extra only in the last three months of the pregnancy. When the green fodder is not available sufficiently, as a thumb rule 10 kg good quality fresh green fodder can be replaced by one kg concentrate mixture (20-22% crude protein). The green fodder must be chopped before feeding to the dairy animals for better utilization. The required concentrate mixture, green fodder and straw may be offered either separately or mixing together as total mixed ration (TMR).

Preservation of fodder by nutritional technologies

The excess fodder can be preserved for the lean period by mainly two nutritional technologies i.e. by hay making and silage making.

Constraints in production of green fodder in Goa

The major constraints in the availability of green fodder may be broadly categorized as follows.

Small land holding size of the dairy farmers

The 'no land' or 'small land holding size' factor of the dairy farmers is the major cause of less fodder production. Majority of the dairy farmers of the state are landless or have small piece land for rice or vegetable or other horticultural production and they just can not afford that piece of land specifically for fodder cultivation. Based on the land holding capacity and interest of the farmer for dairy production, there are mainly four types of farmers. (i) Have dairy unit but no land for fodder production; (ii) Have dairy unit but the land available for fodder production is inadequate to maintain the dairy unit; (iii) Have dairy unit and the land available for fodder production is adequate to maintain the dairy unit; (iv) Have adequate land for fodder production but no interest in dairy production

Unawareness for fodder cultivation

In most of the cases, the dairy farmers are not aware of the package of practices for fodder cultivation and its effective utilization as per the farming conditions for round the year fodder availability for their dairy unit.

Land utilization pattern and crop production system

The availability of feed resources of a state is dependent up on the land utilization pattern and crop production system. The green forages can be contributed from the cultivated fodder (gross cropped area), private primary grazing (fallow land), public primary grazing (permanent pasture, miscellaneous tree crops and cultivated waste land) and public secondary grazing (forest area). Goa is a very small state with a total geographical area of 3702 sq km. The gross cropped area (GCA), fallow land, permanent pasture land, miscellaneous tree crops, cultivable waste land and forest area respectively form about 48.50, 2.40, 0.37, 0.17, 12.64 and 35.92, per cent of the total area. An average of 4% of this GCA should be under fodder production; however, in the map for area under fodder crops of the various states of the country, Goa has no land for fodder production. Further, out of the total forest area, only 14.04% (200 sq. km) is private forest.

Seasonal variation

The seasonal variation in weather or climate is mainly responsible for the inadequate fodder accessibility round the year. There is flush of fodder during monsoon or rainy season (July to September), which reduces in winter and practically there is negligible

amount of fodder during summer season. Although due to improved irrigation facilities, the situation has improved to some extent, but the trends remain almost as above. However, the scarcity of green fodder is aggravated during lean periods of May- June and November-December.

Salinity, Labour problem
Destruction by wild animals

Hydroponics technology of fodder production in Goa

The hydroponics green fodder is produced in greenhouses, which can be hi-tech or low cost devices. The hi-tech greenhouse is associated with a control unit and may be with or without air conditioner. The control unit regulates input of water and light automatically through sensors. In 2011, under Rashtriya Krishi Vikas Yojana (RKVY) of Govt. of India, eleven hi-tech greenhouses with daily production potential of 600 kg fresh maize green fodder have been established by Goa Dairy at different dairy cooperative societies of Goa including one unit at ICAR Research Complex for Goa, Old Goa for production of hydroponics green fodder. The cost of each hi-tech greenhouse was approximately Rs. 15 lakhs.

The low cost greenhouse (devices or shade net structure) for production of hydroponics green fodder can be constructed with bamboo or wood or MS or GI pipes or brick masonry. The existing wall of a house can also be used to construct lean-to-shade net greenhouse, which reduces the cost of fabrication. The cost of the structure depends upon the type of construction material; but is significantly lower than the hi-tech greenhouse. Large number of farmers of Satara district of Maharashtra are producing hydroponics green fodder by different types of low cost greenhouses and feeding their dairy animals. The farmers revealed that the cost of the wooden shade net greenhouse with daily production potential of about 30-350 kg fresh hydroponics fodder was approximately Rs. 6000-50000/-; while the cost of the MS shade net greenhouse with daily production potential of about 150-750 kg fresh hydroponics fodder was approximately Rs. 25000-150000/-. In low cost greenhouse system, the irrigation of the hydroponics fodder can be made by micro-sprinklers (manual or automatic) or a knapsack sprayer at frequent intervals. In shade net structure, the internal environment of the greenhouse is more influenced by the outside climatic condition and therefore, the types of fodder to be grown hydroponically depends upon the season and climatic condition of the locality.

Although many types of fodder crops can be grown under hydroponics technology, in India, maize should be the choice grain for production of hydroponics green fodder due to its easy availability, lower cost, good biomass production and quick growing habit. The grain should be clean, sound, undamaged or not insect infested, untreated and viable. The maize seeds should be soaked in normal water for about 4 hours and strained before placing it in trays or troughs for sprouting inside the greenhouse, usually for 7 days. The quantified seeds of a particular day can be soaked in a bucket and the debrises and broken seeds floating on the water can be removed easily.

The quantity of seeds loaded per unit surface area of the green house tray (seed rate) also affects the germination of the seeds as high seed rate enhances mould growth. The seed rate of 7.6 kg/m^2 (1.5 kg maize seed per tray of 78 cm x 24 cm) can be recommended for growing hydroponics maize fodder for higher output. The trays are put inside the greenhouse and are allowed to sprout for about seven days and on 8th day generally they are harvested and fed to the animals. The germination of the maize starts on 2nd-3rd day and the extension of the roots are clearly visible from 3rd-4th day onwards. The hydroponics green fodder looks like a mat of 20-30 cm height consisting of roots, seeds and plants.

The water should be clean and free from chemical agents. It is observed that recycling of water enhances mould growth inside the greenhouse. Therefore, it is suggested that if water availability is adequate, water should not be allowed to recycle within the system instead regular drained water can be used in a garden or for cropping near to the greenhouse. In hydroponics technology, to produce one kg of maize fodder about 1.50 litres (if water is recycled) to 3.0 litres (if water is not recycled and drained out) of water is required. Cereal seeds germinate equally well under dark or light conditions and high intensity of light is not necessary for the growth of the plants. After harvesting, the trays should be cleaned by mild cleaning solutions. The holes of the foggers must be cleaned by pins for proper fogging. The floor and walls of the greenhouse also be cleaned properly to avoid growth of mould.

Feeding of hydroponics green fodder

The yield of the hydroponics green fodder is highly influenced by the type and quality of the seeds and cleanliness of the greenhouse. Yields of 5-6 folds on

fresh basis (1 kg seed produces 5-6 kg green fodder) and dry matter content of 11-14% are common for hydroponics maize fodder; however, sometimes dry matter content up to 18% has also been observed. Famers of the Satara district of Maharashtra revealed fresh yield up to 8-10 folds for hydroponics maize fodder in low cost greenhouse system. However, the fresh yield is mostly influenced by type & quality of the seeds; degree of drainage of free water prior to weighing; and clean & hygienic conditions of the greenhouse. The cost of production of the hydroponics fodder is mainly influenced by the cost of seeds; as it contributes about 90% of the total cost of production. In Goa, the cost of production of the fresh hydroponics maize fodder is about Rs. 4-4.50/- per kg. However, the farmers of Satara district of Maharashtra revealed that in low cost greenhouse system with home-grown or locally purchased seeds, the cost of production of the hydroponics fodder is very reasonable (about Rs.2.50-3.50/-).

Hydroponics fodder is more nutritious than the conventional green fodder. In comparison to conventional maize fodder, the hydroponics maize fodder contains more crude protein (13.6 vs 10.7; %), ether extract (3.5 vs 2.3; %) and nitrogen free extract (66.7 vs 51.8; %); but less crude fiber (14.1 vs 25.9; %), total ash (3.8 vs 9.4; %) and acid insoluble ash (0.3 vs 1.4; %). The crude protein content of the roots (10.25%) and leaves (22.15%) of the hydroponics maize fodder are similar to the crude protein content of the non-leguminous and leguminous fodder, respectively. Besides, hydroponics green fodder has greatest enzyme activity, rich source of anti-oxidants (in form of β-carotene, vitamin-C, E), good sources of chlorophyll, enhancement of immune system, etc. Hydroponics green fodder is palatable and relished by the dairy animals. The intake of fresh hydroponics maize fodder by dairy cows may be up to 25 kg/ animal/ day along with limited concentrate mixture and jowar straw. However, it is recommended to supplement 5-10 kg fresh hydroponics maize fodder per cow per day. Feeding of hydroponics green fodder increases the digestibility of dry matter (6.9%), organic matter (6.7%), crude protein (5.3%), ether extract (6.9%), crude fibre (11.2%) and nitrogen free extract (4.6%) of the ration; which contributes in the increase in the milk production of the lactating animals by 8-13%. Besides, the other advantages observed by the farmers were improvement in health and conception rate of the dairy animals, reduction in cattle feed requirement, increase in taste (sweetness) of the milk, whiter milk, reduction in labour cost, requirement of less space and water, freshness and high palatability of the hydroponics fodder etc.

Rural Poultry: A Prospective Livelihood Alternative for Goa

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Introduction

Rural Backyard poultry production is the most widespread form of poultry keeping in the world (FAO-OIE-World Bank, 2008), being an important component of small farmers' livelihoods and a tool for poverty alleviation. Birds are kept in a low input/ low output system, with the available scavenging feed base supplemented with food scraps and grains. Birds and their by-products are usually consumed by their owners, sold locally and used as gifts (FAO, 2005; FAO-OIE-World Bank, 2008).

Goa is located in South-Western India in the region, also known as Konkan. It lies on the slopes of Western Ghats, blessed with a unique climate of 18-35^{0}C, 2500-4000 mm annual rainfall with humidity, it is a biodiversity hot spot and best suited for integrated farming system including animal husbandry as a prominent component. As per 17th livestock census (2003), state had 5, 65, 000 fowls and 1000 ducks. There is heavy decrease in fowl population in the state during the inter-censual period. Fowl population has decreased by around 28.4% in the state. So this is matter of serious concern for the stakeholders to increase the population and production of poultry in the state of Goa.

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

Srinidhi Chicken (Dual Purpose)

In this situation, scientific efforts for introduction of the improved backyard varieties of rural poultry adoptable for the state of Goa and effective usage of the existing feed resources and strategic approaches for adoption of new technologies are highly essential.

Constraint analysis of commercial poultry farming in Goa

A study was conducted by ICAR Research complex for Goa in 2009 to know various constraints of poultry farmers in Goa. One hundred poultry farmers were selected in two districts of Goa i.e. North and South Goa. Out of 100 farms, 90% were engaged in broiler production and remaining 10% were layer farmers. Study revealed that main problems encountered by farmers was high feed cost followed by competition with outside farmers, high labour cost, trading, high cost of electricity, high cost of chicks and non availability of health services. Major suggestions were provision of subsidized feed, electricity and water and establishment of feed mill with subsided equipments, remunerative price for broiler and eggs through co-operative marketing.

Grampriya Chicken (Dual Purpose)

Initiatives of ICAR RC Goa for popularizing the Rural Poultry

ICAR Research Complex for Goa, has the responsibility of increasing the agricultural production and productivity by conducting applied and strategic research. Research has been conducted in this Institute on various aspects of rural backyard poultry.

RKVY Project

Under financial assistance of Rastriya Krishi Vignan Yojana (RKVY) a project was undertaken entitled Rural Poultry Production for livelihood security in Goa during 2011-13. Under this project, a poultry hatchery of 5000 eggs capacity was installed with semi-automatic hatcher and setter. Two varieties of backyard poultry were procured i.e., Vanaraja (Dual purpose) and Grampriya (Egg purpose) from ICAR- Directorate of Poultry Reasearch, Hyderabad. The eggs produced from these

Vanraja Chicken (Dual Purpose)

parent stocks were incubated and about 1900 chicks were distributed to the beneficiaries of Goa.

ICAR-Poultry Seed Project

Indian Council of Agricultural Research under XII five year plan has identified ICAR Research complex for Goa as one of the center for implementation of Poultry Seed project. The main objective of this program is to increase the availability of eggs and chicken meat in remote rural/tribal areas through rural poultry farming (RPF) with improved chicken varieties in the state of Goa. Under this project parent stock of improved chicken varieties (Gramapriya, Vanaraja and Srinidhi) will be maintained and propagated for the distribution to the farmers. Capacity building programs will also be conducted to the beneficiaries with regard to the rural poultry farming. The characteristics and economics traits of the improved chicken varieties (Gramapriya, Vanaraja and Srinidhi).

Economic traits of improved backyard chicken varieties suitable for Goa

Economic trait	**Gramapriya**	**Vanraja**	**Srinidhi**
Body weight (grams)			
6 weeks	400-500	650-750	400-450
20 weeks	1600-1800	2000-2200	1700-2000
40 weeks	2300-2500	2200-2300	2200-2300
Egg production			
Weight 28 weeks g.	52-53	42-44	48-50
Weight 40 Weeks g.	57-58	52-58	52-55
Age at first egg, days	160-165	175-180	165-170
Annual egg production (72 weeks)	200-230	100-110	140-150
Survivability (%) up to 6 weeks	99	98	95

Under the poultry seed project, a parent shed, brooder cum grower shed and a hatchery was sanctioned by the ICAR and will be operational by the end of 2015. Once the facility is fully operational, annually 15000 chicks will be distributed to the farmers of Goa. Which in turn will significantly increases the population and production of rural poultry in Goa.

Poultry/Duck-Fish Integration

Fish and meat have high demand in Goa. While marine fish and poultry meat consumption is an accepted practice in Goa, production of carps, a set of fresh water fishes in ponds and duck rearing are recent introduction to the Goa. The fresh water potentials of Goa consist of many small and large ponds that are underutilized at present. There are about 100 hectares of seasonal and perennial ponds and bhandaras in Goa. In addition to many rainwater impoundments adjoining paddy fields and storage tanks that are used for irrigating the crops chiefly paddy and the vegetables. It would be possible to culture 4-6 varities of fast growing carp varieties. By integrating poultry or duck rearing in the pond itself, the chief and expensive inputs like manure, fertilizers and fish feed could be avoided. The droppings of the poultry ot ducks fertilize the pond to produce the sufficient food for the fish.

Duck-fish integration

In the integrated culture of fish and duck, both the components are mutually benefited. This combination increases the production of both fish and duck and reduces as much as 60% total input cost in fish culture by way of pond fertilizers and fish feed. The poultry/ ducks also get about 30-50% of their food from the pond. The ducks feed on aquatic weeds, insects, molluses etc., which do not form the food for wish.

Way ahead

This is in spite of the fact that eggs and meat from rural poultry fetch a much higher price than that from commercial poultry; proper marketing of these products has been a great impediment for the succession of the rural poultry sector. It is well known fact that a significant proportion of the landless and marginal farmers make out their living from poultry. Backyard poultry requiring hardly any infrastructure set-up is a potent tool for upliftment of the poorest of the poor in Goa. Besides income generation, rural backyard poultry provides nutrition supplementation in the form of valuable animal protein and empowers women.

Keeping in mind the potentials and limitations of the rural poultry farming in Goa, a deeper insight need to be taken into the requirements of the rural poultry sector with focus aimed at the poorest of the poor. Since Goa being a one of the smallest state of this country with enterprising farming community, various rural/family poultry models like Bangladesh models (BRAC & Proshika), Cuban model , Mozambique model etc. need to be extensively studied, deliberated and replicated upon in Goa.

On the background of the extreme poverty, most women of rural, landless households are subjected to in Bangladesh, Bangladesh Rural Advancement Committee (BARC) evolved a poultry development model. The model was exclusively targeted at landless women and builds on Government-NGO collaboration. It involved women in a chain of activities as vaccinators, hatchery operators, chicken rearers, feed sellers, producers of hatching eggs and as producers of eggs for the market. Credit as well as marketing is integrated into the model. A recent survey

INTEGRATED SEMI-SCAVENGING PRODUCTION MODEL

Production	Supply/sale	Service
Breeders	Parent Stock	Village group
Hatcheries	Feed	Training
Chicken Rearers	Vaccine/medicine	Credit/savings
Smallholders	Marketing	Extension

has reported considerable positive impact in terms of both income and producer household egg and meat consumption. It was concluded that poor rural women can contribute to economic development as buyers and sellers of goods and services, by contributing to improved household income, and - as important - in the process, their own self-esteem is heightened.

It was seen that those models had adopted a mother unit-cluster approach as per their needs including health service delivery and marketing. With the unswerving efforts of Goan farmers and women, ICAR Research complex for Goa will make its every endeavor to arrive at a suitable and flexible model, a "Goan Model" for rural poultry to suit various agro-climatic regions and socio-cultural conditions of this vast country.

Fishery and fish resources exploration: Initiatives from ICAR in Goa

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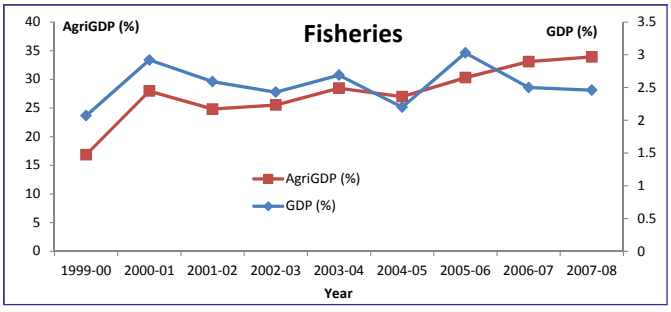
Abstract

Goa holds a huge scope for the fisheries development on account of the heavy demand for fish as well as diverse and rich ecosystems for enhancement. The fisheries sector of the state contributes about 2.5% of the total GDP and 17.1% of the agricultural GDP. Goa state encompasses huge potential of marine, freshwater and brackish water fishery resources with a coast line of 105 km, continental shelf area of 10 million ha, estuarine area of 13,157 ha, brackishwater area of 3,500 ha, Khazan land of 18,000 ha, 555 km length of rivers, freshwater ponds of 100 ha, reservoirs covering 3, 250 ha and mine reject pits of 200 ha. The state is getting an annual average production of about 0.8 lakh tonnes of marine fish, 3000 tonnes of brackish water fish and 100 tonnes of freshwater fish. Marine fisheries sector of the state provides 97% of the fishery resources for food uses and non food uses. Even though the sector is lucrative and enterprising, several challenges are associated with it and management options are holistic. Marine fisheries resources are highly diverse and form the integral part of the culture and diet in Goan life. The fresh water fisheries resources comprise unique germplasm of high diversity. Brackishwater fisheries resources include euryhaline tolerant fisheries resources which are utilised efficiently. The institute carried out surveys along Goa to catalogue the fishery resources in these three water resources along Goa and documented 250 species from marine, 68 species from freshwater and 25 species from brackish waters. Here we briefly describe the research outputs of those efforts along Goa.

Introduction

Fishing is the activity of trying to catch fish and other aquatic animals such as gastropods, bivalves, cephalopods, crustaceans and echinoderms. Fish assumes greater significance to the people of Goa and it forms an integral part of Govan life and culture as it forms one of the most important items of the food of more than 90% percent of population. Goa is the state with a coast line of 104 km (1.28% of Indian coast line of 8117 km) with numerous bays and headlands. The continental shelf area of Goa extends to about 10,000 km2 of about 100 fathoms depths. The fisheries sector contributes to about 2.5% of the total GDP of the state (third position after West Bengal and A.P.) and 17.1% of the agricultural GDP of the State (Fig. 1).Thus fishing industry of Goa plays a vital role in socio-economic development of Goa by contributing substantially towards Net State Domestic Product through export and domestic trade annually. In India fish eating population is about 56% of the total population (Planning Commission, Govt. of India), Percapita fish consumption is about 8.49 kg. Goa contributes to about 1.85% of the total marine fish landings of our country (CMFRI, 2012).



Contribution of fisheries sector to total as well as agricultural GDP of Goa

The contribution of fisheries sector to the total GDP of Goa is found to be 2.46% and there is a decline in the contribution of the fisheries sector to the GDP. On the other hand, the fisheries sector has improved its contribution to the agricultural GDP in the last decade from 16.85% in 1999-2000 to 33.91% in 2007-08. Thus the fisheries sector plays a significant role in the agricultural sector of the state. Marine fishery sector provides livelihood to a large number of people in Goa. Altogether more than 5% of total working population is engaged in fishing and allied activities. Moreover, Fisheries industry forms the second largest industry

both in terms of employment and income. Besides the actual process of fishing, a number of ancillary and subsidiary activities like marketing, processing and small scale vending will also create livelihood for a number of people. Highlighting this background, the institute carried out research initiatives in exploring the fish and shellfish biodiversity in marine, freshwater and brackishwater systems along Goa using landing site based surveys, underwater surveys and fishing experiments. We discuss the research achievements in these studies.

Number of species identified under different groups during the Panjim fisheries harbour survey

Demersal		Pelagic		Crustacean	
Group	**Species**	**Group**	**Species**	**Group**	**Species**
Cat fish	7	Indian Oil sardine	1	Shrimps	9
Sharks	6	Indian mackerel	1	Crabs	8
Rays	6	Ribbon fish	2	Lobster	3
Flat fish	7	Horse mackerel	1	Stomatopods	4
Croakers	13	Seer fish	2	Total	24
Silver bellies	7	Carangids	18	Molluscan	
Silver biddies	3	Mullets	5	Group	Species
Snapper	7	Cobia	1	Bivalves	8
Sea bass	1	Pomfrets	3	Cephalopods	2
Sea bream	2	Dolphin fish	1	Total	10
Grouper	5	Barracuda	4	Estuarine/fresh water	
Threadfin bream	3	Tuna	6	Group	Species
Lizard fish	3	Bombay duck	1	Pearlspot	1
Moon fish	1	Lesser sardines	2	Tilapia	1
Rabbit fish	2	Giant herring	2	Fresh water Prawn	1
Scat	1	Moustached anchovy	4	Total	3
Tiger perch	4	White bait	4	Grand total	215
Big jawed jumper	1	White sardine	1	Marine total	212
Grunt	1	Shads	4		
Bulls eye	2	Bony bream	1		
Threadfin	2	Gizzard shad	1		
Eels	3	Full beak	2		
Triple tail	1	Half beak	2		
Flat head	2	Sand whiting	1		
Puffer fish	4	Long finned herring	1		
Blind goby	1	Ten pounder	1		
Toad fish	1	Glassy perchlets	2		
Tripod fish	1	Golden anchovy	1		
		Tarpon	1		
		Bill fishes	3		
		Rainbow sardine, sprat	2		
Total	97	Total	81		

Marine fish and shellfish diversity in Goa with a special reference to Panjim harbour

Panjim fisheries harbour land mostly the fishes off Goa coast. With a view to catalogue the major marine fisheries resources from Goa region, regular weekly surveys were carried out from November 2013 to May 2014. A total of 20 samplings were conducted during the period. The survey has catalogued a total of 212 marine species including fish and shell fish and three estuarine/fresh water fish species. The numbers of pelagic, demersal, crustacean and molluscan species identified were 81, 97, 24 and 10 respectively. It is reported that about 212 marine fish and shell fish species are found in the marine landings along Goa (Sreekanth *et al.,* 2014 unpublished).

Marine fish landings

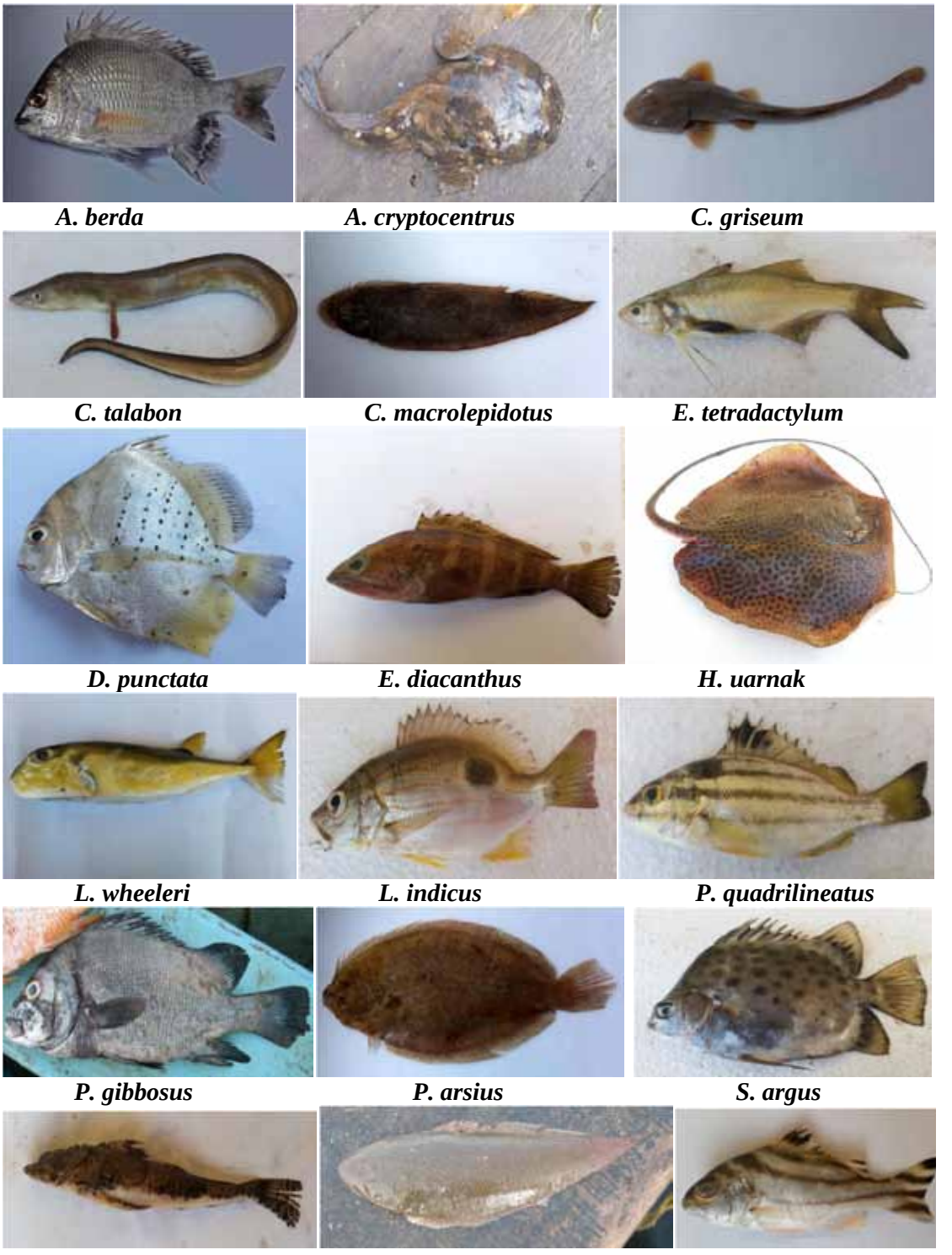
Finfish and shellfish diversity along Zuari estuarine coastal ecosystem

Recently the institute has initiated research project on augmentation of fishery and fish biodiversity in the near shore areas using artificial fish habitats since October 2013. Initial surveys and site selection procedures are going on. Initial fishing experiments were planned for the first six to eight months on the fishery, fish biodiversity along the coast. A complete review has been made in parallel on the international and national research status on artificial fish habitats especially artificial reefs. Sites were surveyed and suitable sites (Siridao, Kakra, Odxal, Nauxim, Bambolim) was selected in the Zuari estuarine mouth and outer for the pre-deployment survey and the fishing experiments for fishery and fish biodiversity studies are going on. The coastal ecosystem, the mouth of Zuari estuary which supports ¼ of the marine and brackish fish production along Goa. Tradititonal fishery within this coastal zone (mouth of Zuari estuary) is considered to be an activity which will be significantly correlated to the finfish and shellfish diversity along the coastal ecosystem. The entire coastal zone has a bed of rocky patches (which makes it unsuitable for trawling) and hence the gillnet fishery represent majority of the landed catch. The region holds a medium fish landing centres like Siridao, Kakra, Odxal, Bambolim and Nauxim which lands an average of 1000-1500 tonnes of fish every year. The gillnet fishery is found to be a major subsistence activity of the traditional and motorised fishermen along these regions along the Zuari mouth with catches consisting of diverse fish and shellfish taxonomic groups. Hence, present study was attempted from October 2013 to September 2014 to catalogue the fish and shellfish diversity along the estuarine ecosystem. A total of 173 aquatic species comprising 137 finfish species (Pelagic-56, Demersal-81) and 36 shellfish species (17 crustacean species and 19 molluscan species) were collected during the study. The 137 finfishes were belonging to 43 families (Pelagic-17, Demersal-26). The 36 shellfish species were belonging to 19 families (Crustaceans-4, Molluscans-15). The fishermen society of the Tiswadi has appreciated our efforts in cataloguing the fishery resources and assured co-operation in community based fisheries management along the coastal ecosystem. A brief report on the research output was communicated to the Director of Fisheries, Secretary (Fisheries), Fisheries Minister and Chief Minister. The current study highlighted the importance of conservation of coastal ecosystems like Zuari estuary for sustainable replenishment of fishery resources and livelihood.

Exploration of freshwater fish diversity in Goa

Of the states in Peninsular India with rivers originating in the Western Ghats, Goa remains the least explored for fish biodiversity. The previous attempts dates back to 1970's with a record of about 35 fish species from rivers of Goa (Tilak, 1972; Yadav, 1976). As part the efforts to catalogue the freshwater fish diversity in the Western Ghats, NBFGR Kochi Unit in conjunction with ICAR Research Complex for Goa conducted intensive appraisal of fish diversity in freshwater habitats in Goa between 2013 and 2014. Nine sampling locations covering the two major river systems in Goa, Mandovi and Zuari, were sampled intensively using cast net, drag net, trap and scoop net. The survey yielded a total of 40 species of freshwater fish and 7 species of crustacean up to March 2014. The final round of sampling was conducted from 15-19 September 2014, where, in addition to previous locations, the lower reaches

of the Zuari and Mandovi basin up to the estuarine zone, as well as the Chapora River, which originates in Maharashtra and enters the Arabian Sea in Goa were also included. The latest round of sampling yielded 15 additional species of fish, along with 6 species of crustaceans, bringing the total number of fish species to 55 and crustacean to 13. This is the first intensive effort in this century for cataloguing the freshwater rivers of Goa to explore the fish biodiversity. The major species obtained during the survey are *Pethia setnai, Haludaria pradhani, Rasbora dandia, Aspidoparia morar, Devario malabaricus, D. aequipinnatus, Garra*



Species catalogued along Zuari estuarine mouth coastal ecosystem

mullaya, Aplocheilus lineatus, Dawkinsia filamentosa, Mystus malabaricus, Schistura altipedunculatus, Carinotetraodon travancoricus, Channa gachua, Puntius mahecola, Puntius vittatus, Systomus sarana subnasutus, X. cancila, Aplocheilus kirchmayeri and Pseudosphromenus cupanus. Crustaceans observed during the survey are Macrobrachium canarae, M. malcolmsonii, M. cf. gracilirostre, Caridina cf. babaulti, C. cf. gracilirostris, C. cf. hodgarti and Parathelphusa sp.

Exploration of brackishwater fisheries resources along the backwaters of Goa

Goa is bestowed with 13,000 ha of brackishwater resources which hold good edible and ornamental fisheries resources such as fingerfish, tiger perches, pearlspot, orange chromide, mangrove red snapper, silverbellies, silverbiddies, tilapia, scat, pufferfish etc. Apart from this shrimp resource like, Indian white shrimp, tiger shrimp, flower tail shrimp and freshwater prawns. Moreover, molluscan fisheries resources like oyster, window pane oyster, mussels and clams are also abundant in these water bodies. We have catalogued about 50 species of fish and shellfish along the backwaters of Karmali region.

Recently the fisheries section has conducted 2 under water surveys along the Grande Island region off Goa during October 2014 with support from DIVEGOA. We have cited several species of fishes, shellfishes, anemones, corals, sea slugs, jellyfish medusae and polyps, sea urchins, sea cucumber, sea squirts etc. The coastal ecosystems of Goa hold rich resources of aquatic life which can sustain good fishery along the Goan marine fisheries. Further detailed underwater explorations will help in identification, cataloguing, collection, field trials and enhancement of aquatic resources of Goa. The experience gained through the explorations will be helpful in the current institute activities involving mariculture (seed collection trails, seed sites identification, culture trials, and data collection) and artificial fish habitats (deployment, under water observations and data collection).

The Institute could carry out fisheries resource and biodiversity based research involving fishermen along the coastal ecosystems of Goa in the recent past. As a part of widening the scope for the entire coastal zone of the country, it will orient the research focus towards diversity enhancement, evaluation and management systems to sustain the production from fisheries sector. The energy gained through our research initiatives in the past will pave the way forward in future developments of the fish biodiversity research in the coastal region of our country.

Aplocheilus kirchmayeri

A. lineatus

Carinotetraodon travancoricus

Devario malabaricus

Garra mullaya

Rock pool habitat

Etroplus *suratensis*

Ambassis commersonii

Monodactylus argenteu

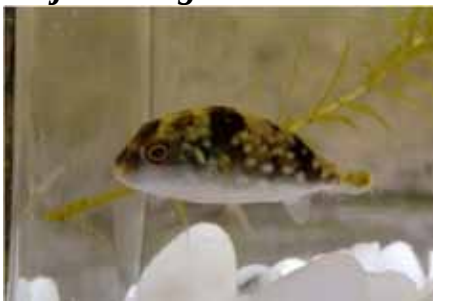
Glossogobius giuris

Leiognathus splendens

Lutjanus argentimaculatus

Mugil cephalus

Oreochromis mossambicus



Chelonodon patoca

Terapon jarbua

Terapon puta

Terapon theraps

Penaeus monodon

Macrobrachium Malcolmsonii

Penaeus indicus

Near sea grant major

Diving buddies

Near Medusae

Amblyeleotris guttata

Apogon compressus

Apolemichthys xanthurus

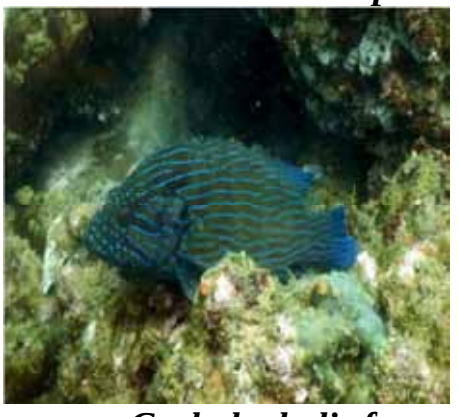
Pomacanthus annularis

Chrysiptera hemiscyanea

Aluterus scriptus

Heniochus accuminatus

Pterois volitans



Cephalopholis formos

Coastal Aquaculture a potential livelihood opportunity for Goa with special reference to mussel culture

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Introduction

Goa state encompasses huge potential of fishery resources with a coast line of 105 Km, continental shelf area of 10 million ha, estuarine area of 13,157 ha, brackishwater area of 3,500 ha, Khazan land of 18,000 ha, 555 km length of rivers, freshwater ponds of 100 ha, reservoirs covering 3,250 ha and mine reject pits of 200 ha. The state is getting an annual average production of about 0.73 lakh tonnes of marine fish, 100 tonnes of freshwater fish and 200 tonnes of brackish water fish. Over the last ten years, the marine fish production remained almost stagnant at 0.8-1.0 lakh tonnes.

On the other hand, the inland fish production is gradually increasing and there is ample scope for coastal aquaculture for further improvement in production on account of demand. Abundant natural settlement of molluscs in the rocky bottoms, wild seeds of brackishwater fishes like Pearl spot, Seabass, Mullet, Milkfish etc in the estuaries and backwaters of Goa could be utilized for low cost aquaculture practices. Goa being a tourist destination and has an enormous potential for marine fisheries development including coastal cage culture, mussel culture and oyster farming. Integrated fish farming system with agriculture, horticulture and animal husbandry and ornamental fish farming are gaining popularity among the local people for increasing their farm income.

Mussel culture potential in Goa

The mussels, basically the Green mussel, *Perna viridis* which are most available species and are relished by the Goan people and the demand for this resource are increasing which is reflected by the price trends in these resources. On the other hand, the production of green mussel in the state by natural recruitment is diminishing in the last decade.

Goa has one of the richest water resource spread over 250 kms which is occupied by brackish and freshwater fisheries. Brackish water fisheries include extensive

Trend of Green mussel production in Goa

estuaries or river mouth, a large number of lagoons, back waters, brackishwater lakes, etc. The nine rivers flowing in Goa are Terekhol, Chapora, Baga, Mondovi, Zuari, Sal, Saleri, Talpona and Galgibag of which Zuari and Mandovi are the major ones (Subramanian 1994). Most of these rivers are originating from the Western Ghats and meeting the Arabian Sea in the west. The total estuarine area in Goa is 13,157 ha. Mandovi and Zuari are the two major estuaries known as life lines of Goa, which are inter-connected by Cumbharjua canal 14 kilometer and 11 kilometer away from the mouth of the respective estuaries. Both the estuaries open into the sea at Dona Paula beach. The salinity and tidal effects are very much pronounced, except in June-September of the year, when there is heavy inflow of fresh water into the Sea. Mandovi estuary is five kilometers wide at the mouth region, where as Zuari is about seven kilometers wide. The estuarine bed of the 253 Mandovi River is mostly sandy or muddy, whereas, Zuari is mostly rocky (Subramanian, 1994). Green mussel is widely distributed and found extensively around Kollam, Alapuzha, Kozhikode, Kannur and Kasargod in Kerala and in small beds in Chilka lake, Visakhapatnam, Kakinada, Chennai, Pondicherry, Caddalore, Mangalore, Karwar, Goa, Ratnagiri and in Gulf of Kutch.

Constraints in coastal aquaculture development in Goa

The important constraint in the coastal aquaculture including mussel farming in Goa is the unavailability of good quality seeds. The surveys indicated that the mussel beds are scantly along the coastal areas of Goa. The second constraint is the lack of awareness on the technologies available for the coastal mariculture. The people are laggards in adopting the technology and intense effort should be made in disseminating the technological advancements in the sector. There is an urgent need of strategic approaches including capacity building programmes to draw the people to these technologies. Similar to the status of other coastal regions, the influence of environmental factors including natural (climatic) and anthropogenic (organic and in-organic pollution and overexploitation, destruction and reclamation of coastal ecosystems) is greatly affecting the development of coastal mariculture in Goa.

Considering all these facts in mind ICAR Research Complex for Goa initiated demonstrations in Coastal aquaculture in Goa. Seeds are transported from the areas where plenty of seeds are available. After the successful demonstrations, many farmers have shown interest to take up the mussel culture in estuarine and coastal waters in Goa. Mussel culture methods are found to be eco-friendly as there is no involvement of additional nutrient inputs to the culture system. The mussels will thrive on the plankton which enters through the tidal forcing by filter feeding. Thus, the successful demonstrations of mussel culture have built a new path for the development of coastal aquaculture in Goa. These demonstrations aimed to assess the ecological and economic impacts of the coastal aquaculture.

Technologies adopted for mussel culture in Goa

Estuarine areas free from strong waves action and with high plankton production were selected for farming. Moderate water current will bring the required planktonic food and will carry away the waste materials. Salinity range of water during the culture period was 22 - 35 ppt from the month of November to May. Water temperature ranged between 21°C to 31°C and dissolved oxygen from 3.8 to 5.5 ppm in the

Mussel spats

Filling mussel spats in bags


Mussel harvest and depuration

culture system. Goan water bodies are Shallow hence Rack and ren method was adopted.

Seed collection and seeding of ropes

Earlier mussel seeds were plenty in Goa. But for the last 5 years mussel seeds are scarce, hence mussel seeds were collected from Kerala. Healthy seeds from the submerged (sub tidal) natural beds were collected for seeding. After removing other organisms and weeds, the seeds were washed thoroughly in seawater. Average size of seeds was 28 mm. About 1kg of seed was required for seeding on one-meter length of rope. The length of rope was decided by considering the depth where the rack was positioned. Suspended the seeded rope on rack in such a way that the upper portion of the rope should not get exposed during low tide. Nylon rope of 12-14 mm was used for seeding. Prestiched cotton mosquito net bags were used for covering the seeds around the rope. Cotton net bags around the seeds were disintegrated within a week of time. Within that period the seeds were secreted byssus threads and were attached itself to the rope.

Some of the future demands in coastal aquaculture in Goa

- Oyster culture
- Small coastal cages(Mullets, Pearlspot, Seabass etc)
- Wild Seed collection technologies
- Rice cum fish culture/Integrated aquaculture
- Crab fattening

Conclusion

Goa is rich in water potential, species resources and demand for resources. Technologies for coastal aquaculture are already developed. Through capacity building and demonstrations interest among the fishermen community and entrepreneurs will develop which will improve the livelihood status as well as resource production in Goa.

Krishi Vigyan Kendra (North Goa) at farmers service

Shri Vishram Gaonkar,
Programme Coordinator Incharge
KVK (North Goa), ICAR – CCARI, Old Goa, Goa

Introduction

The Krishi Vigyan Kendra (Farm Science Centre) was established at the ICAR Research Complex for Goa, Ela, Old Goa, Goa in the year 1983, then under the Administrative control of Central Plantation crops Research Institute(ICAR) Kasargod, Kerala. It is a vocational training centre designed for bridging the gap between the available technologies and its application for increased agricultural production in multi disciplinary areas like Crop Production, Horticulture, Animal Sciences, Fisheries, Home Science, Plan Protection and Agricultual Extension.

The Krishi Vigyan Kendra is ideally located at Ela, Old Goa which is 10 Km from Panaji, the capital city of the state. It was established mainly to cater to the training needs of the farming community of the coastal talukas which constitute about two thirds of the total cultivable area of the state as well as the other interior talukas of the state. As Goa has an undulating terrain with diverse soil conditions, there is a ample scope for introduction of multiple cropping and mixed farming systems on scientific lines in this region.

Mandates:

KVK was established with following mandated activities

1. Conducting "On Farm Testing" (OFT) for identifying economically viable technologies in terms of location specific sustainable land use systems.

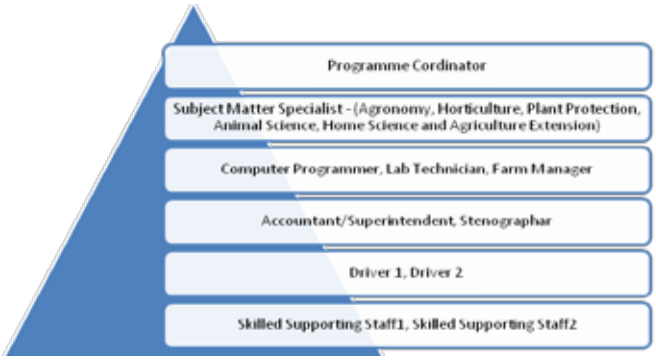
2. Organizing Front Line Demonstrations (FLDs) on various crops and technologies to generate production data and feedback information.

3. Imparting short and long term training courses in agriculture and allied discipline for the farmers and rural youths with emphasis on "Seeing is believing" and Learning by doing" for higher production on farms and generating self-employment.

4. Organizing need based training to update the extension personnel with emerging advances in agricultural research on regular basis.

Krishi Vigyan Kendra Organization Chart

Krishi Vigyan Kendra is headed by Programme Coordinator, there are Six Subject Matter Specialist in discipline of Agronomy, Horticulture, Plant Protection, Animal Science, Home Science and Agriculture Extension. Lab Technician, Computer Programmer and Farm Manager are assisting SMS and Programme Coordinator, in performing their duties, KVK has an Office Superintendent, two Drivers and two Skilled Supporting Staff.



Major Achievement & Important Technologies Transferred

On farm testing:

On Farm Testing is first mandate of KVK under this programme 521 trials were conducted covering 51.25 ha area till January, 2015.

Front line demonstration:

Frontline Demonstration is second mandated activity of KVK under this programme total 759.15 ha area has been covered on various crops / enterprises, and 3,231 farmers are benefited till January, 2015.

On farm testing

2. Front line demonstration

Training programmes

Planting material production

Former Chief Minister visit

Other extension activities conducted

Training programmes:

This is the third mandated activity of KVK. A total of 2,658 training programmes for farm men and women, rural youth and extension functionaries were conducted in which 43,545 personnel participated till January, 2015.

Planting material production:

In order to cater the planting material needs of farming community, KVK established nursery unit. In all 3,75,044 Nos. grafts/seedlings of various crops like mango, cashew, coconut, arecanut, drum stick, ornamental and medicinal plants, etc. prepared in nursery and supplied to needy farmers at reasonable cost till January, 2015.

Other extension activities conducted:

KVK is transferring the various technologies through various other extension activities, Some of other important extension activities conducted to create awareness and popularize technologies till January, 2015 are given below.

1.	Field days	:	65
2.	Agricultural Exhibition	:	66
3.	Farmers fair	:	25
4.	Radio talks	:	185
5.	TV Programmes	:	55
6.	Popular articles	:	111
7.	Pamphlets prepared	:	43
8.	Various days celebrated	:	95
9.	Special lectures	:	381

Technologies transferred in farmers field

Following technologies in agriculture and allied disciplines were transferred to farmers/stakeholders since inception till 2014.

1. Technology on hybrid rice, basmati, fine grained, and salt tolerant rice production
2. Standardization of Vermiculture technology
3. Technology in rice based cropping system
4. Groundnut production in residual moisture
5. High density cropping models in horticulture
6. Grafting techniques in cashew & mango
7. Mushroom cultivation & spawn production
8. Infertility problems in cattle
9. Composite fish culture
10. Fruits & vegetables preservation
11. Income generating activities.
12. Introduce/popularizing high value vegetable crops (capsicum, Chinese cabbage, broccoli, etc.) including water chest nut
13. Popularized gladiolus cultivation
14. Popularized YVMV resistant var. Parbhani Kranti

15. Popularized red kernel rice cv. Revati & M0-9.
16. Intercropping in Arecanut and Coconut Garden with Turmeric var. Pratibha
18. Integrated Farming System
19. Seedling Transplanting Technology in Tur (Red Gram).
20. Introduction of Green Gram var. S-4 cultivation in residual moisture in rice fallows.
21. Introduction of High yielding Onion var. Bhima Kiran
22. Introduction of Capsicum var. Indra.
23. Capacity Building in producing packaging and marketing of organic rice and popularization thereof.
24. Provided technical guidance in conservation establishment of rain water harvesting unit and micro irrigation system and utilization of water for increasing cropping intensity in rice fallows.
25. Two public Private partnerships (PPP) established between 2000-07 to 2000-09 at Saligao and Chodan villages with Reira Eco ventures and TERI respectively.
26. The KVK promoted 356 Self Help Groups which have played pivotal role in the upliftment of socio-economic states of the farming community, particularly farm women by adopting the technologies.
27. KVK promoted 10 farmers club in different adopted villages and provided technical guidance

Award and Recognition

Based on the performance of KVK it was given all India Best KVK Award during 2008 at the hands of Hon. Shri Sharad Pawar, Ex- Minister for Agriculture, Govt. of India.


Indian Council of Agricultural Research

is presented to

Krishi Vigyan Kendra (North Goa)

ICAR Research Complex for Goa, Ela, Old Goa

for outstanding contribution in the field of

Extension Education


INDIAN COUNCIL OF AGRICULTURAL RESEARCH

BEST KRISHI VIGYAN KENDRA AWARD FOR THE YEAR 2008

CITATION

Ongoing Externally Funded Project under

KVK is implementing following projects under RKVY and NHM.

a) RVKY

1. Round the Year vegetable nursery raising and off season vegetable production
2. Establishment of Integrated Agricultural Technology Model
3. Up gradation of training facilities
4. Production of Virgin coconut Oil
5. Strengthening of Soil Testing Laboratory as Central Soil Testing Laboratory for Soil, Water, Plant, and compost in Goa

b) NHM –

1. "Plantation infrastructure development for production of planting material"

Infrastructure

KVK has five hectare land under cultivation, it has its own administrative building well equipped training hall to cater training needs and 18 bedded farmers hostel.

In order to give practical demonstration to the trainees, KVK has established following demonstration units.

1. Vermicompost Unit
2. Crop Court
3. Ornamental Garden
4. Mango Orchard
5. Cashew Orchard
6. Goats Unit
7. Poultry Unit
8. Dairy Unit
9. Nursery Unit
10. Fodder Bank
11. Integrated Agriculture Technology Model
12. Polyhouses
13. Homestead farming

KVK Also have following laboratories:

1. Soil and Water Testing Lab
2. Trichoderma production Lab
3. Home Science Lab
4. Information Technology Lab

Service Providing

The KVK is providing the services to the farming community and other stakeholder in agricultural and allied sectors through:

- Assessment and refinement of various technologies and conducting On Farm Testing trials at farmers' fields.
- Conducting large scale demonstrations of economically viable technologies at farmers' fields.
- Imparting trainings to the farmers/ farm women, rural youth, extension functionaries.
- Conducting vocational trainings to develop entrepreneurships.
- Production and supply of various inputs such as seeds, planting materials, breeds, Trichoderma viride (Bio control agents), Spawn, Vermicompost, Earthworms, etc.
- Farm advisory services
- Diagnostic visits
- Technology dissemination through lectures, demonstration, displays, publications, etc at various forum, Creating awareness through conducting various extension activities like Kisan mela, seminars, symposiums, farmers meets, workshops, field days, exhibition, etc.

Nourish your Coconut with Micronutrients

BORON, ZINC & COPPER

alongwith SAMARTH for optimizing yields

RECOMMENDED DOSAGE FOR COCONUT PER YEAR / TREE

Age of the Tree	Samarth 10:26:26	Urea	Potash	Granubor Natur	Zinc-21*	*Copper Sulphate
1st year	200 gms	100 gms	100 gms	25 gms	50 gms	50 gms
2nd year	500 gms	250 gms	250 gms	50 gms	100 gms	50 gms
3rd year	1.5 kgs	550 gms	500 gms	75 gms	250 gms	50 gms
4th year onwards	2.0 kgs	650 gms	1 kg	100 gms	300 gms	50 gms

Boron deficiency leads to premature fall of flowers and nuts thus reducing yield, which can be corrected by using Granubor Natur.

Method of Application:
Granubor Natur is to be mixed with fertilisers and applied in a ring, one metre away from the tree, 25 cm deep and covered with soil.

** Application of *Zinc-21 and Copper Sulphate is recommended once in two years by maxing with compost.*

For Agri Advisory Services, please contact Toll Free Help Line No: 1800 1212 333
Customer care Email : customercare@zuari.adventz.com

Sangam Let's grow together!

JAI KISAAN

ZUARI AGRO CHEMICALS LTD., GOA