PREFACE

The year 2011 marks the 30th anniversary of National Agricultural Research Project(ICAR) that transformed the erstwhile Coconut Research Station at Kumarakom, Kerala Agricultural University into a Regional Agricultural Research Station (RARS), for the special zone of problem areas, with mandate for problem solving research in Kuttanad, Pokkali and Onattukara region.

It was a clear shift from commodity centric research to a farming system alternative. During the period the centre has developed a number of pro-nature technologies that ensured increased productivity and profitability and environment friendly farming alternatives. The lead contributions of Regional Agricultural Research Station, *inter alia* include development of adaptable integrated farming models for wetlands, biological control of pests & aquatic weeds and biodiversity conservation research.

It is indeed gratifying to note that many of our technologies have found large-scale acceptance among farmers and some have become flagship projects of the development departments in the state. This has been due to our conscious policies based on absolute awareness of farmer's needs and priorities.

Besides pursuits in research, Regional Agricultural Research Station has been proactive in imparting education and training to graduates of different disciplines and clientele farmers. Our technology dissemination activities received a massive boost with the establishment of a full fledged Krishi Vigyan Kendra in the campus.

In order to effectively leverage our experience and technologies, the centre is now being strengthened under Kuttanad package to establish a new research facility for Biodiversity based Farming Systems , Kuttanad Biodiversity Conservation centre, and a Centre for Environmental Surveillance of wetlands . With these, the centre is taking a new trajectory of growth and development.

Despite our poor looks in building & infrastructure and low pageantry, our fortunes and acceptance among farming community is attributed to our devoted scientists, staff, and hardworking labor. We also owe a lot to all our retired institution builders, besides many others who still remain with us. We widely admire the support and encouragement of the present Vice Chancellor Dr. K.R.Viswambharan who is a pillar of strength to us today.

We are indebted to the proponents of Dr. M.S. Swaminathan package for Kuttanad, for recognizing our research contributions and for recommending substantial fund for strengthening research infrastructure.

We dedicate this small volume to the farming community and to all readers who intend to get a glimpse of the accomplishments and priorities of this centre as it enter a new phase now.

Dr KG Padmakumar
Associate Director of Research

RARS, KUMARAKOM

Visit of Dr. M.S. Swaminathan Research Foundation Team
for formulation of Kuttanad Package

Visit of Dr. M.S. Swaminathan
to Cage Culture site at Thanneermukkom

RARS : MILE STONES

The **REGIONAL AGRICULTURAL RESEARCH STATION, KUMARAKOM was originally established as** Coconut Research Station. Kumarakom in the year 1947 with the liberal financial support of the Indian Central Coconut Committee in order to cater to the research needs of coconut in the reclaimed alluvial soils of Kuttanad. Initially, the land required for establishing the station was obtained on lease from the late R.B.A.Baker, an enterprising European planter. However, in 1958, an area of 23.23 hectares was acquired from him by the Government of Kerala and the station was brought under the State Department of Agriculture. With the establishment of the Kerala Agricultural University in 1972, the Coconut Research Station became one of the constituent institutions of the University. In 1982, the station was upgraded to the status of a Regional Agricultural Research Station (RARS) under the National Agricultural Research Project (NARP) funded by the IBRD/ICAR with a mandate for research on crops and cropping systems. This **Special Zone of Problem Areas** has been demarcated to represent geographical areas where agriculture is hazardous and exposed to the vagaries of nature. Encompassing an area of 5254 square kilometers, it comprises parts of the districts of Alappuzha, Kottayam, Ernakulam and Thrissur. Seven distinct farming situations have been identified in the zone, *viz.*, kayal, karappadam, kari, orumundakan and kootumundakan, pokkali and kole.

Location

The R.A.R.S., Kumarakom is situated at 93' latitude and 763' longitude in the Kumarakom village of Kottayam district on the eastern banks of the Vembenad lake and on the southern side of the Kavanar river. It lies at an altitude of 0.6 m below MSL. The nearest municipal town is Kottayam, just 15 km south of Kumarakom.

Weather

Kumarakom enjoys a humid tropical climate. The normal annual rainfall is 2603 mm, the bulk of which (55.4%) is received during the span of 3 months from June to August. A dry spell prevails during December to April. The mean maximum and minimum temperatures are, 30.8oC and 25.3oC, respectively. The mean relative humidity is 86.7 per cent.

RARS, KUMARAKOM

Mandate of the Station

The main objective of the station was originally to conduct research on coconut and coconut based cropping systems with special reference to coconut diseases. However, with the implementation of the NARP, the station became the lead station to conduct problem oriented location specific research on all crops in the special zone of problem areas. The main mandate of the station is research on coconut and coconut based farming systems and integrated farming.

- to serve as a Regional Centre for solving location specific problems in the Special Zone of Problem Areas comprising Kuttanad, Kole and Pokkali tracts.
- to take up research on integrated farming systems incorporating crops, livestock and fish.
- to promote research efforts in respect of food grains, pulses and oilseeds particularly those that are grown under rain fed conditions.
- to evolve agronomic practices and land use patterns in the influence area of the station viz., the Special Zone of Problem Areas.
- to co ordinate research efforts in the control and management of pests and diseases of coconut.
- to co ordinate and guide the research activities of the sub stations in the Special Zone.
- to promote the extension of technology to the farming community.

Lead Functions

R.A.R.S., Kumarakom is the lead station for the zone. It has 3 satellite stations *viz.*, Rice Research Station, Moncompu, Rice Research Station, Vytilla and Agricultural Research Station, Thiruvalla. The functions of these stations are mentioned below

Stations	District	Agro-ecological situation	Lead function
Kumarakom	Kottayam	Kuttanad	Coconut and coconut based farming system, Rice and Rice based Farming System. Crop livestock-fish integrated system. Spices and medicinal plants, Vegetables and Tuber crops.
Moncompu	Alappuzha.	Kuttanad	Rice
Vyttila	Ernakulam	Pokkali	Rice, Fish/ Prawn
Thiruvalla	Pathanamthitta	Sugarcane tract	Sugarcane, Vegetables

Organization

With a view to fulfill the mandate of the station, research programmes are being carried out in the ten seven disciplines of Genetics and Plant Breeding, Agronomy, Horticulture, Aquaculture, Agricultural Engineering, Animal Husbandry, Soil Science, Plant pathology, Agricultural Entomology and Meteorology. The Krishi Vigyan Kendra for Kottayam District is functioning at this station.

Crops

The bulk of the land area (19.5 ha) is planted with coconut. Rice, at present occupies an area of 6.0 ha. Coconut is grown on bunds reclaimed from the Vembanad lake. The other important crops grown are: banana, vegetables, Garcinia, clove, nutmeg, cocoa, pepper and fodder grass. An area of about 1.50 ha is utilized for culture of fish and prawns .

The station operates a number of research projects funded by different agencies.

Land, area and soil

The total geogra phical area of the farm attached to the RARS is 44.76 ha. Wetlands occupy an area of 23.26 ha, while reclaimed garden lands composed of dykes and channels occupy an area of 21.50 ha. The farm is divided into 15 blocks

The soil of the farm is riverine alluvium, silty clay in texture. It is acidic in reaction with the pH ranging between 5.0 and 5.4. The average nitrogen, phosphorus and potassium contents of the soils are 0.047, 0.009 and 0.004 per cent, respectively.

Ongoing Research Projects

Sl.No	Name of Projects	Funding Agency
1	RKVY Project on Fish Biodiversity for livelihood Enhancement through SHG's	RKVY
2	Centre for Bio-Waste and Bio-energy recycling at Kuttanad	RKVY
3	Enhancing rice production in Kari lands of Northern Kuttanad	RKVY
4	Paddy mission Programme- Training on Paddy Mechanisation in Karilland	RKVY
5	Paddy mission Programme - Evaluation of Newer molecules for the management of Pests and diseases of Rice in Kuttanad	RKVY
6	Establishment of organic pepper plots in Idukki district	SHM
7	Establishment of model pepper nursery	SHM
8	Establishment of vermicompost demonstration unit using diverse organic residues	SHM
9	Establishment of pest and disease forecasting unit at RARS, Kumarakom	SHM
10	Soil Fertility Mapping of Kuttanad soils	GOK
11	SPB Project on Soil based nutrient management plan for agro eco system in kerala	GOK
12	Integrated Agromet Advisory Service	IMD
13	Integrated and sustainable watershed development in Madappally East and West watersheds	GOI
14	Integrated and sustainable watershed development in Vellyanad Block	GOI
15	Seed Production in Fisheries	ICAR
16	Project on Mushroom Spawn production nursery	SHM
17	Seed Production in Agricultural crops	ICAR
18	Breeding of mosaic resistance in vegetable cowpea	KAU
19	Nutrient Management of Garcinia Grafts in the reclaimed alluvial soils of Kuttanad	KAU
20	Multi locational Trial of coconut hybrids	KAU
21	Breeding of mosaic resistance in vegetable cowpea	KAU
22	Collection, Maintenance and Evaluation of the Germ plasm of *Garcinia gummijutta*	KAU
23	Dynamics of pesticide residues in the rice eco system of Kuttanad at a catchment scale and its management by good agricultural practices	FAO-IAEA
24	Multilocational trial of coconut hybrids (Keraganga, Lakshaganga Anandaganga)	KAU

Kuttanad Package

Under the Kuttanad Package, recommended by Dr.M.S Swaminathan Commission, two major projects have been sanctioned for the Kumarakom centre considering the expertise of this centre in organizing studies on assessment of productivity, monitoring the environmental quality, and biodiversity management of wetland systems, with a total outlay of Rs 5.99 crores .

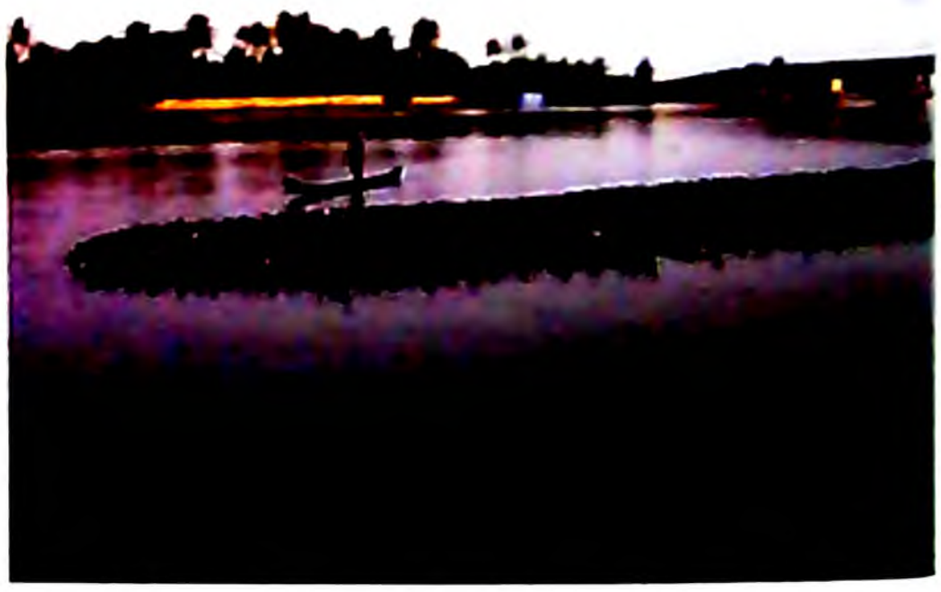
Environment surveillance centre for wetland farming development in Kuttanad with the objectives of

- Establishing an environmental monitoring centre to monitor the hydrobiology of the Vembenad wetlands
- Evaluate short and long term fluctuations to develop strategies for environmental management

Productivity Enhancement Through Energy Efficient Biodiversity Based Farming Models

The project envisages

- Development of Farming system models suited to variousagrarian situations of Kuttanad- refinement, application and feed back assessment.
- Development and Extension of Bio prospecting and Biodiversity based Farming for nutritional and livelihood security in Kuttanad



Objectives :

- Enhancement of productivity by 40- 60 percent and income by 200 percent by integrating diverse enterprises
- Increase in cropping intensity to 200 percent from the present level of 112 percent
- Render farming more organic and environment friendly
- Demonstrate that small farms can be more productive and profitable.
- Demonstrate that environment friendly farming can be more productive and profitable
- Demonstrate that biodiversity based farming system has a higher output at the total systems level than one dimensional monocultures.

PROJECTS WITH DETAILED PROGRAMMES UNDER KUTTANAD PACKAGE

ENVIRONMENT SURVEILLANCE CENTRE FOR WETLAND FARMING DEVELOPMENT IN KUTTANAD

Monitoring pesticide residues in the rice ecosystem of Kuttanad

Hydrology and water balance studies of Kuttanad wetlands

Influence of weather parameters on soil abiotic factors and its effect on biotic events of garden land crops of Kuttanad

Investigations on hydrobiology and ecology of Vembenad wetlands

PRODUCTIVITY ENHANCEMENT THROUGH ENERGY EFFICIENT BIODIVERSITY BASED FARMING MODELS

Nutrient Dynamics of the rice based wetland farming system

Farming systems of Kuttanad – Analysis with respect to nutrient dynamics, energy flux and productivity in garden lands

Germplasm inventory, evaluation and gene banking of rare, endangered, threatened (RET) and endemic plant species with emphasis on bio prospecting

Inventory, collection and evaluation of commercially important crop varieties with tolerance to abiotic stress situations for integration as cropping system components in farming system modeling

Collection, evaluation and gene banking of low land fruit trees of Kuttanad

Germplasm inventory and evaluation of botanicals for their insecticidal, nematicidal and fungicidal properties

Germplasm maintenance of cultivated and new species of edible mushrooms in Kuttanad

Use of bio inoculants in wetland and upland paddy

Biological effects of fish on wetland rice ecologies: Allocation of resources in a multi commodity rice- fish farming model of Kuttanad

Establishment of a mini hatchery unit for the conservation and propagation of Kuttanad Duck varieties (Chara and Chemballi) with emphasis on selection of male ducks for meat production

Integrating male buffalo and broiler duck with rice farming in Kuttanad with emphasis on enhancement of meat and rice production

Conservation of Vechoor cattle in its home tract of Kerala

Dynamics of moisture movement in garden lands/cultivated bunds of Kuttanad subsequent to water level fluctuations

Use of Biocontrol agents for the management of water hyacinth *Eichhornia crassipes* under aquatic ecosystem

RESEARCH ACCOMPLISHMENTS

Since its inception in 1981, the Regional Agricultural Research Station, Kumarakom has been actively engaged in research on crops and cropping systems for the Kuttanad tract. The region comprising the deltaic area of four major river systems consists typically of low lying wetlands "nilams" where rice is the major crop and reclaimed uplands, "purayidoms" where coconut is the principal crop interspersed with a variety of intercrops. The region is beset with several problems: floods during the monsoons, saline incursions during the summer, poor soil quality, pests and diseases, low productivity and low economic returns.

Research efforts have been directed towards addressing these problems and in identifying technologies to stimulate production and productivity and to augment economic returns from these ecologically vulnerable areas. The station could evolve several management practices and remedial measures to increase yield from coconut plantations severely affected by the root(wilt) disease of coconut. A number of crops: vegetables, tuber crops, fodder, pulses, oilseeds and spices, were assessed for their suitability to the region. On the basis of this study, the research centre has released a short duration variety of tapioca "KMC-1", vegetable cowpea " KMV-1" and a variety of yam "KMDa-1 (Indu)". A tree spice Garcinia cambogea that has great potential in the international market was found to be suitable for the region. Mass multiplication techniques of this spice has been evolved and the station is the sole centre in India distributing grafts of this tree spice. Cropping systems research has enabled a significant improvement in the production potential of both the nilams and the purayidoms of the region. Adopting a resource based approach, a novel crop "fish" was introduced to the inundated wetlands successfully. This practice has been taken up enthusiastically by the farming community and as of today a total of 5000 acres has been brought under rice fish rotational farming. Carrying out research under the watershed concept, the station could achieve considerable increase in farmers income by identifying appropriate crops and evolving agronomic practices to maximize production. Today, the station functions as an invaluable reference centre for tackling the diversity of problems facing the agricultural community of the Kuttanad tract.

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COCONUT AND COCONUT BASED FARMING SYSTEMS
TACKLING THE ROOT (WILT) PROBLEM

Since 1981, the Kumarakom Research Centre has been involved in identifying the etiology of the root(wilt) disease and to evolve measures to combat the progressive onslaught and spread of this debilitating disease on coconut palms.

Studies conducted on the management of root (wilt) affected coconut palms indicated a general increase in yield of nuts and a decrease in disease intensity due to incorporation of green manure crops (grown *in situ*) in the basins of palms. The green manure crops found ideal for sandy and reclaimed alluvial soils are, cowpea and Sesbania, respectively.

Studies on the application of fertilizers with good management and average management fertilizer were taken up to assess their effect on root(wilt) affected palms. Fertilizer recommendation for coconut with 50% and 75% dose of fertilizer recommendation and the remaining 50% and 25% as farmyard manure, revealed that treatments had no significant effect o the yield of nuts of root(wilt) affected palms in sandy, laterite, alluvial and reclaimed alluvial soils. Disease intensity showed a reduction due to better agronomic manipulation in all the soil types.

Water and fertilizer management studies in root(wilt) affected coconut palms in laterite soils with sandy loam texture revealed that application of 50 mm water at IW/CPE=0.5 (19days interval) recorded significantly higher yield. In general, disease intensity also decreased. Average management fertilizer dose and good management fertilizer dose did not influence the yield of nuts significantly.

Different methods of application of fertilizers, *i.e.*, placement in perforated polythene bags, crowbar holes as a single dose and split application of fertilizers in coconut basins had no significant effect on the yield of nuts of root(wilt) affected palms grown on bunds in the reclaimed alluvial soils of Kuttanad. However, placement of fertilizer as a single dose in crowbar holes or perforated polythene bags seems to be economical and practical under the bund system of coconut cultivation in Kuttanad where there is limited scope for opening basins.

Carbide ash and dolomite were found to be equally effective as soil ameliorants in coconut plantations of Kuttanad.

It is generally believed that micro nutrient deficiency is one of the causes for root (wilt) disease incidence. The investigations conducted at Kumarakom ruled out the possible role of Fe, Mn, Cu, Zn, B and Mo on the incidence of the disease.

The role of nematodes in root (wilt) disease expression were studied in detail. These studies indicated that (i) no single species of plant parasitic nematode is constantly associated with coconut palm. (ii) there is no relationship between the total population of parasitic nematodes and intensity of disease incidence and (iii) inoculation of parasitic nematodes does not result in

root injury or lesions.

Root excavation studies in alluvial, laterite and sandy soils in the diseased tract indicated that root decay is more in root (wilt) infected coconut palms than in apparently healthy ones in all the soil types. The total number of roots in diseased palms was only one fourth of that in apparently healthy palms.

A comparison of root development and decay between coconut palms in root (wilt) affected area and root (wilt) free area has shown that there is tremendous difference in the total number of roots as well as decay of roots. A coconut palm in the healthy area possesses about ten times roots than of an apparently healthy palm in the diseased tract. As against no root decay in palms in healthy area, root decay was prominent in coconut palms in the diseased tract, including the apparently healthy palms. This presents clue for a hypothesis that root decay occurs prior to the symptoms of root (wilt) disease *viz*., flaccidity, yellowing and necrosis.

Administration of oxytetracycline and penicillin in root (wilt) affected palms has indicated a general decline in root (wilt) intensity irrespective of treatments. This finding does not support the mycoplasmal etiology of root (wilt) disease.

Improving productivity of coconut

Root(wilt) of coconut has brought down the yield of coconut palms of the Kuttanad substantially. In efforts to enhance the productivity of these coconut gardens, largely reclaimed from existing lowlands, research efforts have been addressed towards identifying optimum fertilizer doses, weed management, and pest control practices for the main crop coconut

An economic fertilizer dose for coconut grown in the reclaimed alluvial soils of Kuttanad has been formulated – *i.e.*, 0.25 kg N, 0.35 kg P_2O_5 and 0.9 kg K_2O per palm per year.

A manuring schedule of 50, 75, and 100 g N, P_2O_5 and K_2O per coconut seedling during the second year of planting and increasing the nutrient doses by 50, 25 and 50 g respectively till the sixth year induced earliness in flowering, produced maximum number of female flowers and fruit setting.

Application of 200 g of zinc sulphate along with 0.25, 0.35, 0.70 kg N, P_2O_5 and K_2O/palm was found to be beneficial for coconut grown in kayal land soils of Kuttanad.

Application of salt bitters a by product of salt industry which contains 4% each of N, K_2O, $MgCl_2$ and $MgSO_4$ and 10% NaCl as foliar spray along with recommended dose of fertilizer increased the yield of coconut in reclaimed alluvial soils of Kuttanad. Salt bitters has no effect in reducing the leaf yellowing of palms.

Three applications of paraquat @ 2.5 l/ha in March, June and October accompanied by one digging in December-January recorded the lowest weed infestation in coconut gardens of Kuttanad

Tissue isolation and inoculation indicate that a species of *Cephalosporium* possibly *C.sacchari* is constantly associated with the leaf rot

disease of coconut caused by *Bipolaris halodes*. *In vitro* and *in vivo* screening of fungicides against *B. halodes*. the leaf rot pathogen. have shown that bordeaux mixture (1 per cent) is the best. The organophosphorus fungicides viz.. Hinosan and Kitazin are next in the order of merit.

Red palm weevil, *Rhyncophorus ferrugineus* is a very serious pest. especially of young coconut palms. in Kuttanad. Being an internal feeder, red palm weevil is not easily amenable to conventional insecticidal application and an effective control measure is wanting. Among the different attractants tried for trapping red palm weevil, fermenting mucilaginous cocoa beans was found to be effective. In an attempt to control the pest by insecticidal application, it has been found that the root feeding of monocrotophos (7.5 ml per palm in 75 ml water) results in complete control of red palms weevil infestation on coconut.

Studies on the nature and intensity of damage caused by mealy bugs (*Psuedococcus sp.*) to coconut palms showed that quinalphos, phosalone and carbaryl were equally effective in controlling the pest.

Intercrops suitable for partial shaded conditions of coconut gardens

A variety of crops have been found to be suitable for the partial shaded conditions of coconut plantations. These include banana, vegetables like bhindi, vegetable cowpea, cucurbits and tomato; tuber crops like sweet potato, elephant foot yam, Dioscorea, Chinese potato, and tapioca; spice crops like ginger, pepper and garcinia; miscellaneous crops like fingermillet, grain cowpea, red gram, ground nut and fodder crops. The station has been successful in screening different varieties of the above crops, identify the high yielders and in formulating manurial recommendations for them.

Seeds of vegetable crops viz. cucurbits, cowpea, brinjal, amaranthus and quality planting materials of mango, Mangosteen Anthurium, Orchids and Elephant foot yam worth about Rs. 5.50 lakhs are now being produced annually under the "ICAR Mega seed production of Horticultural crops" being implemented at this station since 2007 onwards.

Hybrid Napier and guinea grass were found to be the best fodder grasses to be grown in coconut garden of the low lying regions of Kuttanad.

Screening trials conducted over a period of 3 years have resulted in the identification of a superior type vegetable cowpea Culture KM V-1 with an yield potential of 13.5 t/ha. This cultivar is tolerant to shade also.

The variety Ptb 1 (Kanaka mony) has been adjudged as the best grain type cowpea for cultivation in the partial shade of coconut gardens.

Application of any of the organic source (cowpea incorporation, vermicompost or biofertilizer Azospirillum and VAM) together with

75% dose of fertilizer can be recommended as integrated nutrient management for Banana cv. Nendran

Banana has been identified as an ideal intercrop in the coconut gardens. Among the the different cultivars of banana put under trial, Palayamkodan proved to be the most profitable under the specific situations of Kuttanad. For Banana var Palayamkodan grown in the reclaimed alluvial soils of Kuttanad, two ratoons with two suckers per clump is ideal. A fertilizer dose of 100:200:400g of N, P_2O_5 and K_2O per plant for the plant crop and a subsequent dose of 150:200:800g of N, P_2O_5 and K_2O per clump is optimum for first and second ratoon crops.

Trials conducted with dessert and culinary types of banana as intercrops of coconut revealed that among the dessert types Palayamkodan is the best suited for raising both as Plant and ratoon crops(13.90 kg/plant and 14.23 kg respectively) and among culinary types 'Batheesa' is the best (13.65 kg/plant and 13.90 kg respectively).

A fertilizer dose of 75:25:25 kg of N, P_2O_5 and K_2O per hectare was found optimum for Brinjal (*Solanum melongena*) crop grown in the reclaimed alluvial soils of Kuttanad

Intercropping trials were conducted with six varieties of pepper. Results showed that Panniyoor-1 gave the best yield when trailed on coconut as well as Thespesia

Trials with different accessions of ginger revealed that Accession 204 was promising with an yield of 36t/ha This accession is free from soft-rot incidence. This promising accession has been recommended for placing in the subcommittee meeting for variety release.

Screening for early duration (6 months) cassava varieties to be grown in the partial shade of coconut gardens led to the identification of KM C-1(Kalpaka) with potential yield of 24.5 tons per ha

Research work had been taken up for the standardization of agro techni ques for the culti vation of Amorphophallus using finger corns as planting materials. Finger corms of 60g weight at 45X45cm spacing on raised beds is economically viable method for large scale cultivation of Amorphophallus especially when there is scarcity of conventional planting materials viz (mother corms).

Study conducted on the performance of annual and biennial crops of Amorphophallus under Kuttanad conditions revealed that the biennial cropping of Amorphophallus gave a higher yield per hectare with a higher cost benefit ratio. Work has been also done for standardization of agro techniques like time of planting and size of planting materials of Elephant foot yam.

A promising type of greater yam *Dioscorea alata* - INDU has been identified for cultivation in the partial shade of coconut gardens on the basis of yield evaluation conducted since 1988. In performance, it is superior to the released varieties from CTCRI viz.. Sri

Keerti and Sree Rupa. The potential yield of this variety is 39.3 tonnes. The tuber is white in colour and contains 73.5% starch on dry weight basis. This variety is suitable for cultivation under high water table condition owing to the shallow tuberisation.

Trials with 24 types of *Dioscorea esculenta* have led to the identification of 2 high yielding types, DeK 4/86 (11.6 tonnes per ha) and DeK 17/87 (11.5 tonnes per ha). They are tolerant to shade and superior to Sri Latha released from the CTCRI.

Manurial recommendations for sweet potato (50:25:50 kg/ha), bhindi (70:05:15 kg/ha) and vegetable cowpea (10:20:10 kg/ha) have been formulated for the reclaimed soils of Kuttanad based on field trials.

Studies on the integrated nutrient management of cassava indicated that chemical fertilizer appli cation could be reduced to 50 per cent when organic inputs were used in an integrated manner. Higher dose of organic input had not influenced tuber yield

Experiments conducted for three years from 2000-2003 to standardize Nitrogen and Potassium requirement of short duration variety Kalpaka (KMC-1) at RARS Kumarakom revealed that a fertilizer dose of 25 kg N , 50 kg P2O5 and 75 kg K2O can be recommended for short duration cassava KMC-1 grown in the garden lands of Kuttanad for higher yields and higher net returns.

A study on integrated nutrient management in coleus indicated that the dose of chemical fertilizers could be reduced by 25 per cent by the use of the biofertilizers, ie. either AMF or pseudomonas or a combination of both the biofertilizers. In another study, the highest tuber yield in cassava var. Vellayani Hraswa was obtained by the use of 75:50:100 kg N: P_2O_5: K_2O ha^{-1} as inorganic fertilizers, along with the biofertilizers Azospirillum and Phospho bacteria.

Garcinia

Garcinia – a high value tree spice suitable for Kuttanad

Garcinia, an evergreen tree spice known under the scientific name *Garcinia gummi-gutta*(L.), belongs to the family Clusiaceae. Commonly seen in the western ghats and plains of Kerala. Occur in plenty in mid-Travancore tract along river banks and valleys. It grows well in dry or occasionally water logged or flooded soils. Garcinia shows wide variability in yield, growth habit, and fruit qualities.

The economic part of the plant is mature fruit which are highly acidic. The rinds of the ripe fruit are proce ssed and used as a spice in fish and prawn preparations to impart flavour, taste and also to improve the keeping quality. The extracts obtained from the fruit rind, Hydroxy Citric Acid(HCA), attracts foreign markets-thanks to its multiple uses like preparation of medicines controlling obesity etc. It is also one of the ingredients in many ayurvedic medicines.

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Varieties

Even though garcinia is one of the oldest tree spices of the State, it has

attained international importance only recently. Most of the trees in the field are of seedling origin and hence exhibit wide variability in fruit and yield characters. Kerala Agricultural University through its Regional Agricultural Research Station, Kumarakom, undertook a detailed survey and identified 214 elite genotypes of garcinia mother trees in farmers fields. Graft mother trees of these genotypes are maintained in its farm at Kumarakom. Promising types identified from among them are multiplied for evaluation and cultivation. The RARS maintains largest germplasm collection of garcinia in India.

Propagation by seedlings

Criteria for selection of mother trees and the method of seed processing could be standardized at this center. When it was noticed that the conventional method takes more days for germination. different seed treatment methods to trigger early germination were tried and succeeded.

Planting materials used

Use grafts prepared through softwood grafting/side grafting or healthy seedlings raised in the nursery for cultivation. If seedlings are planted, 50-60 per cent will be male, and hence planting of grafts are advocated as they ensure true maternal characters and bear early.

Propagation by grafting:

Two vegetative propagation methods- soft wood grafting and approach grafting, were standardized at this Centre. Grafts normally start bearing in three to four years time, true to type progenies are obtained, height of the trees can be controlled and high density planting can be adopted.

Technology of after care of grafts in the mist house, its hardening in the shade house, plant protection measures etc connected to softwood grafting were also standardized at this center. Protocols of approach grafting were also evolved and got tested to success.

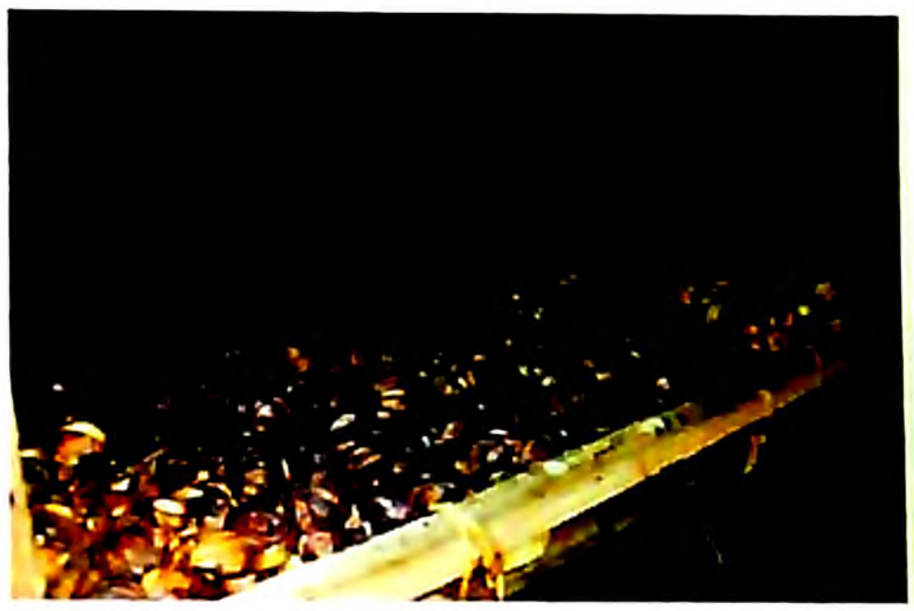
Methods for main field planting and management of grafts/seedlings were standardized. Effective control measures for hard scales and beetles were evolved.

Harvesting

Grafts start bearing from third year onwards and will attain the stage of full bearing by 12-15 years. Flowering is during January-March months and fruits mature in July.

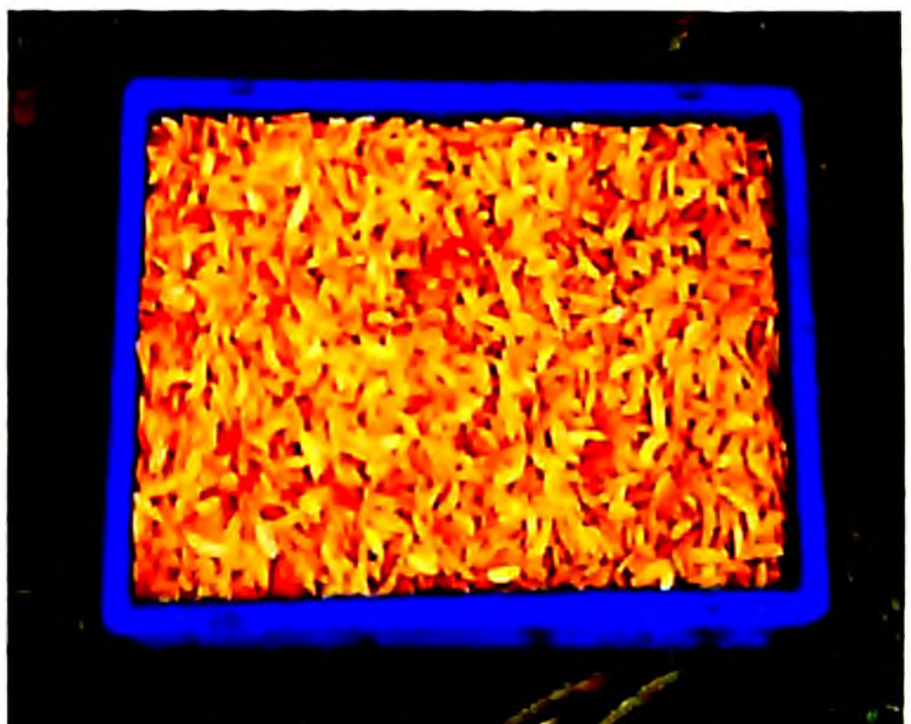
Off-season bearers

A few promising off season bearers, which bear twice a year, *ie.*, during January-July and September-February, could be located.



Processing

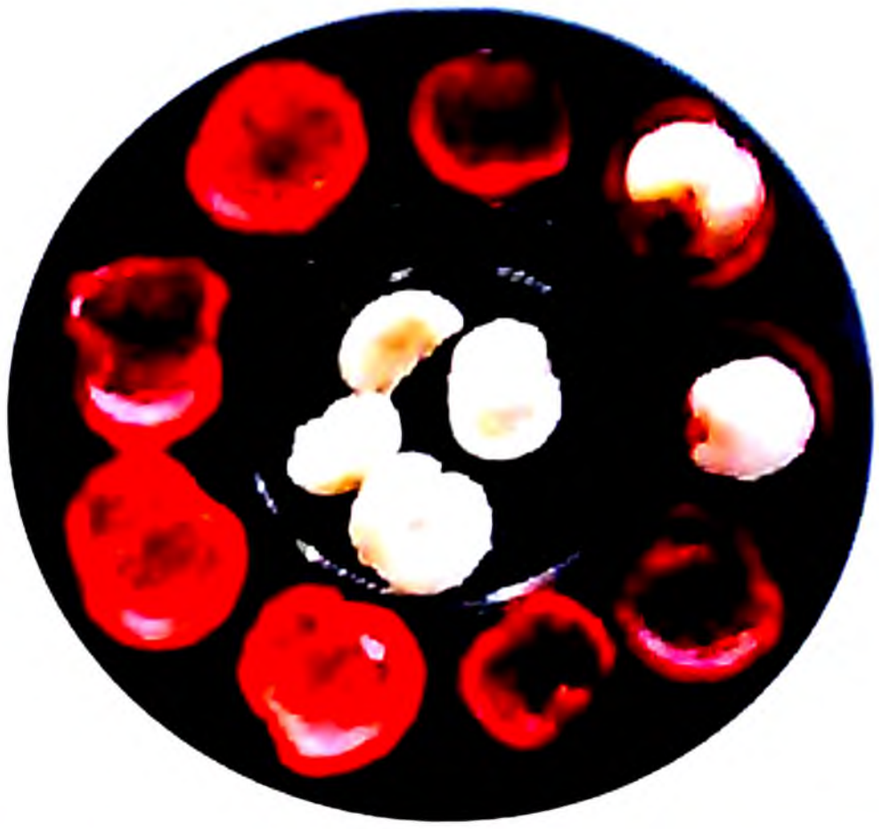
Fruit rind is separated from ripe fruits for processing. Separated fruit rind is first sun dried and then either smoked or oven dried. *A clean method for fruit rind through oven drying was first standardized at this center.* The conventional belief that smoke drying imparts black colour for the processed fruit rind, could then be disproved through our trials. As smoked product is apprehended to be deleterious to health, the new method paved way for healthy products.



Mangroves

Mangroves play a very important role in soil accretion in coastal regions. However,they have been subject to wanton destruction for fuel and timber in the southern stretches of the Vembanad lake. Three species of mangroves found suitable for rehabilitation in

freshwater zones of the Vembanad lake were *Rhizophora apiculata*, *R. mucronata* and *Avicennia alba*.



Kokum

Kokum (*Garcinia indica)* was introduced in 2002 . The crop has established well and started yielding. It is a promising tree spice as well as rich source of incomparable natural refreshing juice rich in Hydroxi citric acid. This has wide potential to be another income earner for the women in rural sector.

Development of Integrated Fish Farming Models

In the context that per capita land availability of land is very low in Kerala. a farming system approach involving integration of aquaculture in to the agricultural system deserves greater encouragement. Accordingly the fisheries research in RARS Kumarakom has been oriented 1)To develop holistic farming models involving fish farming that fit in to the overall agricultural system and 2) To ensure livelihood opportunities , income and nutritional security to the masses

Several models on integrated fish farming evolved by the Regional Agricultural Research Station, Kumarakom has shown that aquaculture is one of the most ideal component in the farming system in lowlands, as agricultural wastes and domestic wastes have proved to be essential inputs to aquaculture. RARS, Kumarakom has done commendable work in this area and has been successful in evolving integrated farming system models comprising crops, livestock and fish suited to lowlands of Kerala. At the same time waste emerging from aquaculture could be ploughed back in to the crop faring system.

Coconut- livestock-Fish: IFS models

Studies on integrated farming taken up in

Regional agricultural research station, Kumarakom has shown that 40-50 kg animal manure can produce 1kg fish and manure added to a fish pond vary in their efficiency to produce fish. It has been demonstrated that cow dung from one milch cow can produce 200-500 kg fish per annum and a fish pond that produces 7- 7.5 ton of fish per ha accumulate 10-15 cm layer of pond humus which can be recycled for crop production.

Duck- Fish farming model

It has been demonstrated that by raising 400 ducks per ha of fish pond, 12-13 tons of dropping can be recycled in the ponds to produce 5- 5.3 tons of fish at no extra cost on feed for fish. It was also demonstrated

that deshi breed of ducks is ideally suited to these combination.

Pig- Fish model standardized

It is well known that construction of pig sties on pond embankments and fish pond dykes is useful strategy for enhancing fish production .Under pig- fish integrated

farming system, pig dung is utilized as feed and manure to fish species with total saving of feeding cost to fish. In studies carried out at the centre it was demonstrated that 25 pigs per ha of fish pond is sufficient to produce 4 to 4.5 tons of fish in such combination, with total savings on fish feed. Under this integrated system, Yorkshire white pigs was found to attain slaughter size in 6 months.

Coconut-Scampi (Bund/Channel system) farming model

Macrobrachium rosenbergii, Kuttanadan konchu (scampi) has been shown to be the most suitable candidate species for farming in channels of coconut gardens under bund and channel system of coconut cultivation, prevalent in coastal lowlands of Kerala. The coconut root network was shown to facilitate the much needed hideouts and habitat substrates for giant prawns in such situations. Studies conducted at RARS Kumarakom has shown that prawn production and growth in such a system is much higher 800 kg/ha/6 months than that achieved in open pond system under comparable stocking rate, 10,00/ ha. This has been the first report on farming of scampi in channels of coconut gardens.

Oru Nellum Oru Meenum model developed by RARS

The most spectacular achievement on integrated fish farming research of the

Agricultural University University has been the development of a rice-fish rotational farming model popularly known as *Oru nellum oru meenum* in Kuttanad. Judicial integration of rice and fish has been demonstrated to enhance income of the farmers by 40 percent with significant saving on rice production costs making rice farming more attractive and remunerative. Besides savings on cost on feed for fishes, due to utilization of rice straw as a source of plankton and detritus by fish, the mutualistic benefits of fish on rice has been demonstrated in terms of increase in rice yield by over 15 percent. Apart from indirect benefits viz., control of pests and diseases and reduction in costs on plant protection, a perceptible reduction in cost on weeding, ploughing and harrowing was also demonstrated. RARS has also standardized a stocking model for herbivorous and macracrophagous and omnivorous fish species in rice field situations. This farming model is considered the most appropriate and environment friendly farming practice for Kuttanad on considerations of its unique agro ecology and resource endowments The system is also a strategic intervention to protect our rice lands and sustain rice production, making rice farming more productive and profitable and environment friendly. The area coverage under this system is now over 5000 acres.

Rice- Attu konchu farming model

Possibility of integrating more economic species

Research Station, Kumarakom it was shown that the menacing aquatic weed, water hyacinth, *Eichornia crassipes*, can be processed and utilized as feed for macrophagous fish species such as grass carps. The partially digested fecal matter of grass carps will form rich manure and feed for other filter feeding fish species. For utilization of water hyacinth as forage for grass carps, a mechanical weed chopping device, was designed and developed by the station . The chopped weed processed with common salt is shown to be a palatable feed relished by grass carps.

such as giant freshwater prawns in rice fields of Kuttanad was also a subject of study at Kumartakom .It was demonstrated that rice- prawn rotation is economically more advantageous, than rice-fish integration owing to the high market value and export demand for prawn species. However, prawn integration is suited mostly to smaller polders as it demands high capital investment and more rigorous management practices.

Utilization of *Eichornia* as feed for Fish

In studies conducted by the Regional Agricultural

Fish/Prawn Ranching in Vembenad lake

One of the major achievements of the Regional Agricultural Research Station, Kumarakom has been the

successful demonstration of ranching of giant freshwater prawn, 'Kuttanadan konchu' in Vembenad for enhancement of its natural fishery.

As part of a project funded by the state Fisheries Department and Jilla panchayaths of Alappuzha and Kottayam the centre has standardized ranching techniques and protocols. Marking and recapture studies of this species has thrown light on the migrational behaviour of this species. The impressive growth performance of ranched individuals and their recruitment to fisheries during the next season indicated that rational stocking programs adopted on scientific lines are most effective tools for conservation and management of declining fish stocks. The ranching protocols developed are utilized by the State Department of Fisheries.

Open water fish farming-Cage and Pen Culture

Pioneering studies in the State

Land being a scarce resource in Kerala, there is little scope for diversion of arable land for fish culture. A practical approach for

increasing aquaculture production is to take up fish husbandry in cage and pen enclosures in the vast open water bodies viz., Kayals, reservoirs and lakes. Pioneering studies taken up by the Kumarakom center on enclosure fish culture in net cages in Vembenad lake ndicate that open water fish culture in cages can yield high production.

owing to dense stocking, intensive feeding and continuous water exchange. It has high commercial possib ilities and can gene rate employment opportunities to thousands of people. These studies indic ated that *Etroplus suratensis* . Karimeen, is the most appropriate fish species suited for cage farming as it can grow to an average size of 230 g in 6-7 months, when reared under intensive feeding regime in cages, as compared to 100-125 g under pond situations. Very high average fish production, 9 to 35 kg/ sq.m highlight its commercial possibilities.

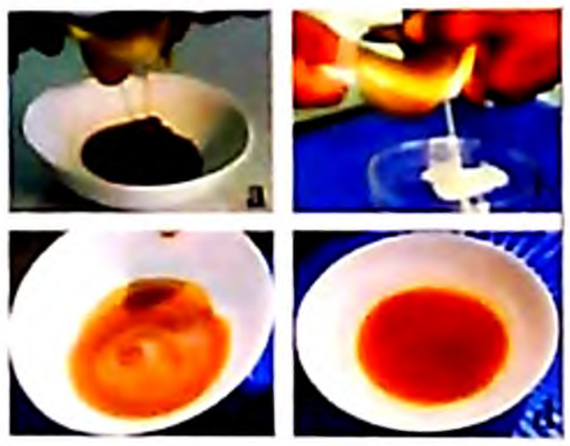
In open waters, pen culture was also demonstrated to be yet another strategy to utilize open waters for productive aqua farming.

Pilot studies on cage & pen culture in Vembenad lake also indicates that enclosure fish culture can play a complementary role in augmenting capture fisherySeveral self Help Groups have begun cluster based open water fish culture projects in open waters in Kerala, utilizing this technology of cage farming of Karimeen developed by RARS. Impressed by these findings, under the Kuttanad Package, special allocations have been earmarked for expanding open water cage farming.

Studies on fish biodiversity conservation and utilization

Blessed with 44 rivers originating from the Western Ghats and vast network of lakes, lagoons and backwaters in the lowlands, the riverine systems of the Western Ghats are considered, the goldmines of freshwater fish diversity. These pristine habi tats harbour several poten tially cultiv able and ornamental species. Some of these species are critically endangerd or are facing serious threats of extinction and decline due to habitat destruction, unsustainable and unethical fishing practices and over fishing.

Prioritization of rich natural habitats for *in situ* conservation and development of captive breeding techniques of prioritized endemic species for mass production of seeds for stocking are some of the conservation strategies. In what is considered a breakthrough in biodiversity conservation,



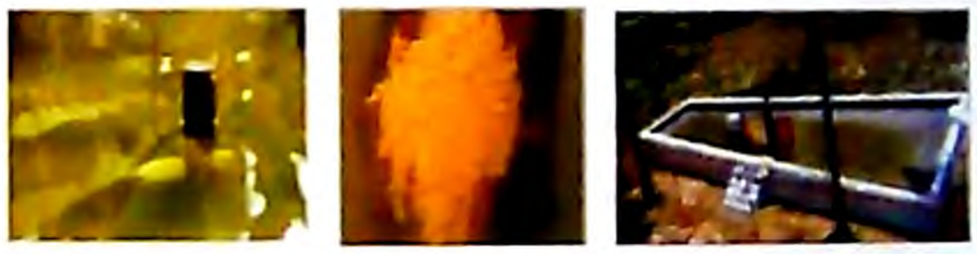
Kumarakom center has succeeded in captive breeding of four endemic food fish species, viz., *Clarias dussumieri* (Naadan mushi) *Gonopro ktopterus curmuca* (Kooral) *Horobagrus brachysoma*, (Manja koori), and *Etroplus suratensis*(KarimeenCaptive breeding techniques for these species ares new report to science..

Captive breeding and propagation of endemic catfish, *Horabagrus brachysoma* accomplished by RARS Kumarakom is a great success story. *Horabagrus brachysoma*, popularly known as Golden catfish, has been an endemic species in the Western Ghat rivers of Peninsular India. Once abundant in our river systems, this species has become extremely endangered categrorized as critically endangerd by IUCN. This has been due to indiscriminate destruction of their natural habitats , destructive fishing practices and over exploitation.

Standardization of captive breeding techniquers through efforts at RARS Kumarakom has opened up opportunities for mass production of seeds of this species for restoration stocking and for conservation. Consequent to introduction of hatchery reared seeds produced by these techniques in to natural waters, the species, once categorized as endangered is on a come back trail in our river systems.

Captive breeding of Karimeen

Efforts for induced spawning of Pearlspot, *Etroplus suratensis*, the



largest of the three indigenous cichlids, has not been successful for long owing to their unique parental care and complex courtship behaviour, involving pairing and nesting. In such a context, captive breeding of *Etroplus suratensis* was successfully undertaken, at RARS in specially designed artificial raceway tanks provided with simulatednatural conditions.

Egg incubation and hatching could be achieved with in the breeding tank ensuring care of the breeding pairs and in separate larval rearing tanks with out parental care. Breeding could be achieved almost round the year in this controlled system. Seed recovery is facilitated with less effort and this has opened up opportunities for mass production of seeds of pearlspots , the high value state fish of Kerala .

Engineered Fish sanctuary in Vembenad lake- the first of its kind in the country

The Pearlspot, *Etroplus suratensis* is a high valued table fish endemic to peninsular India with unique parental care and larval nursing habits. Unabated habitat changes on the lake front have hindered their natural breeding. Development of designated areas as 'protected sanctuaries' is one of the suggested strategies for conservation and promotion of recruitment of endangered fish species With this objective, the Kumarakom center has established a protectedsanctuary for pearlspot, the first of its kind in the country, by simulating tyheior breeding requirements in protected environment in an open lake location in Vembenad lake. Considering the unique advantagesof this system devised byRARS, M.S. Swaminathan Commision for Kuttanad has recommended establis hment of a series of such sanctuary systems in Vemband for rehabitiation of Karimeen fisheries. The state Fisheries Department is now venturing to develop more open water sanctuaries utilizing this model developed by the RARS at Kumarakom.

Biodiversity Inventory with public participation

As the greatest threat to biodiversity is the lack of awareness on the

strength of biodiversity, in order to create awareness among the civil society about the importance of biodiversity and its conservation, the RARS Kumarakom, in participation with local environmental organizations has been organizing annual fish counts every year since 2004 in the river systems of Vembenad lake. The *Meenachil Fish count2004*, the pioneering effort that received massive public support has been the first instance in the country wherein an inventory of fish fauna is organized with public participation.

Fish Feed for endemic fish

As lack of species specific feed formulations has been the critical constraint that limit expansion of aquaculture of endemic fish species, the center station has initiated efforts for formulation of appropriate formulations for endemic fish species such as Karimeen on considerations of their feed preferences. For this artificial feed formulations were developed using locally available agricultural byproducts and crop residue ingredients. The fish feed unit is established and operated through women self Help Groups. The feed is branded as 'Meenoote'.

Composting of aquatic weeds

For Composting Salvinia and Eichhornia the best additive was found to be cowdung. It can be applied at 10:1 or 10: 0.5 ratio. For Salvinia , urea at the rate of 2 g / kg of weed and Trichoderma at the rate of 1.5 g / kg of weed was found to be suitable. For large heaps of Salvinia ,urea @ 100 g and Trichoderma 100 g / 100 kg of weed was found to be better for higher compost percentage. For composting Salvinia in large heaps a mixture of cowdung and compost 5-kg/50 cm ht. of the heap with aeration was found to be the best treatment. For quick composting drying salvinia for 7 days was found to beneficial. Drying beyond 7 days reduced compost percentage.

Using SHM funds, a model vermicomposting demonstration unit was established at RARS, Kumarakom and one model demonstration unit each was established in selected farmers' holdings at Vechoor, Kumarakom, Aymanom, Thiruvarppu, Kurichy and Puthuppally panchayaths. Also trainings on vermicompost production were imparted to farmers.

Organic Rice Production

A field experiment aimed at evolving an organic rice production technology was conducted for five years. The experiment could evolve package of practices for rice production devoid of inorganic inputs of fertilizers and plant protection chemicals. The field experiment compared the existing package of practices for rice production with full requirement of nutrients as organic inputs with the following treatments.

- Full nutrient requirement equivalent from organic source alone (vermi compost, azospirillum, phosphobacter, and biopotash as basal; and topdressing with vermi compost, bioslurry and oil cakes) and plant protection with botanical pesticides.
- Half the nutrient requirement equivalent from organic source as above.
- Full nutrient requirement as inorganic fertilizers as per POP.

The organic inputs during the first three years didn't match the grain yield of the chemical fertilizers. However the yields from organic practices leveled with the chemical practices during the subsequent years.

Though, the yields for organic treatments during the initial years were substantially less, yields more than 5 tons per hectare could be realized as the time progressed, with organic inputs as given in the table. An improvement in soil chemical characters is evident for organic treatments as revealed by lower EC and higher available phosphorus values. A significantly superior biological activity is also evident as revealed by higher total bacterial population, higher azospirillum and pseudomonas population

Effect of Organic Inputs on Rice grain Yield and Soil Characters - Additional crop season 2010

Treatments	Grain yield t/ha	Soil chemical characters					Soil Biological characters		
		P[H]	EC	OC	Available P	Available K	Total Bacterial Load	Azospirillum	Pseudomonas
Full nutrient equivalent as organic	6.66	3.38	1.00	1.03	12.96	318.07	171.1×10^{7}	2.9×10^{3}	1.3×10^{5}
Half nutrient equivalent as organic	6.06	3.68	1.05	1.13	8.45	383.21	37.6×10^{7}	3.3×10^{3}	Nil
Nutrients as per package of practices	8.06	3.63	1.11	1.10	8.36	348.95	24×10^{7}	1.9×10^{3}	0.6×10^{5}

Organic Pepper

Under SHM funding, two model organic pepper plots with high yielding Panniyur varieties of pepper (Panniyur 1-7) as per KAU POP were established at two locations in Kudayathoor and Ottallur of Idukki District and nursery production and sale of the high yielding pepper varieties had been started. Vermicompost units were also established at both the locations.

Establishment of a Model Pepper nursery

A model pepper nursery with a production capacity of 2 lakh rooted pepper cuttings was established at the Regional Agricultural Research Station, Kumarakom at a total cost of Rs. 18 lakhs. Theproject could strengthen the infrastructure facilities viz. green house, mist chamber and shade houses. Disease free planting materials were collected by identifying plantations with true to type varieties by an on the spot inspection by an expert committee in endemic pepper growing areas.

Vines were procured during April-May 2010 and 2 lakhs vines were planted for rooting. One lakhs rooted cutting were supplied to pepper farmers through the SHM projects of Kottayam districts during June- July, 2010. Similarly direct sale through the sales outlet of the stations was also done on a day today basis

RARS, KUMARAKOM

Centre for Biowaste and Bioenergy recycling in Kuttanad.

A farm model capable of converting agro waste and house hold waste to quality organic manure and bio energy was evolved. Based on this a low carbon emitting bio energy based farming system model integrating crop, fish and livestock could be laid out and installed. The main features of the model are

- Agro based recycling between crop, livestock and fishes.
- Slurry recycling between channels and bunds by annual desilting.
- Biogas generation from cow dung, vegetable waste, aquatic weeds and household wastes.
- Integrating solar and bio energy for farm use.
- Solar energy powered Protective fencing for fish pond protection.

The project laid emphasis on low carbon emission technologies to shield global warming and climate changes.

As a viable practice use of inorganic fertilizers in homesteads could be replaced with quality organic manures like vermi compost and bio slurry which could be produced in situ by recycling biowaste and crop residues. Conversion of vegetable waste, aquatic weeds and house hold waste to biogas is another alternative. The daily energy requirement especially for cooking could significantly reduce the dependence on LPG for energy requirement

The project could demonstrate different types of compost units depending on the requirement of demand groups. Terracotta units, portable silpaulin units, concrete ring units and permanent brick tanks where the type of compost units tried. Biogas units of different capacities and gas appliances viz. driers, lanterns and

Research On Mosaic virus disease

Mystery about transmission ,host range and virus-vector relationships of Indian Cassava Mosaic Virus(ICMV) was resolved for the first time in India. A special technique was developed for maximum acquisition of the virus by the whitefly vectors under controlled conditions in the acquisition cages. The method was successful for transmitting the virus up to 19 %. The virus-vector relationships were worked out by using *Nicotiana tabacum* var. Jayasree as the indicator host for the first time. The virus was transmitted to 48 different species of plants and 23 cultivars of *Nicotiana tabacum* by sap inoculation or by whitefly vectors. Based on host rage and serological studies existence of strain variation also was identified for the first time in ICMV. The study also revealed that the virus can be easily managed by using disease free cuttings for planting followed by systematic rouging. These studies were responsible for the award of young scientist award (Agri)by the Kerala State Committee on Science, Technology and Environment in the 2nd Kerala Science Congress held at Trivandrum during February, 1990

A severe malady which threatened Bitter gourd cultivation during 1990's was identified due to a hitherto unreported whitefly transmitted geminivirus, the Bitter gourd Mosaic Virus. The virus was easily transmitted by whiteflies, *Bemisia tabaci* from bitter gourd to bitter gourd and to a few cultivated cucurbits , a wild cucurbit, *Melothria leiosperma* and a few varieties of *Nicotiana tabacum*. The virus was not transmitted by sap or seeds of infected plants. An integrated virus management strategy was worked out and communicated to the growers.

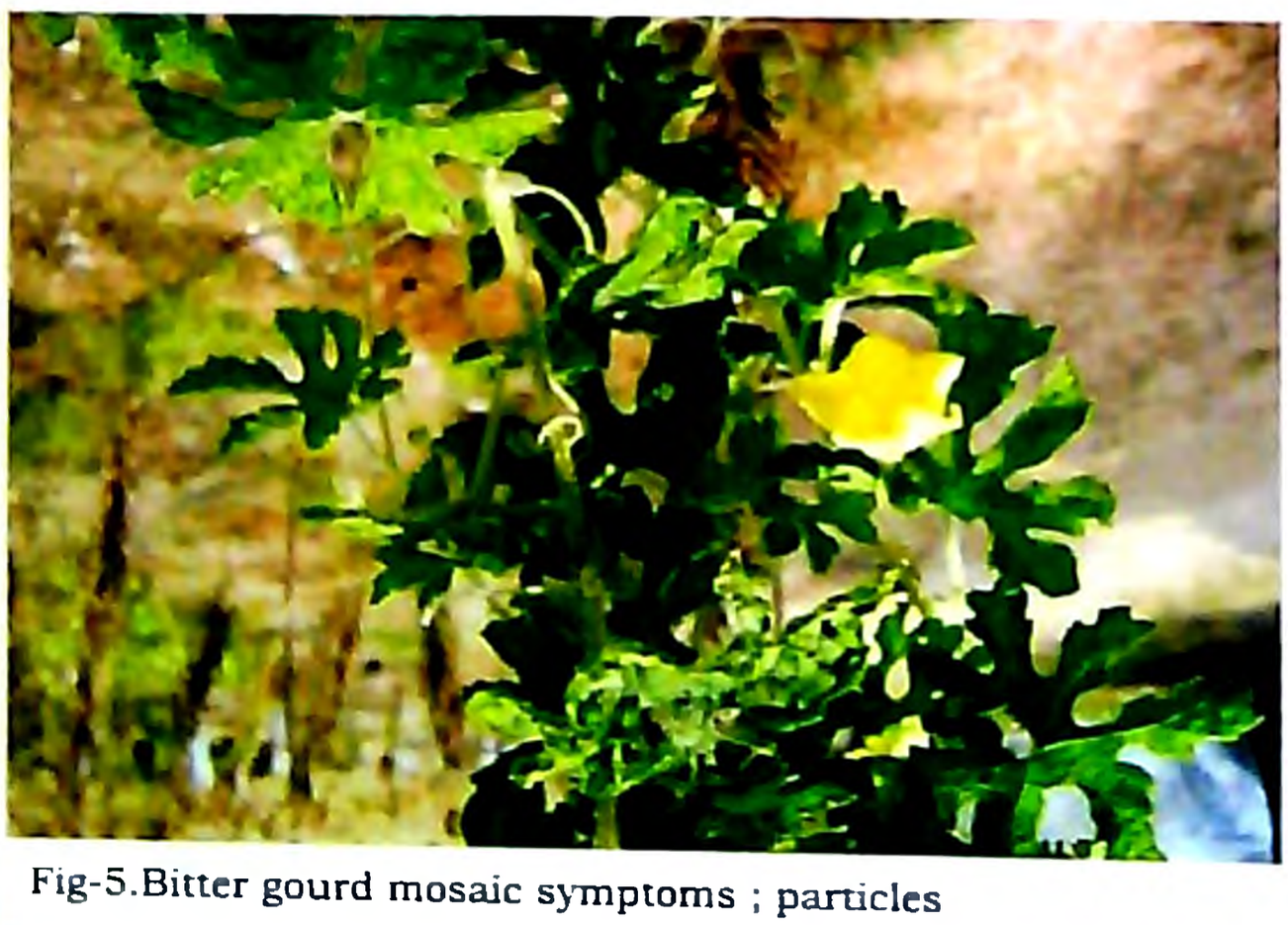


Fig-5.Bitter gourd mosaic symptoms ; particles

Fig-1 Mosaic infected Cassava plant
Fig-2. Whitefly vector;
Fig-3 ICMV Particles
Fig-4. ICMV infected Nicotiana benthamiana plants(sap transmitted)

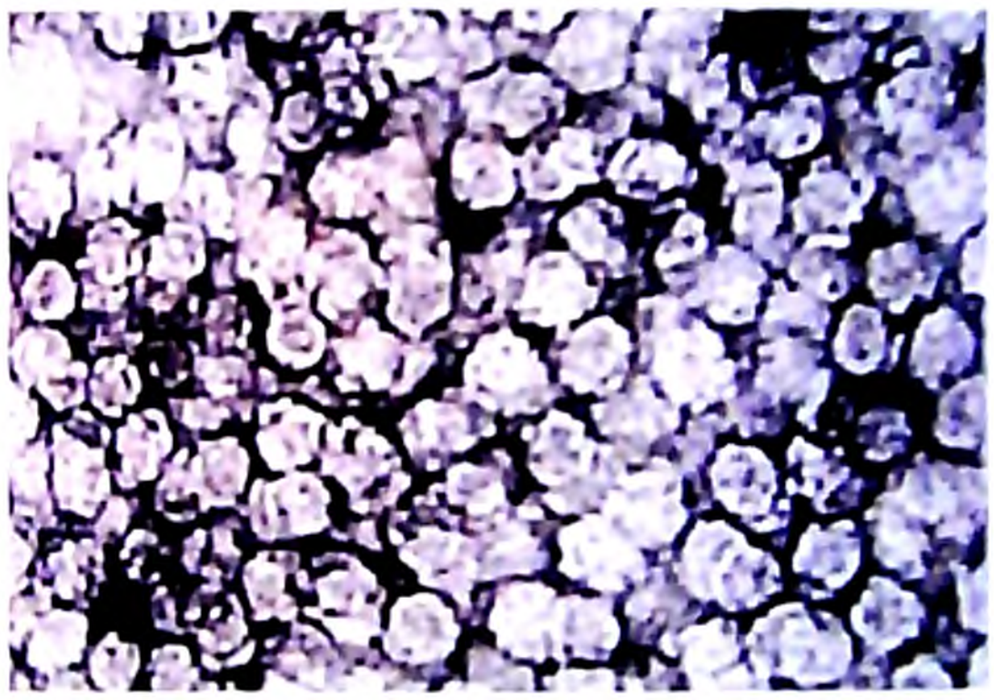


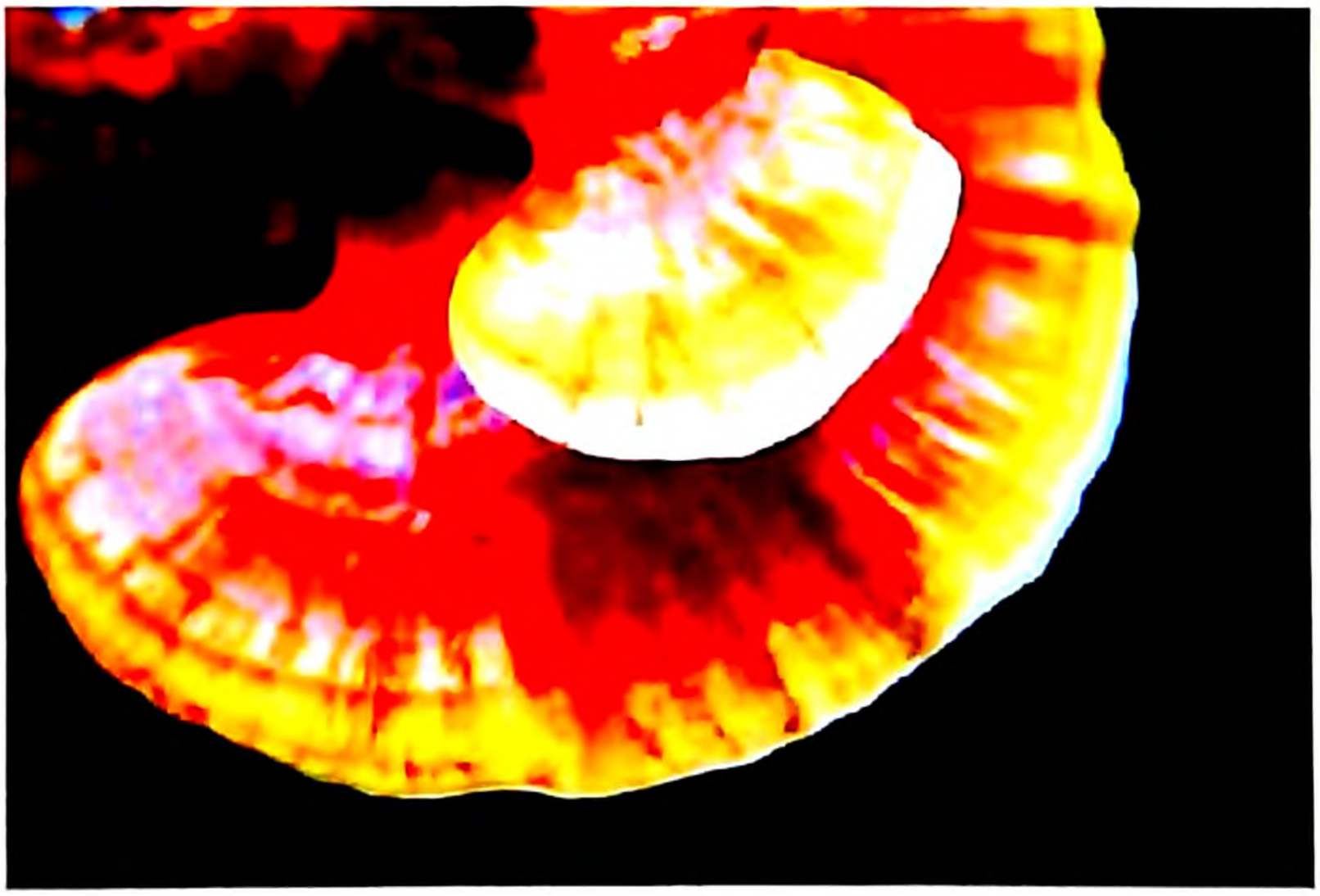
FIG-6. Causal organism-Gemini virus particles

Research on Bio-control Agents

In Vanilla 12 different fungal and three viral diseases were identified and a management strategy was worked out mainly using bio-control agents like *Trichoderma viride* and *Pseudomonas fluorescens* .The fungal diseases could be managed by proper shade regulation during rainy season, proper mulching, basal application of Trichoderma along with neem cake and spraying with 1% Pseudomonas. Virus diseases could be managed by using virus free planting materials and timely rouging of virus

affected vines. Studies on the use of alternate media for mass multiplication of *Trichoderma* showed that it can be grown successfully on 5% jaggery+0.5%peptone or on coconut water. Similarly *Pseudomonas* was also successfully mass multiplied on coconut water and found that it can replace the commonly used chemical medium ,the Kings B for commercial mass multiplication. Another significant finding was the study on compatibility of *Pseudomonas* with commonly used chemical pesticides. It was found compatible with most of the commonly used pesticides at the recommended dose except copper formulations, bleaching powder and some anti-bacterial antibiotics. It was also compatible with several neem based formulations including 2% neem oil and the commonly used adjuvant, Apsa-80 @2ml/lit. Liquid formulation technology of *Pseudomonas* also was standardized for the first time in Kerala by using some natural plant products.

Mushroom Research



The Plant Pathology Department has been engaged in mushroom research, development and training since 1985. Nearly 10,000 farmers were given training on scientific mushroom growing and 500 people on mushroom spawn production, so far. Regular training programmes are being conducted on First Saturday of every Month. Paddy straw mushroom (*Volvariella*), Oyster mushroom (*Pleurotus spp*)and Milky mushroom (*Calocybe indica*) are the three major types studied in this Department. Of late, two new local species of mushrooms viz., *Tricholoma indicum* and *Ganoderma lucidum* were isolated and their cultivation technology was standardized for the first time in India. *Tricholoma* is an edible mushroom whereas *Ganoderma* is a non-edible medicinal mushroom. Now Paddy straw mushroom is not commonly cultivated in Kerala because of it's grey colour, poor keeping quality and poor consumer preference. The most preferred mushroom is the white oyster mushroom (*Pleurotus florida & Pcitrin opileatus*), pinkoyst er(*Peous*) is more medicinal and nutritive while grey oyster(Psajor-caju) is the most tasty one. Another mushroom known as Co2 (*Hypsizygus ulmarius*) suitable for cultivating in the rainy season also is available at this station. All these mushrooms are cultivated on paddy straw except *Ganoderma* which is cultivated on a mixture of soft wood saw dusts. Oyster mushrooms and Co2 can also be successfully cultivated on rubber wood saw dust. *Ellocharis plantogena* an aquatic graminae weed was found to be a cheap substitute for paddy straw for growing oyster mushrooms. A mixture of *Ellocharis* and paddy straw (1:1) also gave comparable good mushroom yield . A mixture of banana pseudostem and paddy straw (1:1) also gave good yield when compared to straw alone. On all these

media like paddy straw, banana sheath, paddy straw + banana sheath(1:1) with 60-100% bio-efficiency. A simple method of cooking was developed to remove the sour taste of milky mushrooms. A new cheap and safe method of spawn

Fig-7.Ganoderma lucidum;

Fig-8.Pleurotus florida;

Fig-9.Calocybe indica

Fig-10.Peous

media the maximum cropping period is 50-60 days. Rubber wood saw dust was found to be an excellent medium for growing oyster mushrooms on a commercial scale. Standardization of the poly bag method of cultivation with rubber wood saw dust has revolutionized oyster mushroom cultivation in Kottayam and adjoining Districts of Kerala. Mushrooms produced on rubber wood saw dust are superior in colour, texture ,keeping quality and less prone to attack by the pests when compared to those on paddy straw. Another advantage of rubber wood saw dust is the extended cropping period of 120-150 days with 100% bio-efficiency. An organic pest control

Fig-11.Tricholoma buttons and fully developed mushrooms

Fig-12.Volvariella sp.

Fig-13.Pleurotus sajor -caju

method , spraying 0.5% Lemon grass oil weekly in the mushroom house was also developed.Cultivation of milky mushroom was also standardized on several

Pest and disease Surveillance & Plant protection advisory services

Plant Pathology and Entomology Departments give timely advices to the farmers who contact the station for the purpose . If necessary, field visits are also made for assessing the actual field situation before suggesting suitable remedial measures. Scientists of Plant pathology and Entomology of the Station usually help the Department staff in conducting training programmes on integrated crop pest and disease management and mushroom growing for the farmers and in-service trainees.

Under SHM funded project on "Pest and disease surveillance of vegetables and fruit crops", Pest and disease incidence is correlated with weather parameters and timely forewarnings are given to farmers. Pheromone traps for fruit flies of mango and cucurbits are formulated and distributed to farmers.

Biological Control of Salvinia

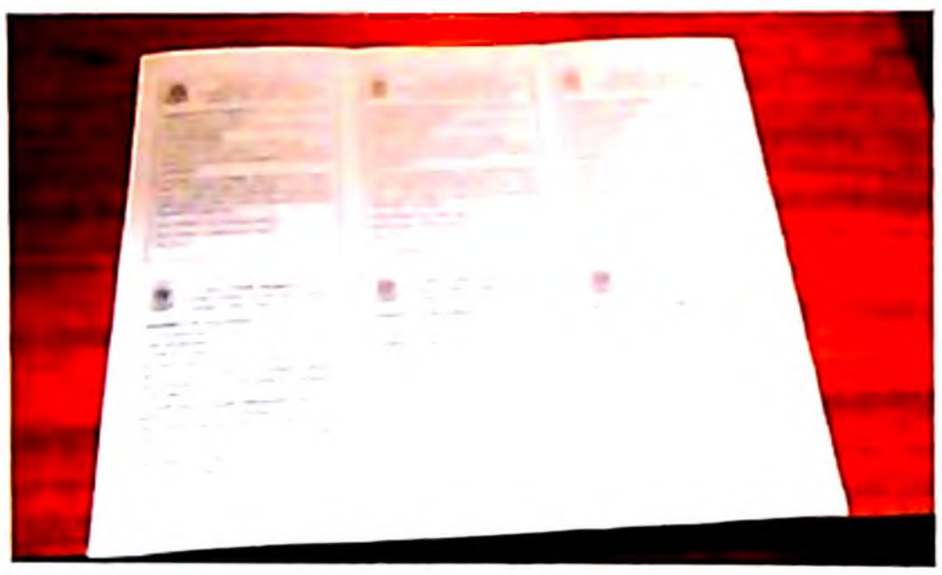
Following the construction and commissioning of the saltwater extrusion barrier at Thannermukkom, and the consequent prevalence of total freshwater conditions throughout the year, Kuttanad has been beset with a number of environment related problems. The foremost amongst these has been the spread of the aquatic weed commonly called 'Africal payal ' *Salvinia molesta*.. This weed which has been a menace to Kuttanad for a decade was suppressed using the tiny weevil *Cyrtobagous salviniae*. This is a classical example of biological control over a large area in India.

Rice production in Kari lands

Under the RKVY funded project on "Enhancing Rice production in Kari lands of Northern Kuttanad, Soil samples were collected from different padasekharams of the kari lands during Kharif & Rabi seasons of 2009-10 and 2010-11 and analyzed for pH, EC, Nitrogen, Phosphorus & Potash. The soils were characterized by low pH, high organic carbon, Medium to high range of available Nitrogen, low phosphorous, high potash, very high levels of iron and sulphur, very low Boron and normal levels of Copper, Zinc and Manganese. Among the cu;ltures/varieties evaluated for their performance Vyttila 6 and IR 50138 were found to perform well in Kari soils. Regular pest and disease surveillance and forewarnings based on it and training programmes for farmers were also conducted.

Biocontrol Laboratory

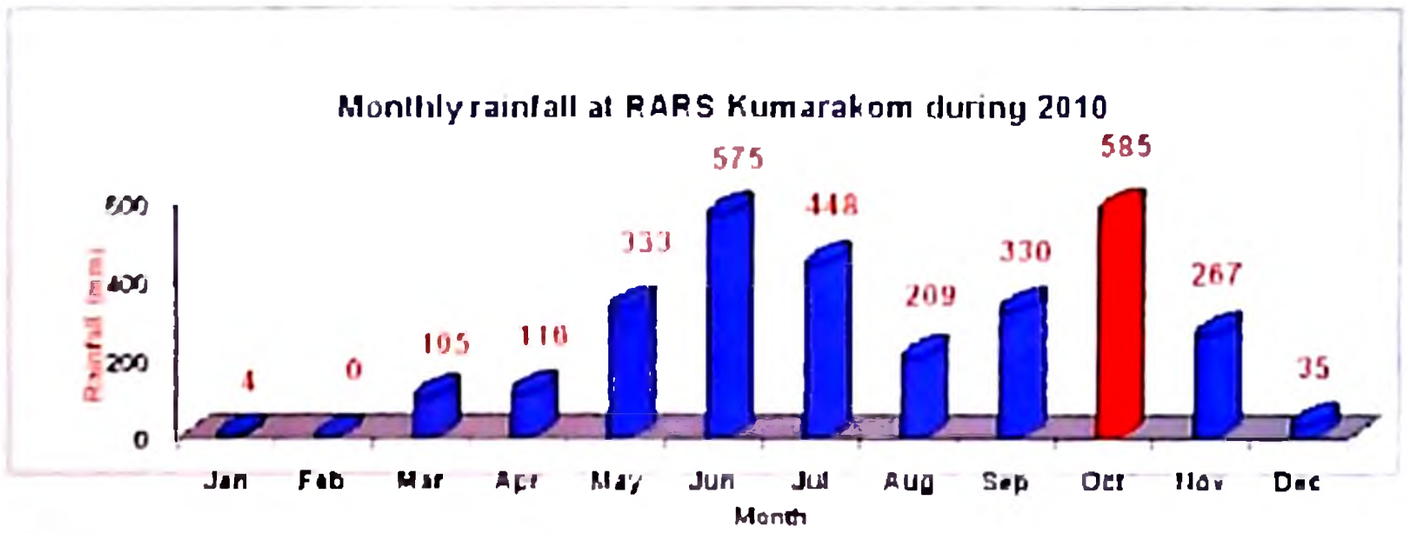
Under the project, a biocontrol laboratory for the production of *Trichogramma japonicum* and *Trichogramma chilonis* for the biological control of Rice stem borer and leaf folder had been established and distribution of *Trichocards* to farmers had been started



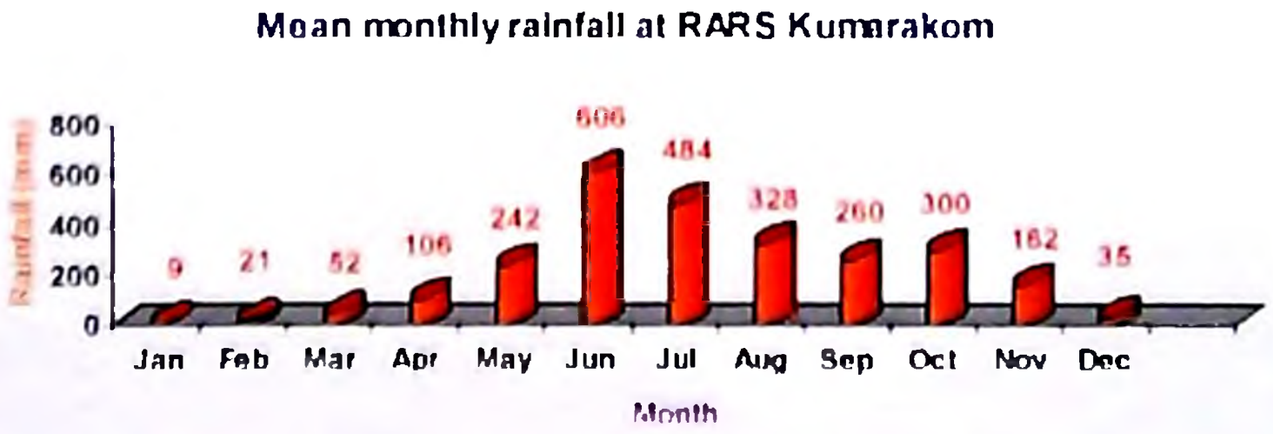
Meteorological Research

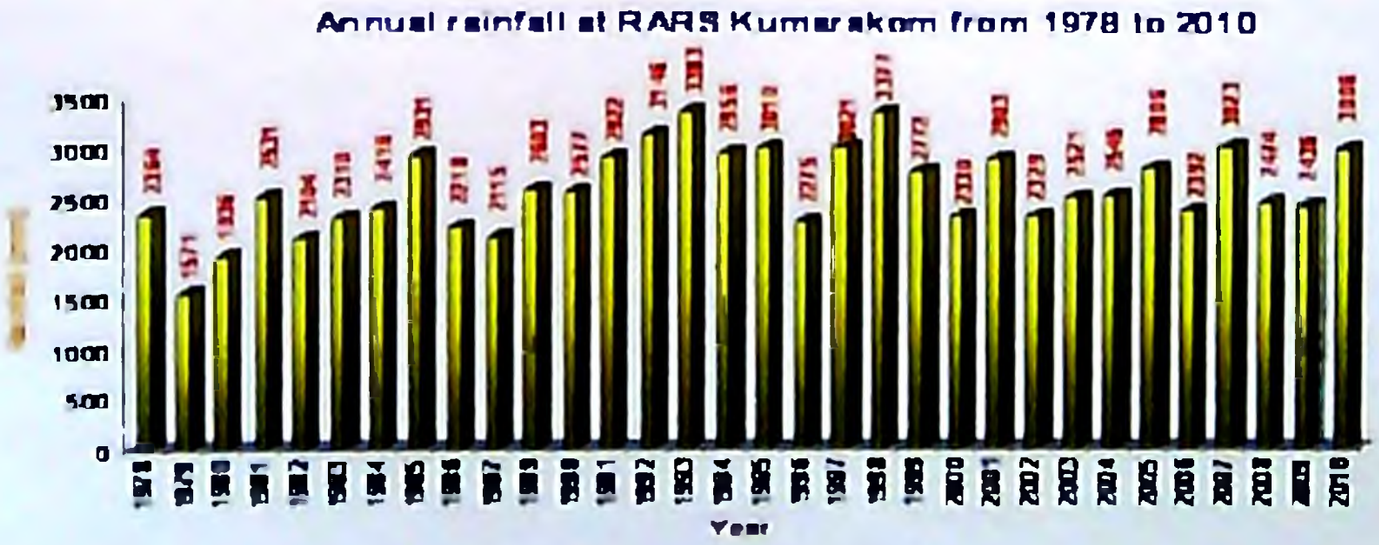
Mean annual rainfall at Kumarkom is 2603 ± 416 mm over a period of 1978 to 2010. Maximum rainfall (3383 mm) was recorded during the year 1993 while the lowest (1573mm) during 1979. The coefficient of variation of annual rainfall is only 15.9 %, indicating that it is highly stable and dependable though the monthly coefficient of variation varied from 31.2 % in June to 200.4% in January. However, the monthly rainfall is relatively stable in June (CV 31.2%), July (33.7%) and August (38.2%) during the southwest monsoon. June and July are the rainiest months while January and February receive the least rainfall.

Out of the thirty two years, only four years rainfall was deficit and the highest deficit was during the year 1979 (-616 mm) followed by 1980 (-251 mm). Highest rainfall received during the year 1993(+ 780 mm above normal) followed by 1998 (+773mm) and 1992 (+ 543mm). Season wise rainfall contribution over Kumarakom indicated that 64 per cent of annual rainfall is received during the monsoon, followed by post-monsoon (18%), summer (15%). The least (3%) is seen in winter.



The monthly rainfall distribution during 2010 is found to be abnormal. Even though the total rainfall was normal: its distribution over month is very irregular. The highest (585mm) rainfall received during this year was during October. During this year there was an un expected heavy rain(10% more than normal) during the post monsoon season resulted in heavy crop loss especially rice.





Agricultural Engineering

Agricultural engineering division is providing technical support to activities of the station like farm development works, maintenance of farm structures, shade houses, rain shelters, drainage pumping systems and purchase of equipments. The computer network of the station and procurement and maintenance of computers are done by this division.

Zonal information centre

In order to facilitate speedy storage, analysis, report generation and dissemination, various devices like PC, laptops, printers, copiers etc are provided. The project facilitates frequent up gradation of hard wares and soft wares, its repair and maintenance and the procurement of new devices for creating and updating the data base.

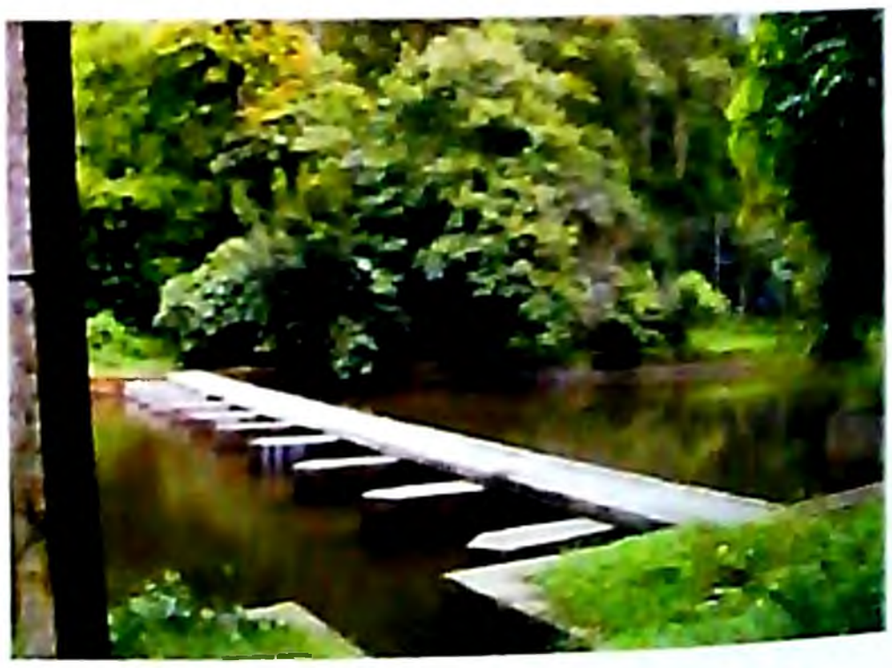
Under the Kuttanadu project two research programmes are under taken

Hydrology and water balance studies of Kuttanad wetlands.

Kuttanad is a deltaic region formed by four rivers viz, the Manimala, Achancoil, Pamba and Meenachil. The changes in these river basins and the existing flood control structures modified the ecological balance of the region. In this context this study is initiated to assess the present hydrology and water balance of Kuttanad wetlands based on flow characteristics of rivers draining in to Vembanad lake. Four river gauging stations and three lake monitoring stations have been established. The flow characteristics of rivers has been assessed.

Dynamics of moisture and nutrient movement in garden lands/cultivated bunds in Kuttanad subsequent to water level fluctuations

The level of water in the channel is a major factor that influence availability and movement of moisture and solutes in the root zone of crops cultivated on bunds. The study is initiated to analyse the soil moisture flux and the solute transport in the root zone and the influence of water table position in the root zone moisture flow dynamics A new petti and para for drainage and water management research has been installed in the farm. Weekly soil moisture status is being monitored.



Broiler Duck Farming

The snow white Vigova breeds of duck is the latest craze among duck farmers. These are cross breed from White Peckin and Ayles berry breeds. These ducks are disease resistant and ideally suited for Kerala climate. It is also suitable for integrated farming system.

Rearing of Vigova Broiler ducks was started in the station as a part of RKVY Project in February 2010. It was found that Vigova ducks have remarkable growth rate and feed conversion efficiency. Performance and economics of Vigova Broiler Ducks is detailed below.

Performance and economics of Vigova Broiler Ducks

Day old Weight	47 g
Feed consumption up to 6 weeks	5.9 kg
Weight at 6 weeks	2.5 kg
Feed conversion efficiency	1 : 0.423
Mortality rate	3 %
Cost of day old duckling	Rs 37.00
Feed Cost (23 x 5.9)	Rs. 135.70
Selling rate	RS 130/ Kg on live weight

Now Vigova broiler ducks are one of the major components in multi integrated Farming System Research in Kuttanad project. It includes rice, buffalo, fish, fodder and banana.

Prototype of a mechanical device for the management of downer cows was developed with the financial assistance of Agricultural Technology Management Agency (ATMA), Kottayam 2010. It is being tested and modified form will be released in near future.

Changes in the eco-system of Kuttanad

Serving as the largest rice tract of the state, Kuttanad has witnessed a large number of developmental projects aimed at enhancing the cropping intensity and productivity. These include the construction of a regulator at Thanneermukkom to check the influx of saltwater into the rice growing padasekharams of Kuttanad, a spill way at Thottapally to divert flood waters from Kuttanad to the sea and adoption of agronomic practices that would augment yield. A study was taken up to analyse the impact of the Thanneermukkom regulator on the agrarian economy of Kuttanad.

The regulator which was commisssioned in 1975 to prevent seasonal inundation of Kuttanad with saline waters from the Arabian sea, to enable an additional rice crop in about 8000 ha has ultimately resulted in more evil than good. The ecological balance of the region has been dangerously disrupted, many species of fishes and molluscs have become extinct and there has been large scale labour displacement in fishing and coir industry. However, the direct benefits by way of increase in income and employment were observed in the case of rice farmers, toddy tappers and agricultural labourers. A fall in income and employment was reported by fishermen, coconut farmers, coir workers and clam collectors.

Gender studies in the agricultural sector of Kuttanad

In Kerala very little attention has been given to scholarly work on the economic involvement of women in agrarian systems. Women are an extremely important pivotal point in the rural economy, but their work and drudgery largely go unnoticed and unrewarded. Much of their labour is non-monetized. A study on the role of farm women in the agrarian economy of Kuttanad, Kerala, was conducted to generate reliable data on the work participation, income generation and management perception of the women folk in the rural households of Kuttanad.

The study revealed that women worked for about 6 hours a day in the farm over and above their familial duties of collecting fuel, water, cooking, rearing the children and nursing the aged. Influencing of women in farm centered decisions was very low. They exercised more power in home and children centered decisions. Apart from the lion's share of the household duties, women accounted for about one third wage - labour component of the family labour. The then prevailing wage rates for men and women labourers in the rice-farming sector, of Rs.75/- and Rs.30/- respectively spoke for themselves the gravity of gender discrimination in the rural sector.

Soils of Kuttanad

Supporting nearly 25-30% of the total rice production of the state, the soils of Kuttanad are characterized by very low pH values and very high values of EC (3276 millimhos/cm), Sodium (500 ppm) and Chloride (46.4 m.eq./lit). The adjoining water body generally has a very low pH during the months of April and May dropping down to a low of 3.7 in the Kavanar river. The summer months of April and May are therefore hazardous for both agriculture and aquaculture of this region.

Production trends in crops

A simple algebraic formula known as "P-GAN'S formula" has been derived to estimate precisely the influence of area and productivity on the production trend of a crop over a period of time. The formula can be used both for research and extension activities. It can be used by Government agencies in highlighting the achievements and for taking various policy decisions relating to plantation crops and paddy.

Extension Activities

Krishi Vigyan Kendra

The KVK, Kottayam unit has been functioning at the Regional Agricultural Research Station, Kumarakom from May 2000. A number of short term and long term training programmes are being operated at this KVK.

Linkage with Women SHGs

One bio-pesticide production unit and one horticultural nursery are being manned by Haritha SHG members who were trained in the KVK. The produce is marketed through the sales centre, KVK, Kottayam.

Other Extension Activities include:

a. Sale of Publications, seeds and planting materials

b. Conducting on-campus and off-campus training

c. Conducting on-farm demonstrations ■

Thrust areas for research

The following thrust areas have been identified for research:

Integrated farming involving crops, livestock and fish

Conservation and management of mangroves

Changes in the ecosystem of Kuttanad and their impacts

Reclamation and management of problem soils

Womens' role in the agrarian economy of Kuttanad

Testing and popularising improved farm implements

Inter cropping with annual and perennial crops in coconut gardens

Establishing a data base (Information system) Kumarakom

Aquaculture in kari lands of Kuttanad : selection of species and their culture

High density culture of fishes in open waters

Fish ranching and augmentation of fish production in the Vembenad backwaters

Economics of rice-fish farming systems of coastal agro-ecosystems

uvial lands of Kuttanad

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