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Part - I

Faculty of Agriculture

1. RICE AND RICE BASED CROPPING SYSTEMS

Co-ordinator: Dr. S. Leena Kumary

HIGHLIGHTS

- A new promising virippu variety **Chingam (KYLM 6)** with resistance to drought and tolerance to pests and diseases, developed by Regional Agricultural Research Station, Kayamkulam was released.
- Red kernelled Cul. 210-25 with a duration of 110-115 days suitable for direct seeding as well as transplanted irrigated low lands of Kerala developed by Regional Agricultural Research Station, Pattambi was released as **Varsha (Ptb 56)**.
- KAU M 38-4-1, a cross between MO4/Cul 25331, having a duration of 115-120 days, high yield and tolerance to major pests and diseases of Kuttanad, developed by Rice Research station, Moncompu was released as **Gouri (MO 20)**.
- A new promising mundakan variety **Dhanu KYLM 7)** evolved through mutation breeding of Ptb 20 by the Regional Agricultural Research Station, Kayamkulam was released.
- A new white rice variety **Swetha (Ptb 57)** with 135-140 days duration was developed by the Regional Agricultural Research Station, Pattambi for the second crop season of irrigated low lands of Chittoor areas of Palakkad district and was released.
- Two new rice varieties viz. **Kunjukunju Varna (VK-1)** and **Kunjukunju Priya (VK-2)** were released from the College of Horticulture, Vellanikkara.
- Out of the 16765 accessions screened for tolerance to biotic stresses 3370 entries showed tolerance to sheath blight, 2431 to Sheath rot and 1530 entries showed multiple tolerance to both diseases.
- A study in hybrid rice revealed that, in order to achieve a complete heterotic effect in rice breeding, the biochemical as well as physiological aspects at different growing stages should be given due importance. Since maximum accumulation of photo-assimilates occurs before heading and differential partitioning of assimilates decide the harvest index, selection of parental genotypes for better heterotic advantage should be made by observing the various physiological and biochemical aspects at early stages of growth.

- Njavara genotypes had wide variations with respect to qualitative and quantitative characters. The maximum range being in the case of spikelet awning, lemma and palea colour, brown rice colour, duration, grain yield and straw yield. The extra short duration nature of the Njavara cultivar makes it ideal for cultivation in drought prone areas and as a donor parent for evolving extra short duration high yielding rice varieties.
- Scented rice varieties Pusa Basmati-1, IET 12606 and Jeerakasala were found promising for the high ranges of Kerala.
- Soaking seeds in Penshibao + *Azospirillum*, foliar spray with Penshibao at 20 and 30 DAT improved almost all growth characters and grain yield in rice. Treatment combinations viz. soaking seeds in *Azospirillum* and Penshibao followed by foliar spray of Penshibao, soaking seeds in Penshibao followed by its foliar spray and soaking in Penshibao and *Azospirillum* followed by foliar spray of GA3 were significantly superior to other combinations. Nutrient uptake was the highest for soaking seeds in Penshibao and *Azospirillum*.
- The low yield of rice from laterite soils was found to be not only due to nutrient deficiency alone but also due to nutritional constraints from excesses, imbalances or metabolic unavailability of elements.
- Micronutrient status study of Kuttanad soils showed zinc deficiency in Karuvatta, Pallippad, Thottappaly and Purakkad soil series, copper deficiency in Manjoor, Mannar and Muthur and the combined deficiency of zinc and copper in the soil series of Thakazhy, Ambalapuzha, Changanacherry, Vechoor and Kurichi. The available zinc status was adequate (i.e. more than 0.5 ppm DTPA extractable zinc) in the Champakulam, Ramankari, Edathua, Mannar and Muthur series. The available copper status was adequate (i.e. more than 0.2 ppm DTPA extractable copper) in the Karuvatta, Pallippad, Ramankari and Edathua series. The iron and manganese content was high in all the series.
- The profitability of zinc sulphate application in zinc deficient soils @ 25kg Zn SO₄/ha is high due to the residual (carry over) benefits of a single application to succeeding crops. It will last for 8 to 9 years and hence soil application of zinc is not required for every season
- Magnesium can be recommended for rice in the form of magnesium sulphate (16% MgO) or magnesite (40% MgO) or dolomite (10% MgO) @ 20 Kg MgO per hectare. On per unit MgO basis, magnesite application was cheaper than magnesium sulphate and dolomite.
- Amelioration with ash and lime at 300 kg.ha⁻¹ each with subsequent change in the N:K ratio to 1:1 enhanced productivity of rice in green manured laterite soil with a benefit cost ratio of 2.25. A change in N source from urea to ammonium sulphate improved the productivity mainly due to the effect of sulphur fertilization.
- Substitution of a major quantity of inorganic fertilizers is possible by the use of organic manures. However, considering the mineralization patterns, a better option would be a combined use of inorganic and organic manures. Incorporation of organic

manure can be carried out along with final ploughing for reducing the cost of cultivation.

- Kasturi and Haryana Basumati recorded the highest grain yield when transplanted during the second week of October with a fertilizer dose of 90:45:67.5 kg NPK ha⁻¹ with 50 per cent N as FYM and 50 per cent N as chemical fertilizer. Adopting 20 x 10 cm spacing and applying pre-emergent herbicide mixture anilofos + 2,4-D EE @ 0.4 + 0.53 kg ai ha⁻¹ at 6 DAT followed by 2,4-D sodium salt @ 1 kg ai ha⁻¹ at 20 DAT had a profound influence on weed control, yield and economics of basmati rice production.
- Maximum net returns from upland rice were obtained upon application of 90 kg ha⁻¹ nitrogen 50 per cent of which was substituted through farmyard manure. However, the benefit-cost ratio was maximum when 35 per cent of 90 kg ha⁻¹ nitrogen was applied as farmyard manure.
- Study on nutrient management of upland rice varieties in coconut garden revealed that among the varieties Harsha and Mattatriveni performed better under partial shade situations. Benefit cost ratio for upland rice was maximum at 80 kg N ha⁻¹ and 45 kg K₂O ha⁻¹ along with the recommended dose of 30kg P₂O₅ ha⁻¹.
- Upland rice intercropped with cowpea in 2:1 proportion can be recommended as an economically viable, biologically suitable and sustainable intercropping system for the kharif season.
- Adsorption of 2,4-D in the rice soils of Kerala followed Freundlich isotherm, i.e. adsorption of the chemical by the soil components increased with the concentration. Variation in the extent of adsorption of 2,4-D between soil samples were not considerable. Leaching of 2,4-D beyond a depth of 20 cm occurred, if the rate of percolation of water through the soil was very high. Application of 2,4-D at the present recommended level in wetland paddy does not have any ill effect on soil or crop produce.
- In addition to *Panicum repens* and *Digitaria sanguinalis*, *Echinochloa crusgali* was found to harbour the pathogen *Ephelis oryzae*, the casual organism of udbatta disease of rice.
- Egg masses of stem borer, galls, larvae of leaf folder, skipper and case worm were collected and sent for identification to IRRI and 22 natural enemies were identified.
- Botanicals + half dose synthetic insecticides were as effective as full dose of synthetic insecticides in suppressing leaf roller and in protecting natural enemies. Hence the full dose of synthetic insecticides can be substituted with combination of botanicals (either NSO 3% or azadirachtin 0.004 per cent) and half dose of synthetic insecticides (either quinalphos 0.0025 per cent or imidacloprid 0.0025 per cent) for an eco friendly management of rice leaf roller.

Sugarcane

- Among the early maturing sugarcane cultures of 1998 -99 series, the overall performance of CoSi 91012 was found to be better than other test varieties.
- From 1998-99 - midlate series, performance of Co.9419 was found to be better than other test varieties
- Overall performance of Co 97001 was found to be better than other test varieties among 1999 - 2000 early maturing series
- In the 1999-2000 midlate series, overall performance of CoJn 86-600 was found to be better than other test varieties.
- Among the early groups, Co 93028 was found to be promising and it required NPK at 165:82:82.5kg /ha for maximum cane growth and yield.
- Among the midlate varieties evaluated, Co 94011 and CoTl 93116 performed well with regard to cane and sugar yield. It required NPK at 165: 82.5:82.5kg/ha for maximum growth and yield.
- Application of sulphur at 60kg /ha in the form of gypsum was found to be beneficial for the black soils of Palghat in Kerala.
- Cultural practices like stubble shaving, trash mulching in alternate rows, dismantling the ridges and gap filling with setts were very critical for enhancing the cane and sugar yield of ratoon sugarcane.

SUMMARY

RICE

Germplasm collection, maintenance and utilization of traditional local rice varieties are in progress at RARS, Kayamkulam, RRS, Moncompu, RRS, Vytilla , RARS, Pattambi and RARS, Ambalavayal

Breeder seed production programme and seed distribution of important rice varieties are being taken up by the Regional Agricultural Research Stations and Rice Research Stations

In the multilocational trial of Pattambi and Moncompu cultures of paddy at RARS, Pilicode, the rice culture M-61-6-1-1-1 recorded the highest grain yield of 2416.75 kg/ha which was on par with Jyothi with 2208.5 kg/ha, Allikkannan (2271.0 kg/ha) and Pavithra (2333.25 kg/ha).

Under the All India Co-ordinated Rice Improvement Project, rice cultures belonging to different duration groups viz. early, mid early and medium and possessing tolerance to different stress situations developed at different research centers all over the country were tested at Regional Agricultural Research Station, Pattambi and Rice Research Station, Moncompu and their performance evaluated.

In the farm trials with seven short duration high yielding rice cultures developed at Rice Research Station, Moncompu, Cul. SD 6 of 105 days duration with 5573 kg/ha and Cul. M9 (mutant of MO 6) of 95 days duration with 4615 kg/ha out yielded the check variety Jyothy (4177 kg/ha).

Maintenance breeding of A & B lines, fertility estimation of A and B lines with 100 % sterility and fertility respectively were undertaken at Regional Agricultural Research Station, Pattambi as part of the project on Evolution of high yielding rice hybrids suitable for Kerala.

Rice varieties and cultures developed within and outside the state were screened for various pests and diseases as part of various screening trials viz., National Screening Nursery (NSN), Multiple Resistance Screening Trials (MRST), Gall Midge Screening trials, Screening for sheath blight resistance, Screening for blast resistance, Screening for sheath blight and sheath rot diseases (NSN) and Screening rice varieties against important diseases at Regional Agricultural Research Station, Pattambi and Rice Research Station, Moncompu. Resistant varieties and donors were identified. After confirmation of the genetic control of resistance these will be used for further breeding trials.

In farm trials with three advanced rice cultures viz. M87-1, M87-5 and M 95-1 developed at Rice Research Station, Moncompu, from the experiment to evolve high yielding varieties of rice resistant to, the important diseases prevalent in Kuttanad, during Puncheda 2002-2003, in five cultivators field at Alappuzha and Kottayam dist. Culture M 95-1 gave a grain yield of 5322 kg/ha which out yielded all other cultures as well as the check variety Jyothy (4177 kg/ha).

Three saline resistant cultures viz. Cul. CIRJ-3, Cul. CIRJ-7 and Cul. CIRJ-8 from the cross (Vytila-2/IR-5/Jaya) developed at Rice Research Station, Vytilla from the project Breeding high yielding varieties of rice suitable for Pokkali areas by hybridization between Pokkali varieties and IR5 were tested in farmer's fields at Ernakulam and Alappuzha. Based on the performance of the cultures, it was decided to release the Culture CIRJ-7 for Ernakulam district.

Under the project Breeding lodging resistant rice varieties for the dry sown condition during the virippu season conducted at Regional Agrl. Research Station, Pattambi, purification of Cul. C3-2 was undertaken on ear to row basis.

Seed production of two pre release cultures viz. Cul. 2006 (semi tall, non lodging, with fine white rice) and Cul. V-1- 20 (semi tall, non lodging with red kernel) developed from the project Breeding for earliness in the rice varieties H4 and SR 26B by induced mutation was undertaken at Rice Research Station, Vytilla.

Two short duration rice cultures viz. Cul. HHS-1 and Cul.HS-40 of 85 and 90 days duration respectively, were developed at ARS, Mannuthy through re-selection from Hraswa.

Seed multiplication of the mutant culture M-44-1-3 developed at Onattukara Regional Agricultural Research Station, Kayamkulam, which is resistant/tolerant to salinity and flood and suitable for Orumundakan tract, was carried out during 2001-2003.

Studies on the evaluation of scented and slender rice varieties for the high range of Kerala revealed that Pusa basmati 1, IET 12606 and Jeerakasala can be successfully cultivated in the high ranges during the first crop season.

Seven promising lines were identified at Rice Research Station, Vytilla from the National Saline Alkaline Screening Nursery (NSASN) - Saline Alkaline Tolerant Variety (SATVT) and International Rice Saline Alkaline Tolerance Observation and Nursery (IRSATON).

A dwarf photoperiod sensitive culture viz. Cul. 20 D1 (mutant of Ptb 20) developed at Regional Agrl. Research Station, Pattambi, was found to out-yield the check in farm trials at all the six locations at Thrissur and Ernakulam dist. The average yield of the culture over six locations was 3582 kg/ha. Seed multiplication of this culture was undertaken during 2003-04.

Cul. C.26, C.28 and C.80 developed at Agricultural Research Station, Mannuthy from the project on Evolution of rice varieties having high grain and straw yield from interracial crosses of diverse origin were selected for farm trials in different locations.

Experiments conducted at CSR subcentre, Wadakkanchery on identification of suitable high yielding rice cultivars for different farming situations showed that short duration varieties Jyothi, Harsha and Aiswarya would be better for Palakkad, Aiswarya and Aruna for Thrissur and Aiswarya and Kanchana for Ernakulam district during kharif season. Among medium duration varieties, red riced varieties like Bhadra, Kanakom, Aathira, Pavizham or Panchami and white riced ADT 38 was suitable for Palakkad, Pavizham for Chalakkudy, Aathira for Wadakkanchery and Muvattupuzha. Among the long duration varieties Neeraja and Swetha performed better than Ponni, Paiyur -1, ADT - 44 and Pranava. During Rabi season, Aiswarya or Uma would be the best variety for Alathur, Pavizham, Kanakom, or Uma for Kozhalmannom, and ADT - 38 and Remanika for Chittoor area of Palakkad. At Wadakkanchery, Remanika and Uma were the best varieties and at Chalakkudy, Remya, Uma and Karishma were the best varieties. Among the photosensitive varieties, Nila and Makaram were suitable for Rayamangalam.

Varietal combinations like Swamaprabha + Makaram, Cul C3 - 2 + Makaram, Chenkayama + Makaram were suitable for Koottumundakan cultivation in Palakkad district.

Studies on feasibility of replacing transplanting and broadcasting of sprouted seeds by wet-seeder in kharif, rabi and summer seasons revealed that the grain yield by drum-seeding method was better both in terms of yield increase and reduction in cost of production, than broadcasting and transplanting, and hence direct drum seeding can be safely introduced as a substitute for transplanting without sacrificing productivity.

In the project Multiple use of cowpea & nutrient balance in rice based cropping system conducted at Cropping System Research Centre, Karamana, it was found that in rice based cropping system a third crop with economic importance (like cowpea) or a green manure crop (sunhemp) and its incorporation is having positive influence on the subsequent rice crop resulting in enhanced grain yield.

In the evaluation of fertilizer response and production potential of promising saline tolerant cultures of rice at Rice Research Station, Vytilla it was found that an yield of 4-5 t/ha could be obtained under single cropped high fertile pokkali situation without any additional fertilizers.

Experiments on maximisation of rice yield/productivity using FYM, spacing and levels of fertilizer at CSRC, Karamana revealed that enhancement of fertilizer above the present POP recommendation or plant population was not having any influence on rice yield. Application of manure at the rate of 5 or 10 t/ha during first crop season enhanced the yield during the season and showed its residual effect during the second crop season.

Results of experiments on yield maximization in rice under irrigated and favourable rainfed lowland conducted at RARS, Pattambi revealed that application of rice hull ash along with POP recommended manures helped to improve grain yield of rice. Application of silica and higher K dose was also beneficial. Effect of green leaf manure was more pronounced during Rabi and it gave better growth and higher yield as compared to the treatment of recommended fertilizer dose.

NPK level of 120-45-45 kg/ha with 100 kg seed/ha recorded maximum grain yield in Cul. 42-6-3 (Uma-MO.16).

In an experiment to compare the relative efficiency of SPAD and LCC threshold value based N management on growth and yield of rice, LCC based N at 4 without basal gave the highest PFPN (Partial Factor Productivity of Nitrogen) and AEN (Agronomic Efficiency of Nitrogen) during Khariff season. During Rabi, there was no significant variation between LCC based N top dressing at 4 or 5 with or without receiving basal N. Among the treatments to identify the most appropriate SPAD value for efficient rice production, T10 (basal 25 kg N + SPAD based N at 37) gave the highest yield, better PFPN and highest AEN during Kharif while during Rabi, N use efficiencies was highest in SPAD 33 without basal.

Application of urea mixed with neem cake from planting up to PI stage recorded the highest yield. Application of CRU 4.5% coating or 6% coating @ 60% of recommended N at planting gave an yield as good as N application at various splits. In addition, the N use efficiencies were much higher for CRU.

Experiments conducted by CSR Wadakkanchery on the response of rice to nutrients N, P and K in farmers fields under different agro ecological situations revealed that the response to N was lowest at Wadakkanchery (2.96) and the highest at Vadavukkode (19.64). The district wise average response to N was 9.56 in Palakkad, 8.45 in Thrissur and 11.93 in Ernakulam. The zonal average was 9.98. The response to P was the lowest at Alathur (2.02) and highest in Plopullly. (12.22). In Palakkad district, the average response was 7.12, in Thrissur 8.03 and in Ernakulam 8.83 with a zonal average of 7.79. Alathur gave the lowest response to K (4.27) and Chalakkudy the highest (23.2). The average response in Palakkad was 8.71, Thrissur 15.3 and in Ernakulam 16.04 with a zonal average of 13.35. With regard to N& P, there was not much variation between districts. But for K, the response was more in Thrissur and Ernakulam. Among the nutrients, K gave the highest response in the zone.

Studies on agronomic management practices for sustainable production in rice-rice system showed that application of cow dung @ 5 t/ha + factom phos 150 kg/ha + MOP 15 kg/ha at planting + N@ 25 kg/ha+ MOP 15 kg/ha at 20 DAT and LCC based N application at LCC 4 during Rabi season was the most effective management practice for maximum rice production in Palakkad district. In Thrissur district, application of cow dung @ 5 t/ha + soil application of ZnSo₄ @ 25 kg/ha + *Azospirillum* @ 2kg/ha + NPK 90:45:45 kg/ha (basal N as urea and top dress N as ammonium sulphate) and urea mixed with neem cake in 5:1 ratio

or cow dung @ 5 t/ha + ZnSo₄ @ 25 kg/ha + *Azospirillum* @ 2kg/ha + 1/3 rd n as urea as basal followed by LCC based N at LCC 4 + P and K as recommended split were found better. In Ernakulam district, the treatment of random planting + factom phos 150 kg/ha + MOP 15 kg/ha at planting + N@ 25 kg/ha as urea was found promising.

Four years of studies on the synchronisation of K supply for rice hybrids at RRS, Moncompu revealed that K application did not influence the grain yield significantly.

In an experiment on the effect of different sources of NPK on the incidence of rice diseases, conducted at CSRC, Karamana, it was found that nitrogen influenced the severity of sheath blight disease whereas phosphorus had an impact in reducing brown spot disease. Potassium was found to decrease the incidence of sheath blight, sheath rot and brown spot diseases.

Application of Pretilachlor (0.7 kg ai/ha) + one hand weeding or Butachlor (1.25 kg ai/ha) + one hand weeding or Pretilachlor (0.7 kg ai/ha) + 2, 4- D (0.8 kg ai/ha) can be adopted for weed control in dry seeded rice. For direct sown rice under puddled conditions, pre emergence application of Pretilachlor + Safener (Sofit) @ 0.45 kg/ha followed by hand weeding at 40 DAS or post emergence application of Pyrazo Sulfuron Ethyl @ 0.02 & 0.025 kg ai/ha were effective. Weed control efficiency as well as weed control rating was high with Pretilachlor + Safener + Almix (T5 & T6) and Pyrazo Sulfuron Ethyl, but they showed crop toxicity, which was low with Almix.

Pyrazo Sulfuron Ethyl 50WP, 0.025 kg.ai/ha 8-10 DAT and Butachlor (Machete) followed by Almix 50 EC + 20 WP, 0.938 and 0.004 at 3 DAT and 21-25 DAT were found to be the choice herbicides for transplanted rice

Two sprays of Contaf 5 EC was found to be most effective for the control of sheath blight disease of rice followed by Tilt 25 EC. Among the new generation molecules, Rhizolex 50 WP (2.0 g/l), Amistar (0.75 ml/l), RIL formulation (010 @1.5 ml/l) and Kitazin were superior over all other newer fungicides including Validamycin in controlling the disease.

Botanicals viz. neem gold, ahook, wanis and tricure were effective in reducing the incidence and intensity of sheath blight disease of rice.

In an experiment on the evaluation of green manures for the control of sheath blight of rice at RARS, Pattambi, incorporation of the green manures daincha (2.5 and 5 t/ha), green gram (2.5 t/ha), vengai (5 t/ha) and sunnhemp (2.5 t/ha) showed significant reduction in sheath blight severity. Yield was maximum in the daincha (5 t/ha) incorporated plot followed by vengai (2.5 and 5 t/ha), green gram (2.5 and 5 t/ha) and sunnhemp (2.5 and 5 t/ha). The treatment, FYM plus inorganic fertilizers produced significantly higher yield even with high incidence of sheath blight.

Contaf 5 EC (Hexaconazole) and Tilt 25 EC (Propiconazole), Kitazin 48 EC (Kitazin) and Antracol 70 WP (Propineb) were effective in controlling brown spot disease of rice and increasing the yield. Bael extract and neem leaf extract also reduced the leaf infection and seed infection due to brown spot in rice

Combination spray of Bavistin + Ekalux and Hinosan + Ekalux were most effective in controlling the sheath rot disease of rice.

Foliar spraying of Carbendazim 0.1% at flower emergence and again after three weeks, solar drying of seeds on cemented floor prior to storage and sowing + foliar spraying with carbendazim 0.1% at flowering stage, seed treatment with carbendazim 0.1% + foliar spray with carbendazim 0.1% at flowering stage and solar drying of seeds on cemented floor prior to storage and sowing + foliar spraying with carbendazim 0.1% at flowering and again after three weeks were equally effective in controlling udbatta disease of rice.

Pesticide combination of Profenophos + Cypermethrin and pesticide Imidacloprid were found superior to Monocrotophos in controlling stem borer incidence.

Carbofuran application @ 1000 g ai/ha effectively checked incidence of stemborer, whorlmaggot and blue beetle at RRS, Moncompu.

The major pests observed in rice are leaf rollers, rice bugs, short horned grass hoppers, green leaf hoppers and whorl maggots. Predators such as spiders, damsel flies, coccinellids and ground beetles and the parasites viz. *Xanthopimpla* sp. *Tetrastychus* sp. and *Cotesia* sp. as well as neutrals coming under family Chironomidae, Culicidae, Tanyderidae and Otitidae are present in the rice ecosystem

SUGARCANE

In the evaluation of sugarcane varieties for the different agro-climatic tracts of Kerala and fluff exchange programme, Culture no.6/95 and 16/95 from the 1995 series were promoted to farm trial. The superior cultures from the subsequent series are at different stages of testing.

Madhuri and Madhumathi are suitable for multiple ratooning as compared to other varieties.

Paired row planting with 30:60cm was found to be ideal and the crop had shown response to N upto 150kg per ha.

In the zonal varietal trial for identifying midlate maturing varieties –2002-2003 series, variety 93-R-5 recorded the highest cane yield of 126.67 t/ha which was on par with the standard variety Co 7219 and significantly superior to Co 6304 and Co 86032. Variety 93-R-5 recorded highest CCS of 15.93 t/ha followed by Co 99012 (15.42 t/ha) and were found to be statistically superior to Co 86032.

In the zonal varietal trial for identifying early maturing varieties - 2003-2004 series, CoM 9516 recorded highest cane yield of 148.98 t/ha and CCS of 17.18 t/ha followed by Co 2000-03 (129.17 and 17.08 t/ha) and were found to be significantly superior to standard varieties. In the 2003-04 series, CoTI 1153 recorded highest cane yield of 132.1 t/ha followed by Co 2000-11 (131.36 t/ha) and were significantly superior to Co 6304 and Co 7219 and on par with Co 86032.

Integration of organics with inorganic forms of nutrients enabled to enhance cane yield and thereby reduced the use of chemical fertilizers to the extent of 25% of the recommended dose. Mineral nutrition with NPK at 75 percent of the recommended dose combined with 25 percent N as press mud and inoculation of biofertilizer produced maximum cane and sugar yield

Three hoeings at 30,60 & 90 DAP effectively controlled the weeds and produced maximum cane and sugar yield in sugarcane.

RR- I and RR-II, the two isolates of red rot pathogen *Colletotrichum falcatum* obtained from Co 997 showed close similarity in virulence pattern and hence are grouped under the same pathotype. The isolate showed resistant reaction on 10 varieties viz. Baragua, Khakai, SES 594, CoS 767, Bo 91, Co 7717, CoJ 64, Co 1148, Co 62399 and Co 975 and susceptible reaction on CoC 671 and Co 997. Co 419 showed intermediate reaction to both isolates.

Out of 95 sugarcane entries tested for reaction to red rot by artificial inoculation, eight entries showed resistant reaction, 60 entries showed moderately resistant reaction, 17 moderately susceptible reaction, eight susceptible reaction and one highly susceptible reaction by plug method of inoculation. By nodal method, out of 82 entries tested, 77 showed resistant reaction and five showed susceptible reaction.

In a survey conducted in Pathanamthitta, Alleppey and Palghat districts on naturally occurring sugarcane diseases, red rot disease was noted only in the variety Co 997. Other major diseases like smut and wilt were not observed in the area. Rust caused by *Puccinia melanocephala* was observed in culture 577/84 in a moderately minor form. Mild to moderate incidence of yellow leaf spot (*Cercospora koepkei*), eyes spot (*Helminthosporium sacchari*) banded leaf blight (*Rhizoctonia solani*) and mosaic (virus) were noticed in all cultivated varieties. Twisted top condition (*Fusarium moniliformae*) was observed in some cultures in minor form.

List of experiments

i) KAU Projects

a) Concluded experiments

Sl. No.	Code No.	Title of the experiment	Location
	RICE		
1	RIC-05-00-03-76/KYM (9)/KAU	Evaluation of high yielding photosensitive varieties suited to different agro climatic zones	ORARS, Kayamkulam
2	RIC-11-00-03-91/MON (3)/KAU	Micronutrient status of Kuttanad soils	RRS, Moncompu
3	RIC-09-02-14-96/MON(3)/KAU	Magnesium management in irrigated rice based cropping system	RRS, Moncompu
4	RIC-13-00-16-97/MON(4)/KAU	Biological control of major rice pests in Kuttanad- its role in IPM	RRS, Moncompu
5	RIC-02-03-01-84/MON(9)/KAU	Breeding for high yielding varieties of rice with multiple resistance to major pests and diseases of Kuttanad	RRS, Moncompu
6	RIC-03-02-10-97/ACV(9)/KAU/PG	Genetic analysis of bacterial blight (<i>Xanthomonas oryzae</i> pv. <i>oryzae</i> Ishiyama) resistance and yield in rice (<i>Oryza sativa</i> L.)	CoA, Vellayani
7	RIC-02-01-01-2000/ACV (1)/KAU/PG	Nutrient management of upland rice (<i>Oryza sativa</i> . L) varieties in coconut garden	CoA, Vellayani
8	RIC-02-02-03-2000/	Effect of seed soaking and foliar spray of	CoA,

	ACV (1)/KAU/PG	growth regulators on rice	Vellayani
9	RIC-02-02-11-2001/ ACV(1)/KAU/PG	Integrated nutrient management for upland rice	CoA, Vellayani
10	RIC-01-04-11-2001/ ACV(1)/KAU/PG	Performance of basmathi rice varieties as influenced by date of planting	CoA, Vellayani
11	RIC-02-02-12-2001/ ACV(1)/KAU/PG	Nutrient management for basmati rice (<i>Oryza sativa</i> L.) in wet lands	CoA, Vellayani
12	RIC-03-03-04- 2001/ACV (1)/ KAU/PG	Impact of plant population and weed management practices on the performance of basmathi rice	CoA, Vellayani
13	RIC-02-01-02- 2001/ACV (1)/ KAU/PG	Competitive behaviour of different legumes grown as intercrop with direct seeded upland rice	CoA, Vellayani
14	RIC-03-01-02/2002/ ACV (4)/KAU/PG	Management of the leaf roller complex on rice (<i>Oryza sativa</i> .L)	CoA, Vellayani
15	RIC-02-02-02-2000/ VKA (1)/ KAU/PG	Source efficiency relations of organics in wetland rice culture	CoH, Vellanikkara
16	RIC-05-00-02-2002/ VKA (1)/KAU/PG	Standardisation of mat nursery for rice	CoH, Vellanikkara
17	RIC-03-03-06-2002/ VKA (1)/ KAU/PG	Weed management in semidry rice intercropped with green manure crops	CoH, Vellanikkara
18	RIC-02-02-14-2001/ VKA (1)/ KAU/PG	Nutritional resource use efficiency in rice production	CoH, Vellanikkara
19	RIC-07-02-05-97/ VKA (1)/KAU/PG	Nutritional constraints of rice legume systems in laterite soils of humid tropics	CoH, Vellanikkara
20	RIC-01-04-13-2002/ VKA (9)/KAU/PG	GxE interaction in the F6 generation of wide crosses of rice(<i>Oryza sativa</i> . L)	CoH, Vellanikkara
21	RIC-01-04-12-2001/ VKA (9)/KAU/PG	Stability analysis of Kunjukunju rice cultures (<i>Oryza sativa</i> . L)	CoH, Vellanikkara
22	RIC-01-04-07- 2001/VKA (9)/ D.P&KAU	Participatory plant breeding for genetic improvement of the local rice cultivar Kunjukunju	CoH, Vellanikkara
23	RIC-01-04-03-2000/ VKA (9)/KAU/PG	Physiological genetics of character associations in hybrid rice	CoH, Vellanikkara
24	RIC-10-00-12-97/ VKA (3)/KAU/PG	Assessment of 2,4-d residues in the major rice soils in Kerala	CoH, Vellanikkara
25	RIC-01-00-12-98/ VKA (9)/KAU/PG	Characterisation and evaluation of the rice (<i>Oryza sativa</i> L.) cultivar Njavara	CoH, Vellanikkara
26	RIC-03-02-06-83/ PTB(9)/KAU	Breeding high yielding rice varieties resistant/tolerant to sheath blight	RARS, Pattambi
27	RIC-08-00-15-96/ KDY(1)/KAU	Standardisation of agro technique for promising rice cultures suited to Kari lands	AICRP on Agrl. Drainage, Karumady
	SUGARCANE		
28	CC-06-00-07/TLA (9)/92-KAU	Evaluation of sugarcane varieties for the different agro-climatic tracts of Kerala and fluff exchange programme of 1992 series	SRS, Thiruvalla
29	CC-06-00-19-94/TLA	Agronomic evaluation of promising sugarcane genotypes (midlate)	SRS, Thiruvalla
30	CC-06-00-19-94/TLA	Agronomic evaluation of promising sugarcane genotypes (early)	SRS, Thiruvalla

b) Experiments in progress

Sl. No.	Code No.	Title of the experiment	Location
	RICE		
1	RIC-09-01-13-93/KAR (3)/KAU	Maximisation of rice yield/productivity using FYM, spacing and levels of fertilizers	CSRC, Karamana
2	RIC-02-01-22-93/KYM (9)/KAU	Genetic Improvement of popular variety Cheradi for the mundakan season in laterite areas	ORARS, Kayamkulam
3	RIC-02-03-02-86/KYM (9)/KAU	Evolution of short duration, high yielding varieties suited to first crop season of Onattukara with resistance to drought, pests and diseases	ORARS, Kayamkulam
4	RIC-03-03-17-91/KYM 9)/KAU	Breeding tall high yielding rice varieties resistant/tolerant to salinity and flood for Oorumundakan tract	ORARS, Kayamkulam
5	RIC-03-01-03-2002/ KYM (4)/KAU	Assessment of perception and practices of rice IPM among the farmers in Onattukara	ORARS, Kayamkulam
6	RIC-01-00-02-82/MON((9)/KAU	Collection, maintenance and evaluation of rice germplasm	RRS, Moncompu
7	RIC-03-02-08-93/MON(9)/KAU	Breeding high yielding varieties of rice with resistance to important rice diseases of Kuttanad	RRS, Moncompu
8	RIC-02-01-21-93/MON(9)/KAU	Breeding short duration high yielding varieties of rice suited to Kuttanad	RRS, Moncompu
9	RIC-12-02-09-89/ MON(5)/KAU	Chemical control of sheath rot disease of rice	RRS, Moncompu
10	RIC-03-02-04-84/ MON(5)/KAU	Screening rice varieties against important diseases	RRS, Moncompu
11	RIC-12-04-01-91/ MON(5)/KAU	Etiology and management of viral and bacterial diseases of rice in Kuttanad	RRS, Moncompu
12	RIC-09-01-15-96/ MON(1)/KAU	Response of pre-release moncompu cultures to varying levels of nitrogen (cul No:M42-6-3)	RRS, Moncompu
13	RIC-09-02-12-94/ MON(1)/KAU	Studies on P fertilizer saving techniques for irrigated transplanted rice	RRS, Moncompu
14	RIC-01-01-01-2003/ MON(9)/KAU	Breeding for high yielding rice varieties with resistance to major pests of Kuttanad	RRS, Moncompu
15	RIC-01-03-05- 2003/ MON(9)/KAU	Breeding for high yielding rice varieties with submergence tolerance	RRS, Moncompu
16	RIC-01-03-06-2003/MON(9)/ KAU	Breeding for high yielding rice varieties with resistance/tolerance to adverse soil conditions.	RRS, Moncompu
17	RIC-02-02-15-2003/MON(1)/KAU	Effect of tillage and nutrient management on performance of direct seeded rice under rice-rice-water fallow cropping system	RRS, Moncompu
18	RIC-03-01-08-2003/ MON (4)/KAU	Integrated pest and disease management in rice	RRS, Moncompu
19	RIC-03-03-12-2003/MON(1)/KAU	Studies on weed management for economic crop production of wet seeded rice	RRS, Moncompu
20	RIC-04-00-01-2003/MON(1)/KAU	Studies on crop stand establishment and water management of direct sown rice under puddled conditions	RRS, Moncompu

21	RIC-01-00-03-77/VTL(9)/KAU	Collection, maintenance and utilisation of saline resistant varieties	RRS, Vytilla
22	RIC-03-03-03-80/VTL(9)/KAU	Breeding high yielding varieties of rice suitable for Pokkali areas by hybridization between Pokkali varieties and IR5	RRS, Vytilla
23	RIC-03-03-04-82/VTL(9)/KAU	Hybridization programme – Improvement of Pokkali rice	RRS, Vytilla
24	RIC-03-03-13-80/VTL(9)/KAU	Breeding for earliness in the rice varieties H4 and SR 26B by induced mutation	RRS, Vytilla
25	RIC-03-03-20-94/VTL(9)/KAU	National Saline Alkaline Screening Nursery (NSASN) - Saline Alkaline Tolerant Variety (SATVT) and International Rice Saline Alkaline Tolerance Observation and Nursery (IRSATON)	RRS, Vytilla
26	RIC-08-00-05-81/VTL(1)/KAU	Evaluation of fertilizer response & production potential of promising saline tolerant cultures of rice	RRS, Vytilla
27	RIC-01-03-08-2004/VTL(9)/KAU	Induced mutagenesis of pokkali rice land races	RRS, Vytilla
28	RIC-02-01-25-99/MNY(9)/KAU	Identification and development of rice genotypes suitable for mechanised rice farming	ARS, Mannuthy
29	RIC-02-01-26-99/MNY(9)/KAU	Development of a super rice for organic rich kole lands of Kerala	ARS, Mannuthy
30	RIC-03-03-14-83/MNY(9)/KAU	Evolution of short duration rice varieties/cultures for kole lands	ARS, Mannuthy
31	RIC-01-04-10-2001/MNY(9)/KAU	Evolution of rice varieties having high grain and straw yield from interracial crosses of diverse origin	ARS, Mannuthy
32	RIC-16-00-01-99/MNY(1)/KAU	Production technology for rice under mechanised transplanting	ARS, Mannuthy
33	RIC-01-03-07-2003/MNY(9)/KAU	Evolution of short duration rice (<i>Oryza sativa</i> .L) varieties for drought resistance/ tolerance	ARS, Mannuthy
34	RIC-01-04-17-2003/MNY(9)/KAU	Adaptability testing of high yielding rice varieties in Kole lands	ARS, Mannuthy
35	RIC-03-03-13-2003/MNY(1)/KAU	Weed management in the wet sown rice fields of Kole land	ARS, Mannuthy
36	RIC-01-00-11-98/VKA(9)/KAU/PG	Variability analysis of allogamous traits in rice (<i>O. sativa</i> L.)	CoH, Vellanikkara
37	RIC-03-03-02-2000/VKA(1)/KAU/PG	Biology and ecology of <i>Echinochloa</i> sp. in rice ecosystem of Kerala	CoH, Vellanikkara
38	RIC-01-04-08-2001/VKA(9)/DP & KAU	Participatory plant breeding to combine red kernel colour with the high yield potential of ponmani	CoH, Vellanikkara
39	RIC-02-02-13-2001/VKA(1)/KAU/PG	Influence of phosphorus levels on absorption, dynamics and productivity of rice	CoH, Vellanikkara
40	RIC-01-03-02-2002/VKA(9)/KAU/PG	Androgenesis in rice (<i>Oryza sativa</i> . L) breeding	CoH, Vellanikkara
41	RIC-02-03-01-2002/VKA(1)/KAU	Influence of phosphorus on absorption and dynamics of nutrients in rice	CoH, Vellanikkara

42	RIC-02-02-12-2002/ VKA(1)/KAU/PG	Integration of nutritional inputs for improving rice productivity in laterite soils	CoH, Vellanikkara
43	RIC-01-03-03-2003/ VKA (9)/KAU/PG	Breeding for two line hybrids in rice (<i>Oryza sativa</i> L.)	CoH, Vellanikkara
44	RIC-01-04-15-2003/ VKA (9)/KAU/PG	Convergent breeding for new plant type in rice (<i>Oryza sativa</i> L.)	CoH, Vellanikkara
45	RIC-01-04-16-2003/ VKA (9)/KAU/PG	Genotype x Environment interaction of commercial rice (<i>Oryza sativa</i> L.) hybrids	CoH, Vellanikkara
46	RIC-03-01-06-2003/ VKA(4)/KAU/PG	Indigenous natural organic materials for management of major pests of rice	CoH, Vellanikkara
47	RIC-03-01-07-2003/ VKA (4)/KAU/PG	Impact of different insecticides on pest, natural enemy and neutral complex in rice ecosystem	CoH, Vellanikkara
48	RIC-02-01-06-2004/ VKA (1) KAU/PG	Concurrent growing of green manure crops in dry and wet seeded rice	CoH, Vellanikkara
49	RIC-03-01-11-2004/ VKA(4)/KAU/PG	Bioecology, population dynamics and integrated management of rice blue beetle <i>Leptispa pygmaea</i> Baly (Chrysomelidae Coleoptera)	CoH, Vellanikkara
50	RIC-01-00-01- 72/ PTB(9)/KAU	Genetic conservation of rice germplasm	RARS, Pattambi
51	RIC-01-00-08-96/ PTB(9)/KAU	Conservation of genetic diversity of rice in Kerala	RARS, Pattambi
52	RIC-02-01-23-94/ PTB/ MNY/ MON(9)/KAU	Evolution of high yielding rice hybrids suitable for Kerala	RARS, Pattambi
53	RIC-02-03-05- 99/PTB(9)/KAU	Identification of a suitable basmati rice for Palakkad district	RARS, Pattambi
54	RIC-03-01-12- 99/PTB(9)/KAU	Evolving high yielding multiple resistant rice varieties through gene pyramiding	RARS, Pattambi
55	RIC-03-03-09-88/ PTB(9)/KAU	Breeding lodging resistant rice varieties for dry season conditions during virippu season	RARS, Pattambi
56	RIC-05-00-01- 83/PTB(9)/KAU	Evolution of semi tall or dwarf types of tall indica rice varieties	RARS, Pattambi
57	RIC-05-00-07-76/PTB (9)/KAU	Breeding high yielding tall photosensitive varieties with good straw yield, specifically suitable for the mundakan season of Kerala	RARS, Pattambi
58	RIC-01-04-14-2002/ PTB(9)/KAU	Identification of suitable varietal combinations for koottumundakan cultivation in Palakkad	RARS, Pattambi
59	RIC-01-03-01- 2001/PTB(9)/ KAU	Participatory selection for improvement of indigenous rice varieties for deep submerged areas of Kerala	RARS, Pattambi
60	RIC-02-03-03- 2002/PTB(1)/ KAU	Participatory approach for developing suitable agro-techniques for koottumundakan system of rice cultivation	RARS, Pattambi
61	RIC-03-01-04- 2002/PTB(4)/KAU	Integrated pest management of rice stem borer	RARS, Pattambi
62	RIC-03-01-05- 2002/PTB(4)/KAU	Screening biocides against major pests and diseases of rice	RARS, Pattambi
63	RIC-03-02-01- 2002/PTB(5)/KAU	Evaluation of green manures for the control of sheath blight of rice	RARS, Pattambi
64	RIC-03-02-05- 2002/PTB(5)/KAU	Management of blast, brown spot and sheath rot of rice using plant extracts	RARS, Pattambi

65	RIC-05-00-03-2002/PTB(8)/KAU	Economic analysis of kootumundakan system with single crops (virippu and mundakan) of rice cultivation	RARS, Pattambi
66	RIC-02-01-03-2003/PTB (13)/KAU	Effect of biogas plant on rice based integrated farming system	RARS, Pattambi
67	RIC-02-01-04-2003/PTB (5)/KAU	Response of rice to inoculation of Arbuscular Mycorrhizal Fungi	RARS, Pattambi
68	RIC-02-02-16-2003/PTB (6)/KAU	Knowledge and adoption level of rice farmers on organic farming practices	RARS, Pattambi
69	RIC-03-01-09-2003/PTB(4)/KAU	Screening rice varieties for multiple resistance to insect pests of rice	RARS, Pattambi
70	RIC-03-01-10-2003/PTB (4)/KAU	Evaluation of biocontrol agents viz., <i>Trichogramma japonicum</i> and <i>T.chilonis</i> for the management of stem borer and leaf folder	RARS, Pattambi
71	RIC-05-00-05-2003/PTB (6)/KAU	Farmer participatory identification of constraints and prioritization of problems in rice production	RARS Pattambi
72	RIC-09-00-01-2003/PTB (8)/KAU	Market analysis of organic rice in the central zone	RARS, Pattambi
73	RIC-02-01-05-85/PIL (9)/KAU	Multilocational trial of Pattambi and Moncompu cultures of paddy	RARS Pilicode
74	RIC-02-01-06-85/PIL (9)/KAU	Varietal trial in rice	RARS Pilicode
75	RIC-01-03-04-2003/PNR (9)/KAU	Evolution of high yielding rice varieties suitable to Pokkali tracts of northern Kerala through farmers participatory approach	PRS, Panniyoor
76	RIC-01-00-05-74/AMB (9)/KAU	Evaluation and screening of rice varieties suitable for high altitudes – maintenance of germplasm and performance evaluation of promising germplasm	RARS, Ambalawayal
77	RIC-03-03-19-94/AMB (9)/KAU	Evaluation of scented and slender rice varieties suitable for Wayanad	RARS, Ambalawayal
78	RIC-13-00-11-94/AMB(5)/KAU	Management of Udbatta disease of rice	RARS, Ambalawayal
79	RIC-01-04-09-2001/AMB (9)/KAU	Evolution of short duration rice varieties for the high ranges of Kerala by hybridisation and selection	RARS, Ambalawayal
80	RIC-03-03-05-2001/ACV (1)/KAU/PG	Performance of selective herbicides in rice - rice cropping system	CoA, Vellayani
81	RIC-03-03-09-2003/ACV (1)/KAU/PG	Integrated weed management in lowland rice	CoA, Vellayani
82	RIC-03-03-11-2003/ACV (1)/KAU/PG	Floristic diversity, autecology and competitive behaviour of weed flora in wetland ecosystem	CoA, Vellayani
83	RIC-05-00-04-2003/ACV(1)/KAU/PG	Evaluation of establishment methods and AMF application on growth and yield of rice	CoA, Vellayani
84	RIC-02-01-05-2004/ACV(1)/KAU/PG	Response of upland rice (<i>Oryza sativa</i> , L.) to NK ratios and S under partial shade	CoA, Vellayani
85	RIC-02-02-17-2004/ACV(1)/KAU/PG	Impact of long term integrated nutrient supply system on soil health and rice productivity	CoA, Vellayani
86	RIC-03-03-14-2004/ACV (1)/KAU/PG	Bioefficacy and residual effect of the new generation herbicide Pyrazo Sulfuron Ethyl in transplanted rice	CoA, Vellayani

	SUGARCANE		
87	CC-06-00-07/TLA (9)/95-KAU	Evaluation of sugarcane varieties for the different agro-climatic tracts of Kerala and fluff exchange programme of 1995 series	SRS, Thiruvalla
88	CC-06-00-07/TLA (9)/96-KAU	Evaluation of sugarcane varieties for the different agro-climatic tracts of Kerala and fluff exchange programme of 1996 series	SRS, Thiruvalla
89	CC-06-00-07/TLA (9)/97-KAU	Evaluation of sugarcane varieties for the different agro-climatic tracts of Kerala and fluff exchange programme of 1997 series	SRS, Thiruvalla
90	CC-06-00-07/TLA (9)/98-KAU	Evaluation of sugarcane varieties for the different agro-climatic tracts of Kerala and fluff exchange programme of 1998 series	SRS, Thiruvalla
91	CC-06-00-07/TLA (9)/99-KAU	Evaluation of sugarcane varieties for the different agro-climatic tracts of Kerala and fluff exchange programme of 1999 series	SRS, Thiruvalla
92	CC-06-00-07/TLA (9)/2000 KAU	Evaluation of sugarcane varieties for the different agro-climatic tracts of Kerala and fluff exchange programme of 2000 series	SRS, Thiruvalla
93	CC-06-00-07/TLA (9)/2001-KAU	Evaluation of sugarcane varieties for the different agro-climatic tracts of Kerala and fluff exchange programme of 2001 series	SRS, Thiruvalla
94	CC-06-00-07/TLA (9)/2002-KAU	Evaluation of sugarcane varieties for the different agro-climatic tracts of Kerala and fluff exchange programme of 2002 series	SRS, Thiruvalla
95	CC-06-00-16/95-TLA (3)/KAU	Evaluation of varieties/promising cultures for multiple ratooning and jaggery production.	SRS, Thiruvalla
96	CC-06-00-15- 95/TVL(3)/KAU	Characterisation of sugarcane soils in Kerala.	SRS, Thiruvalla
97	CC-06-00-14/90 TLA(3)/KAU	Characterisation of sugarcane soils in Kerala.	SRS, Thiruvalla
98	CC-06-00-19-94/TLA	Agronomic evaluation of promising sugarcane genotypes (midlate)	SRS, Thiruvalla
99	CC-06-00-19-94/TLA	Agronomic evaluation of promising sugarcane genotypes (early)	SRS, Thiruvalla

ii) Externally aided projects

a) Concluded experiments

Sl. No.	Code No.	Title of the experiment	Location
	RICE		
1	RIC-01-04-05-00/KYM (9)/KAU PLAN	Breeding of short duration rice varieties for virippu season and photosensitive, semi tall high yielding varieties for mundakan season in Onattukara	ORARS, Kayamkulam
2	RIC-09-04-04-91/ MON(3)/ICAR	Zinc management in irrigated rice based cropping system (long term study)	RRS, Moncompu
3	RIC-02-02-10-2001/ MON (3)/AICRIP	Evaluation of innovative nitrogen practices for rice	RRS, Moncompu
4	RIC-03-02-09-93/ MON(9)/ICAR	Evaluation of rice germplasm for biotic stresses	RRS, Moncompu

5	RIC-02-01-12-90/ MNY(9)/ICAR	Initial variety trial – IME	ARS, Mannuthy
6	RIC-02-01-13/ MNY(9)/ICAR	Initial yield trial – IM	ARS, Mannuthy
7	RIC-02-01-16-96/ MNY(9)/ICAR	Advanced yield trial – IME	ARS, Mannuthy
8	RIC-02-01-17-90/ MNY(9)/ICAR	Advanced yield trial – IM	ARS, Mannuthy
9	RIC-01-04-02-2000/ PTB (1)/AICRIP	Nutrient response of selected rice hybrids under irrigated transplanted conditions	RARS, Pattambi
10	RIC-02-03-04-2002/ PTB (1)/AICRIP	Evaluating the benefits of conservation tillage as compared to the conventional tillage system for growing rice	RARS, Pattambi
SUGARCANE			
11	CC-06-00-11-TLA-9/ 14- ICAR	Evolving red rot resistant varieties of sugarcane and standardization of agro- techniques for selected varieties Zonal varietal trial for identifying early maturing varieties – 1998-99 series	SRS, Thiruvalla
12	CC-06-00-11-TLA-9/ 15- ICAR	Zonal varietal trial for identifying midlate maturing varieties – 1998-99 series	SRS, Thiruvalla
13	CC-06-00-11-TLA-9/ 16- ICAR	Zonal varietal trial for identifying early maturing varieties – 1999-2000 series	SRS, Thiruvalla
14	CC-06-00-11-TLA-9/ 17- ICAR	Zonal varietal trial for identifying midlate maturing varieties – 1999-2000 series	SRS, Thiruvalla
15	CC-06/19-94/ TLA (1)/ICAR	Agronomic evaluation of promising sugarcane	SRS, Thiruvalla
16	CC-06/-00-19-94 TLA (1)/ICAR	Agronomic evaluation of promising genotypes (midlate group)	SRS, Thiruvalla
17	SSA-10-00-02-2000/ TLA (1)/ ICAR	Comparative performance of different sources of sulphur on yield and quality of sugarcane	SRS, Thiruvalla
18	SSA-10-00-03-2000/ TLA (1)/ ICAR	Agrotechniques for multiple ratooning	SRS, Thiruvalla

b) Experiments in progress

Sl. No.	Code No.	Title of the experiment	Location
RICE			
1	RIC-07-03-01- 92/KAR(1)/ICAR	Multiple use of cowpea & nutrient balance in rice based cropping system	CSRC, Karamana
2	RIC-09-03-02- 89/KAR(5)/ICAR	Effect of different sources of NPK on the incidence of rice diseases	CSRC, Karamana
3	(RIC-03-03-10-2003/ KAR(1)/AICRP	Integrated weed management in rice based cropping systems	CSRC, Karamana
4	RIC-09-02-18- 99/MON(3)/ICAR	Synchronisation of potassium supply for rice hybrids	RRS, Moncompu
5	RIC-03-01-11- 99/MON(9)/ICAR	Genetic analysis of gall midge resistance in rice and evolving resistant varieties for gall midge biotype 5	RRS, Moncompu
6	RIC-02-01-09-90/ MON (9)/ICAR	Initial variety trial	RRS, Moncompu
7	RIC-02-01-10-90/ MON (9)/ICAR	Advanced variety trial	RRS, Moncompu

8	RIC-12-02-06-89/ MON (5)/ ICAR	Evaluation of new fungicidal formulation for the sheath blight control	RRS, Moncompu
9	RIC-13-00-19-99/ MON (5)/ICAR	Evaluation of bio-pesticides against sheath blight disease	RRS, Moncompu
10	RIC-03-02-03-84/ MON (5)/ICAR	Screening for sheath blight and sheath rot resistance (NSN)	RRS, Moncompu
11	RIC-13-00-04-89/MON (5) ICAR	Disease observation nursery	RRS, Moncompu
12	RIC-09-01-08-91/ MON(1)/ICAR	Yield maximization of rice under irrigated conditions	RRS, Moncompu
13	RIC-10-00-03- 84/MON(1)/ICAR	Weed control for transplanted rice	RRS, Moncompu
14	RIC-10-00-02- 84/MON(1)/ICAR	Weed control for direct sown rice under puddle condition	RRS, Moncompu
15	RIC-02-02-02-84/ MON(4)/ICAR)	Multiple resistance screening trial	RRS, Moncompu
16	RIC-03-01-02-84/ MON(4)/ICAR	Gall midge screening Trial	RRS, Moncompu
17	RIC-03-01-09-99/ MON(9)/ICAR	National Screening Nursery (NSN)	RRS, Moncompu
18	RIC-12-03-02-86/ MON(4)/ICAR	Insecticide evaluation trial	RRS, Moncompu
19	RIC-13-00-02-83/ MON(4)/ICAR	Gall midge biotype monitoring trial	RRS, Moncompu
20	RIC-01-04-06-2001/ CSR (VAD)(1)/ICAR	Identification of suitable high yielding varieties for different farming situations	CSR Sub Centre, Vadakkenchery
21	RIC-02-02-04- 2001/CSR (VAD) (1)/IRRI	Compare the relative efficiency of SPAD and LCC threshold value based N management on growth and yield of rice	CSR Sub Centre, Vadakkenchery
22	RIC-02-02-06- 2001/CSR (VAD) (1)/IRRI	Studies on the dynamics of SPAD and LCC values at different phenological stages in rice under variable N levels	CSR Sub Centre, Vadakkenchery
23	RIC-02-02-07- 2001/CSR (VAD) (1)/IRRI	Response of rice to nutrients N, P and K in farmers fields under different agroecological conditions (PDCSR network trial)	CSR Sub Centre, Vadakkenchery
24	RIC-02-02-08- 2001/CSR (VAD) (1)/IRRI	Agronomic management practices for sustainable production in rice-rice system (PDCSR network trial)	CSR Sub Centre, Vadakkenchery
25	RIC-02-02-09-2001/ CSR (VAD)(1)/IRRI	Identification of N-efficient genotypes assessment with chlorophyll meter	CSR Sub Centre, Vadakkenchery
26	RIC-02-02-05-2001/ CSR (VAD) (1)/IRRI	Evaluation of the effect of Controlled Release Urea (CRU) on growth and yield of Rice	CSR Sub Centre, Vadakkenchery
27	RIC-05-00-01- 2001/CSR (VAD) (1)/KAU PLAN	Studies to evolve appropriate and low cost crop establishment method for direct sown system	CSR Sub Centre, Vadakkenchery
28	RIC-06-00-01-2001/ CSR (VAD)(1)/KAU PLAN	Studies on feasibility of replacing transplanting and broadcasting of sprouted seeds by wet- seeder in kharif, rabi and summer seasons	CSR Sub Centre, Vadakkenchery
29	RIC-02-01-19- 91/PTB(9)/ICAR	Initial variety trial	RARS, Pattambi
30	RIC-02-01-20-91/PTB (9)/ICAR	Advanced variety trial	RARS, Pattambi

31	RIC-02-02-06-90/PTB(4)/ICAR	Multiple resistance screening trial	RARS, Pattambi
32	RIC-02-02-07-90/PTB(4)/ICAR	National Screening Nursery (NSN)	RARS, Pattambi
33	RIC-03-01-01-69/PTB(4)/ICAR	Gall midge screening trial	RARS, Pattambi
34	RIC-03-02-01-89/PTB(5)/ICAR	Screening for sheath blight resistance	RARS, Pattambi
35	RIC-03-02-02-89/PTB(5)/ICAR	Screening for leaf blast resistance	RARS, Pattambi
36	RIC-10-00-01-88/PTB(1)/ICAR	Weed control trial for direct sown rice under semi dry condition	RARS, Pattambi
37	RIC-12-02-05-89/PTB(5)/ICAR	New fungicide evaluation trial for blast diseases	RARS, Pattambi
38	RIC-12-02-08-89/PTB(5)/ICAR	Evaluation of new fungicidal formulations for sheath blight control	RARS, Pattambi
39	RIC-12-02-13-95/PTB(5)/ICAR	Economic spray schedule trial for the control of sheath blight and location specific diseases	RARS, Pattambi
40	RIC-12-03-06-90/PTB(4)/KAU	Insecticide evaluation trial	RARS, Pattambi
41	RIC-12-03-10-95/PTB(4)/ICAR	Optimum pest control trial (OPCT)	RARS, Pattambi
42	RIC-01-04-01-2000/PTB (1)/AICRIP	Yield maximization in rice under irrigated and favourable rainfed lowland	RARS, Pattambi
43	RIC-01-02-01-2000/PTB (9)/RF & UGC	Development of blast and bacterial blight resistant rice cv. Jyothi suitable for cultivation in Kerala	RARS, Pattambi
44	RIC-02-02-01-2000/PTB (1)/AICRIP	Appropriate techniques for growing direct seeded rice under puddled conditions	RARS, Pattambi
45	RIC-03-03-01-2000/PTB (1)/AICRIP	Screening of herbicides under puddled irrigated conditions	RARS, Pattambi
46	RIC-01-05-01-2001/PTB (9)/ ICAR	Identification of stable diagnostic characters of seed, seedling and plant and preparation of identification manual with color photographs	RARS, Pattambi
47	RIC-03-01-01-2001/PTB (4)/AICRIP	Nursery and early stage pest control trial in rice	RARS, Pattambi
48	RIC-03-03-08-2002/PTB (1)/AICRIP)	Evaluation of herbicides for transplanted rice.	RARS, Pattambi
49	RIC-03-02-02-2002/PTB (5)/AICRIP	Evaluation of fungicides against brownspot of rice	RARS, Pattambi
50	RIC-03-02-03-2002 PTB (5)/AICRIP	Evaluation of biopesticides against sheath blight disease of rice	RARS, Pattambi
51	RIC-03-02-04-2002/PTB (5)/AICRIP	Disease observation on trap crops	RARS, Pattambi
	SUGARCANE		
52	CC-06-00-11-TLA-9/16-ICAR	Evolving red rot resistant varieties of sugarcane and standardization of agro-techniques for selected varieties	SRS, Thiruvalla
53	CC-06-00-11-9/17/ICAR	Evolving red rot resistant varieties of sugarcane and standardization of agro-techniques for selected varieties	SRS, Thiruvalla
54	CC-06-00-11-TLA-9/20-ICAR	Evolving red rot resistant varieties of sugarcane and standardization of agro-techniques for selected varieties	SRS, Thiruvalla

55	SSA-10-00-01-2000/TLA (1)/ ICAR	Screening of new herbicides for effective weed control in sugarcane	SRS, Thiruvalla
56	SSA-10-00-02-2000/TLA (1)/ ICAR	Comparative performance of different sources of sulphur on yield and quality of sugarcane	SRS, Thiruvalla
57		Agro-techniques for multiple ratooning	SRS, Thiruvalla
58		Identification of patho-types/races in red rot pathogen	SRS, Thiruvalla
59		Evaluation of pre-zonal/IET/zonal varieties/genotypes for resistance to red rot	SRS, Thiruvalla
60		Survey of sugarcane diseases naturally occurring in the area on important sugarcane varieties	SRS, Thiruvalla
61		Assessment-cum-demonstration of IDM module against major diseases of the area	SRS, Thiruvalla
62		Sustaining sugarcane production and soil health through integration and nutrient sources in sugarcane based cropping system	SRS, Thiruvalla

2. COCONUT AND COCONUT BASED CROPPING SYSTEM

Co-ordinator: Dr. P.C. Balakrishnan

HIGHLIGHTS

- A unique germplasm of coconut consisting of 40 indigenous and 35 exotic cultivars is maintained at RARS, Pilicode.
- RARS Nileshwar maintains the first ever planted coconut hybrid in the world planted during the year 1936.
- Among the 51 steady yielding cultivars of coconut, Andaman Giant and Philippines ordinary out yielded the other cultivars.
- Among the 15 new introductions in coconut germplasm planted during 1976, the cultivar Seychelles was found to be promising and recommended for release by XXV zonal workshop.
- Among the 11 parental combinations planted in 1994, the combination, Malayan Yellow Dwarf x Ayiramkachi is found to be more vigorous.
- The hybrid WCT x CGD ranked top in all the four locations in cumulative nut production and was on par with Kerasree.
- The optimum physiological maturity of tender nut having maximum quality, quantity and consumer acceptance was found at 210 DAIE.
- Developed technology to store coconut inflorescence sap for one year under ambient condition.
- Seasonal variation in coconut neera yield was noticed and the highest mean yield was recorded during the month of July followed by June.
- Long term fertilizer experiments conducted at Coconut Research Station, Balaramapuram have shown that in the absence of potash, nitrogen application had antagonistic effect on coconut.
- The present recommendation of 25 ml calixin/25 l water as soil drenching or 25 ml calixin/25 ml water as root feeding can control stem bleeding of coconut.
- A schedule of three sprays of carbaryl 0.1 per cent during May, August and October can be recommended for the effective management of coreid bug on coconut.
- Maximum volume of tender nut water was found at 190 days after inflorescence emergence whereas sugars, reducing sugars, ascorbic acid and potassium were found maximum at 210 DAIE.

SUMMARY

The germplasm collection of coconut planted at RARS, Pilicode consisted of 40 indigenous and 35 exotic cultivars. Morphological and yield characters of all the available germplasm were recorded. Among the old germplasm collection 51 steady yielding cultivars were studied for their copra out turn per palm per year for an average of 32 years. Andaman giant and Philippines ordinary out yielded the other cultivars. The lowest copra yield was recorded by Malayan orange dwarf.

Among the 15 new introductions planted during 1976, the cultivar **Seychelles** was found to be promising followed by Andaman Ordinary and St.Vincent in cumulative nut production and copra yield.

The progeny trial conducted by harvesting the nuts from palms of coconut cultivars viz. Seychelles, St. Vincent and Kudat showed pre-potency and expressed mother palm characters in the seedlings.

The four released hybrids viz. Keraganga, Lakshaganga, Kerasankara and Chandrasankara are performing better than all other treatments in cumulative nut production and were superior to WCT. In general, the cross involving MYD as one of the parents performed better than others

In the four locations where the MLT was conducted, hybrids generally performed better than WCT in nut yield, flower production and number of leaves produced. The hybrid WCT x CGD ranked top and was on par with Kerasree. Kerasree and WCT x CGD took 48 months for first flowering, Kerasankara 52 months and WCT 90 months.

Based on seedling characters, five top ranking palms each in West Coast Tall and Komadan were selected. Pre-potent palms, K8 and W2 were selected as pollinator so as to produce TxT hybrids by the selected pre potent palms as mother palms.

With a view to assess the variability and character association in coconut cultivar CGD in the root wilt affected areas, field survey was conducted in the districts of Kottayam, Alappuzha and Pathanamthitta and located 86 mother palms. Seed nuts collected from these palms were sown and the seedling characters were recorded. Based on the seedling vigor, progenies of 44 mother palms were planted in the field for further studies.

Incidence of mite on coconut seed nuts indicated that there was a negative correlation between levels of damage and percentage of germination.

The mean monthly yield of coconut inflorescence sap varied from 45 liters to 93.1 liters per palm even in the same variety. Seasonal variation in sap flow was significant. The highest yield was recorded during the month of July and the lowest during March.

Based on the results of the experiment, NPK nutrition @ 0.68, 0.23, 0.90 kg/tree/year was recommended for the laterite soils of southern Kerala. Significant increase in yield was obtained in higher levels of K_2O (0.9kg/tree/year) treated plots. In the absence of K_2O , nitrogen application had antagonistic effect on coconut production.

A spacing of 10m x 10m recorded the maximum per palm yield of nut and a spacing of 7.5m x 7.5m was optimum to maximum yield in unit area.

Management trial for the control of stem bleeding disease of coconut conducted so far revealed that 25 ml calyxin in 25 ml of water as root feeding or 25 ml calyxin in 25 l of water as soil drenching in highly effective is controlling the disease.

List of experiments

i) KAU Projects

a) Concluded experiments : Nil

b) Experiments in progress

Sl. No.	Code No.	Title of the experiment	Location
1	COC-01-00-01-76/ PIL(9)/KAU	Utilization of existing germplasm and description of varieties	RARS, Pilicode
2	COC-01-00-01-2004/ VKA(16)/KAU/PG	Morphological and biochemical characterisation of coconut (<i>Cocos nucifera L</i>) germplasm	CoH, Vellanikkara
3	COC-02-00-01-76/ PILL(9)/KAU	Evaluation of Tall X Dwarfs	RARS Kumarakom
4	COC-02-00-01-2000/ PIL(2)/KAU	Screening coconut cultivars for tender nut purpose	RARS Kumarakom
5	COC-02-00-01-2001/ KUM(9)/KAU	Variability and character association in the coconut cultivar Chowghat green dwarf with emphasis on resistance to root (wilt) disease and mite infestation	RARS Kumaraion
6	COC-02-00-02-76/ PIL(9)/KAU	Trial of promising seed materials	RARS Pilicode
7	COC-02-00-05-73/ PIL(9)/KAU	Evaluation of Tall x different Dwarfs and their reciprocals	RARS Pilicode
8	COC-02-00-07-88/ PIL((10)/KAU	Multilocational trial on promising hybrid combinations of coconut	4 different locations
9	COC-02-00-11- 88/PIL(9)/KAU	Hybrid seedling production in coconut	RARS Pilicode
10	COC-02-00-13-93/ ACV(3)/KAU	Prepotency analysis in Komadam and west coast tall mother palms for hybrid production	CoA, Vellayani
11	COC-03-00-01-64/ BAL(1)/KAU	NPK fertilizer trial starting from young seedlings	CRS Balaramapuram
12	COC-03-00-02-64 BAL(1)/KAU	Spacing cum manurial trial	CRS Balaramapuram
13	COC-03-00-05- 76/PIL(3)/KAU	Response of D x T hybrid to common salt application	RARS Pilicode
14	COC-03-00-08-89/ KUM(1)/KAU	developing suitable agrotechniques for efficient nutrient management of coconut garden in the reclaimed soil of Kuttanad.	RARS Kumarakom
15	COC-04-00-95- BAL/KAU	Permanent manurial trial	CRS Balaramapuram
16	COC-05-00-11-98 BAL(1)/KAU	Fertilizer management for clove mixed cropped in the coconut gardens of South Kerala	CRS Balaramapuram
17	COC-06-00-02- 89/PIL(5)/KAU	Investigation on stem bleeding disease	RARS Pilicode
18	COC-06-01-06-2003/ ACV(4)/KAU/PG	Population dynamics, intensity of damage and management of coreid bug <i>paradasymus rostratus</i> , dist.	CoA, Vellayani

ii) Externally aided projects : Nil

3. VEGETABLES

Co-ordinator: Dr. L. Rajamony

HIGHLIGHTS

- Selection of suitable pumpkin varieties resulted in the identification and release of "Saras" with attractive orange coloured fruit with thick flesh.
- Two heat tolerant bacterial wilt resistant tomato lines (LE 45 and LE 38) were identified with significantly superior yield over the standard check variety Mukthi in the southern region of Kerala (both in the experimental field and in the farm trials).
- Five superior landraces of ivy gourd have been located from Alappuzha, Kanhangad, Thirunelli, Manjeshwaram and Nangikadappuram through genetic analysis.
- Sustainable nutritional practices for bitter gourd-amaranthus intercropping system revealed a markedly high per plant and total yield of fruit due to combined application of poultry manure and chemical fertilizers. Vermicompost application registered maximum keeping quality of fruits, ascorbic acid, iron content, and B:C ratio and net profit were higher when chemical fertilizer was substituted with poultry manure in 1:1 ratio.
- Performance of bacterial wilt tolerant tomato (*Lycopersicon esculentum* Mill.) genotype (LE45 & LE34) under shade revealed that tomato is tolerant to mild shade of 25 per cent. Superior yield, improved quality in terms of appearance, vitamin A and C content, lowest incidence of spotted wilt virus, fruit borer and serpentine leaf miner were some of the desirable attributes obtained under 25% shade.
- Culinary melon (*Cucumis melo* L.) types viz., CM 5 (Kattakada, Thiruvananthapuram) CM48 (Peria, Wayanadu) and CM6 (Aryanadu, Thiruvananthapuram) were identified as elite types with superior yield, yield attributes and tolerance to mosaic disease.
- Under rain shelter, capsicum produced three to five fold increases in yield with assured quality and reduced incidence of bacterial wilt and stem rot diseases. However, the attack of mites and fruit borer and the diseases, blight and anthracnose, were found more.
- Gherkin (*Cucumis sativus* L.) produced maximum marketable fruits and marketable yield under pandal system of planting with a population of 5333 plants/ha.
- Identification of vegetable chilli (*Capsicum* sp.) genotypes suitable for the homesteads of the southern region revealed CA 38 as significantly superior to the existing standard check, Jwala sakhi in yield, both under open and shade areas of the homesteads.
- Breeding for mosaic resistance in bitter gourd, identified genotypes viz., VKB 135, VKB126 and VKB 140 with field level of resistance.
- Standardization of population density and nutrients in bitter gourd variety Priyanka revealed highest economic yield in spacing of 2m x 2m with a fertilizer level of 75:25:25 kg NPK/ha and in snake gourd variety Kaumudi, the treatment of 2m x 2m spacing with a fertilizer of 105:37.5:37.5 kg/ha was the superior one.
- Maturity periods of 24, 33 and 16 days after anthesis were found optimum to harvest the fruits for seed purpose in bitter gourd (Preethi), melon (Mudicode) and in yard long bean (Lola) respectively.

SUMMARY

Genetic cataloguing of hot chilli (*Capsicum chinense* Jacq.) revealed high heritability coupled with high genetic advance for fruit per plant, yield per plant, fruit weight, fruit girth and fruit length. Thirty two landraces were grouped into six clusters with maximum inter cluster distance between clusters I and VI. Three high yielding landraces viz., CC 23 (Nemom, Thiruvananthapuram), and CC 13 and CC 7 (both from Vithura, Thiruvananthapuram) were located through discriminant function analysis.

Quality characterization of hot chilli (*Capsicum annum*) geneotypes over season revealed their late nature of flowering and harvesting in summer with good quality fruits. Capsicin, oleoresin and carotenoid increased with age of fruit and reached maximum at withering stage whereas ascorbic acid was increased up to red ripe stage and then declined.

High yielding wax type chilli (*Capsicum annum*) varieties viz., Payyannur local and Hungarian wax were identified. Honnavar local, Payyannur local, Periya local, Para local and Hungarian wax also proved promising in the future crop improvement programme.

Variability study for yield, quality and resistance to leaf blight in 32 vegetable amaranth (*Amaranthus dubius*) genotypes located a high yielding, nutritionally superior accession (AD 23) of India with immunity to leaf blight (*Rhizoctonia solani*) and low oxalate content (0.62%). Another line (AD 28) from Maldives was found with multiple resistancen to leaf blight, white rust and leaf webber.

Induction of leaf spot resistance and improvement in quality of amaranth revealed that gamma rays was capable of causing variability in seed germination, survival, growth, flowering, yield contributory factors, leaf spot infection and chlorophyll variations. Stimulatory effects were noticed at lower dose of gamma rays. High yielding and branching mutants were obtained in *A.tricolor* while dwarf and early flowering mutants occurred in *A.hypochondriacus*.

Floral biology, anthesis and fruit development study in drumstick revealed that flowering was throughout the year except November and December. Two peaks were observed in July and March for flowering as well as fruiting. Flower buds took 29.8 days or 472.5degree days for its complete development during rainy season and 24.8 days and 471.18 degree days during summer season. Anthesis continued throughtout the day with two peaks at 14 h and 04 h. Anthers were of closed type at the time of anthesis and dehisced later. Stigma was receptive a day prior to opening and continued up to the day of opening with maxium receptivity. The pollen grains were spherical with smooth exine and had three germ pores. The crop was cross-pollinated and honeybees were the chief pollinators with a maximum pollination activity between 10 and 14 h. Natural pollination was maximum in March and minimum in September. Flower shedding percentage was 92.73 and 88.60 in rainy and summer seasons respectively. The fruit maturity percent was 2.7 and 3.7 during these periods. In rainy season, fruits took 42 days or 635-degree days for horticultural maturity whereas 70 days or 1112.15degree days were required for physiological maturity. In summer season, these were to the tune of 34 days (634.65 degree days) and 59 days (1111.68 degree days) respectively.

An attempt to incorporate mosaic resistance to bacterial wilt resistant genotypes of chilli resulted in identifying five *Capsicum* accessions viz. CA 337, CA 731, CA 738, CA 739 and CS 744 free of virus as well as bacterial wilt incidence.

Advanced varietal trial (AVT) of tomato lines for bacterial wilt resistance and yield revealed lowest wilt incidence coupled with highest yield in LE 415.

Brinjal accession SM 141 had the lowest wilt incidence whereas BB 64 produced maximum fruit yield in the AVT for brinjal lines with resistance to wilt.

A snake gourd line (TA 32) outyielded the check variety Kaumudhi in the summer rice fallow of the central region whereas the line TA 23 was found to be the earliest one among 19 genotypes attempted.

Varietal trial of cucumber proved the superiority of PCUC 15 (333 q/h), an entry from the GB Pant University of agriculture and technology, Pantnagar.

Small fruited culinary melon line, CS 113 and ash gourd line, BH 118 were identified and proposed for further PYT and CYT in the central region.

Triploid species of ivy gourd was found to be high yielding with less polyphenol content in comparison to diploid and tetraploid species.

High yielding and late bolting amaranth lines (A 239 and A 197) and pole type dolichos bean genotypes (DL 6-1 and DL 40) have been identified in the central region and proposed for further farm trial.

Varietal trial in bhindi indicated the field tolerance to yellow vein mosaic virus resistance in lines viz. AE 285-1, AE 285-5, AE 286-1 and AE 286-4. Advance varietal trial showed the superior performance of US 7109 (180 q/h), NOL 101 (136q/h) and JNDO (120 q/h) in terms of YVMV resistance.

Varietal trial in cowpea showed the consistently superior performance of VS 15, an entry from KAU, in comparison with collections of IIVR, Varanasi, IIHR, Bangalore and IARI, New Delhi. Another varietal trial revealed the high yielding character coupled with the field tolerance to anthracnose disease in yard long bean lines viz., VS 492 and VS 498.

Winged bean line PT 31 produced significantly more yield than the POP variety, Revathy in terms of number of fruits and weight of fruits per plant.

Drumstick clones viz., MO 144, MO 55, MO 95 and MO 110 and AD 4, a seed drumstick, were found promising with respect to yield and fruit characters and are being evaluated in MLTs at AMPRS Odakali, ARS, Chalakudy and RARS Pattambi.

Efficiency evaluation of plant growth substances in productivity of chilli revealed that CCC 100 ppm was the best for yield per plot followed by GA 25 ppm and CCC 300 ppm.

Standardisation of systems of planting and pruning technique in melon showed that pit system with the removal of the primary branch tip after 8th node or 10th node was the superior.

List of experiments

i) KAU Projects

a) Concluded experiments

	Code No.	Title of the experiment	Location
1.	VEG-01-01-07-2002/ ACV(14)/KAU/PG	Quality characterization of hot chilli (<i>Capsicum chinense</i> Jacq.) genotypes in rainy and summer seasons	CoA, Vellayani
2.	VEG-01-02-01-2002/ ACV(9)/KAU/PG	Genetic variability and characterization in wax type chilli (<i>Capsicum annum</i> L.)	CoA, Vellayani
3.	VEG-01-03-04- 79/VKA(14)/KAU	Survey, collection and maintenance of brinjal, cucurbits and their wild species – brinjal	CoH, Vellanikkara
4.	VEG-01-04-02-2000/ ACV(14)/KAU/PG	Performance of bacterial wilt tolerant tomato (<i>Lycopersicon esculentum</i> Mill.) genotypes under shade	CoA, Vellayani
5.	VEG-02-01-01-2000/ ACV(9)/KAU/PG	Evaluation of genetic divergence in ashgourd (<i>Bemincase hispida</i> cogn.)	CoA, Vellayani
6.	VEG-02-01-02-99/ ACV(14)/KAU/PG	Collection and characterisation of landraces of culinary melon (<i>Cucumis melo</i> L.) in Kerala	CoA, Vellayani
7.	VEG-02-09-01-99/ ACV(9)/KAU/PG	Genetic analysis in ivy gourd (<i>Coccini grandis</i> Voigt).	CoA, Vellayani
8.	VEG-03-01-02-2001/ ACV(14)/KAU/PG	Variability in vegetable amaranth (<i>Amaranthus dubius</i> Mart. exx Thell.) for yield, quality and resistance to leaf blight	CoA, Vellayani
9.	VEG-03-04-01- 2001/VKA(14)/ KAU/PG	Induction of leaf spot resistance and improvement in quality of amaranth through mutation	CoH, Vellanikkara
10.	VEG-05-00-02- 2001/ACV(14)/ KAU/PG	Floral biology, anthesis and fruit development in drumstick (<i>Moringa oleifera</i> Lam.)	CoA, Vellayani
11.	VEG-06-02-04-2001/ ACV(1)/KAU/PG	Sustainable nutritional practices for bitter gourd-amaranthus intercropping system	CoA, Vellayani
12.	VEG-08-01-02-2001/ VKA(14)/KAU/PG	Performance of capsicum under rain shelter	CoH, Vellanikkara

b) Experiments in progress

	Code No.	Title of the experiment	Location
1.	VEG-01-01-01- 2000/ACV(14)/ KAU	Identification of vegetable chilli (<i>Capsicum</i> spp.) genotypes suitable for the homesteads of southern region.	CoA, Vellayani
2.	VEG-01-01-02-2000/ ACV(14)/KAU/PG	Genetic cataloguing of hot chilli (<i>Capsicum chinense</i> Jacq.)	CoA, Vellayani
3.	VEG-01-01-03- 2000/ACV(9)/ KAU/PG	Gene action and heterosis for yield quality and fruit borer resistance in tomato (<i>Lycopersicon esculentum</i> Mill)	CoA, Vellayani

4.	VEG-01-01-04-2000/ACV(9)/KAU/PG	Evaluation of brinjal (<i>Solanum melongena</i> L.) genotypes for yield and resistance to shoot and fruit borer (<i>Leucinodes orbonalis</i> G.)	CoA, Vellayani
5.	VEG-01/01/05 2001/ACV(9)/KAU/PG	Genetic analysis of yield and shoot and fruit borer (<i>Leucinodes orbonalis</i> Guen.) resistance in brinjal (<i>Solanum melongena</i> L.)	CoA, Vellayani
6.	VEG-01/01/06 2001/ACV(9)/KAU/PG	Genetic analysis of yield and leaf curl virus resistance in chilli (<i>Capsicum annuum</i> L.)	CoA, Vellayani
7.	VEG-01-01-07-93/VKA(14)/KAU	Incorporation of mosaic resistance to bacterial wilt resistant genotypes of chilli (<i>Capsicum annuum</i> L.)	CoA, Vellayani
8.	VEG-01-01-08-2002/ACV(9)/KAU/PG	Genetic analysis of yield and resistance to anthracnose in chilli (<i>Capsicum annuum</i> L.)	CoA, Vellayani
9.	VEG-01-01-09-2004/ACV(14)/KAU	Improvement and standardization of management practices of paprika (<i>Capsicum annuum</i> L.) for southern region	CoA, Vellayani
10.	VEG-01-01-10-2004/ACV(9)/KAU	Development of high yielding multiple resistant variety of tomato suited to southern region of Kerala	CoA, Vellayani
11.	VEG-01-01-11-2004/ACV(14)/KAU	Development of high yielding variety of ivy gourd (<i>Coccinia grandis</i>)	CoA, Vellayani
12.	VEG-01-02-02-2002/ACV(9)/KAU/PG	Genetic improvement and molecular characterization of paprika (<i>Capsicum annuum</i> L.) genotypes	CoA, Vellayani
13.	VEG-01-02-03-2004/ACV(14)/KAU	Evaluation of chilli genotypes for higher oleoresin and capsaicin contents	CoA, Vellayani
14.	VEG-01-02-18-99/AMB(14)/KAU	Development of indeterminate tomato hybrids resisting bacterial wilt and early blight	RARS, Ambalavayal
15.	VEG-01-02-19-99/ACV(14)/KAU	Evolving heat tolerant and bacterial wilt resistant tomato	CoA, Vellayani
16.	VEG-01-03-01-2004/VKA(14)/KAU/PG	Screening brinjal for jassid, <i>Amarasca biguttula biguttula</i> (Ishida) tolerance	CoH, Vellanikkara
17.	VEG-01-04-01-2000/ACV(9)/KAU	Development of high yielding bacterial wilt resistant hybrids and hybrid derivatives of tomato	CoA, Vellayani
18.	VEG-01-04-02-2002/VKA(14)/KAU/PG	Incorporation of resistance to bacterial wilt in indeterminate tomatoes.	CoA, Vellayani
19.	VEG-01-04-03-2000/ACV(9)/KAU/PG	Genetic variability in chilli (<i>Capsicum annuum</i> L.) with emphasis to reaction to leaf curl virus	CoA, Vellayani
20.	VEG-01-04-05-03/VKA(14)/KAU	Evaluation of F1 hybrids in vegetables	CoH, Vellanikkara
21.	VEG-01-04-06-2004/ACV(9)/KAU/PG	Screening for leaf curl virus disease resistance, genetic evaluation and molecular characterization of bird chilli (<i>Capsicum frutescens</i> L.)	CoA, Vellayani
22.	VEG-02-01-02-2002/VKA(9)/KAU/PG	Genetic analysis of F2 and F3 generations for yield attributes and resistance to distortion mosaic virus disease in bitter gourd (<i>Momordica charantia</i> L.)	CoH, Vellanikkara

23	VEG-02-01-03-04/ MNY(14)/KAU	Developing F1 hybrids in cucurbits	ARS, Mannuthy
24	VEG-02-02-01- 2000/VKA(14)/ KAU/PG	Factor analysis of bitterness in <i>Cucumis melo</i> var. <i>conomon</i> Mak.	CoH, Vellanikkara
25	VEG-02-03-07- 99/ACV(14)/KAU	Development of slicing cucumber (<i>Cucumis sativus</i> L.) varieties for southern Kerala	CoA, Vellayani
26	VEG-02-04-01- 2000/ACV(9)/ KAU/PG	Breeding for resistance to distortion mosaic virus in bitter gourd (<i>Momordica charantia</i> L.)	CoA, Vellayani
27	VEG-02-04-05- 93/ACV(9)/KAU)	Development of hybrid varieties of pumpkin	CoA, Vellayani
28	VEG-02-05-04- 93/ACV(9)/KAU	Development of hybrid varieties of bitter gourd	CoA, Vellayani
29	VEG-02-05-05- 94/MNY(9)/KAU	Evaluation of varieties of bitter gourd (<i>Momordica charantia</i>) for summer rice fallows	ARS, Mannuthy
30	VEG-02-06-02- 90/PTB(14)/NARP	Breeding for mosaic resistant cultures of ash gourd	RARS, Pattambi
31	VEG-02-08-02- 94/MNY(9)/KAU	Evaluation of varieties of snake gourd (<i>Trichosanthes anguina</i>) for summer rice fallows	ARS, Mannuthy
32	VEG-03-01-01- 2000/ACV(14)/ KAU	Identification of vegetable amaranthus (<i>Amaranth</i> spp.) with high yield and leaf blight resistance	CoA, Vellayani
33	VEG-04-01-01- 2000/ACV(9)/ KAU/PG	Variability and path analysis in bush type vegetable cowpea (<i>Vigna unguiculata</i> L.) Walp.)	CoA, Vellayani
34	VEG-04-01-02- 2002/ACV(9)/ KAU/PG	Genetic analysis of yield and mosaic resistance in yard long bean (<i>Vigna unguiculata</i> ssp. <i>sesquipedalis</i> L. Verdcourt	CoA, Vellayani
35	VEG-04-01-03- 2004/ACV(9)/ KAU/PG	Genetic variability for yield and fusarium wilt resistance in yard long bean (<i>Vigna unguiculata</i> var. <i>sesquipedalis</i> L. Verdcourt	CoA, Vellayani
36	VEG-04-01-04-2004/ ACV(9)/KAU/PG	Genetic divergence in cluster bean (<i>Cyamopsis tetragonoloba</i> (L.) Taub.)	CoA, Vellayani
37	VEG-04-01-05-2004/ VKA(14)/KAU/PG	G x E interaction of semi-errect cowpea genotypes	CoH, Vellanikkara
38	VEG-04-01-09/93/ ACV(9)/KAU	Development of hybrid varieties of bhindi	CoA, Vellayani
39	VEG-04-01-14- 95/ACV(9)/KAU	Development of a high yielding bhindi variety resistant to yellow vein mosaic disease through induced recombination	CoA, Vellayani
40	VEG-04-02-01- 2003/VKA(9)/ KAU/PG	Genetics of trailing habit in yardlong bean (<i>Vigna unguiculata</i> var. <i>sesquipedalis</i> L. Verdcourt	CoH, Vellanikkara
41	VEG-04-02-03- 87/VKA(14)/KAU	Varietal trial in vegetable cowpea	CoH, Vellanikkara
42	VEG-04-02-08- 98/ACV(9)/KAU	Selection and intravarietal crossing in bhindi variety 'Kiran' for yellow vein mosaic resistance	CoA, Vellayani

43	VEG-04-03-01-2002/ VKA(9)/KAU/PG	Breeding for resistance to shoot and fruit borer (<i>Earias vittella</i> F.) in okra (<i>Abelmoschus esculentus</i> L. Moench.)	CoH, Vellanikkara
44	VEG-04-03-02- 88/VKA(14)/KAU	Survey, collection, maintenance of germplasm of dolichos bean	CoH, Vellanikkara
45	VEG-04-03-02- 2002/ACV(9)/ KAU/PG	Inheritance of resistance to leaf hopper, <i>Amrasca biguttula biguttula</i> (Ishida) in okra, <i>Abelmoschus esculentus</i> L. Moench.	CoA, Vellayani
46	VEG-04-04-01- 2000/KUM(9)/ KAU	Breeding for mosaic resistance in vegetable cowpea (<i>Vigna unguiculata</i> var. <i>sesquipedalis</i>)	RARS, Kumarakom
47	VEG-04-04-02- 2000 VKA(14)/ KAU/PG	Development of yellow vein mosaic virus (YVMV) resistant hybrids in okra <i>Abelmoschus esculentus</i> (L.) Moench	CoH, Vellanikkara
48	VEG-04-04-03- 2001/ACV(9)/ KAU/PG	Genetic analysis for yield and resistance to yellow vein mosaic in okra (<i>Abelmoschus esculentus</i> L.) Moench)	CoA, Vellayani
49	VEG-04-04-04- 2003/VKA(14)/ KAU/PG	Introgression of yellow vein mosaic virus resistance from <i>Abelmoschus caillei</i> (A Cher.) Steveis into <i>A. esculentus</i> (L) Moench.	CoH, Vellanikkara
50	VEG-05-00-01- 85/VKA(14)/KAU	Germplasm maintenance and evaluation of promising genotypes of drumstick	CoH, Vellanikkara
51	VEG-05-00-01- 2000/ACV(14)/ KAU	Collection and characterization of drumstick (<i>Moringa oleifera</i>) clones of the southern region of Kerala	CoA, Vellayani
52	VEG-05-00-03-2003/ VKA(14)/KAU	Collection, evaluation and multiplication of underexploited vegetables	CoH, Vellanikkara
53	VEG-05-00-04-2004/ ACV(14)/KAU	Improvement and management of drumstick for year round fruiting	CoA, Vellayani
54	VEG-05-01-02- 93/VKA(14)/KAU	Improvement of asexually propagated underexploited vegetable crops through polyploidy.	CoH, Vellanikkara
55	VEG-06-01-01- 2000/VKA(1)/ KAU/PG)	Response of tomato (<i>Lycopersicon esculentum</i> L.) to varying levels of fertigation	CoH, Vellanikkara
56	VEG-06-01-03- 2002/ACV(1)/ KAU/PG	Performance of chilli (<i>Capsicum annum</i> L.) as influenced by NK ratio, biofertilizer and shade	CoA, Vellayani
57	VEG-06-01-04-2002/ ACV(14)/KAU/PG	Cultural management of bacterial wilt in tomato	CoA, Vellayani
58	VEG-06-01-05- 2002/VKA(14)/ KAU/PG	Efficacy of bioregulents on growth and productivity in tomato (<i>Lycopersicon esculentum</i> Mill.)	CoH, Vellanikkara
59	VEG-06-01-10-99/ ACV(1)/KAU/PG	Integrated nutrient management in chilli (<i>Capsicum annum</i> L.)	CoA, Vellayani
60	VEG-06-02-01- 2000/TLA(14)/ KAU	Standardisation of population density and nutrients for bittergourd (<i>Momordica charantia</i>) var. Priyanka	SRS, Thiruvalla
61	VEG-06-02-02- 2000/TLA(14)/ KAU	Standardisation of population density and nutrients for snake gourd (<i>Trichosanthes anguina</i>) var. Kaumudi	SRS, Thiruvalla

62	VEG-06-02-03-2000/ VKA(14)/KAU	Standardisation of pruning techniques in oriental pickling melon (<i>Cucumis melo</i> var. <i>conomon</i>) in different systems of planting	CoH, Vellanikkara
63	VEG-06-02-04- 92/KYM(1)/KAU	Manipulation of frequency and quality of irrigation using triazoles in cucumber (<i>Cucumis melo</i>)	ORARS, Kayamkulam
64	VEG-06-02-05- 2002/VKA(14)/ KAU/PG	Crop geometry studies under different methods of irrigation in oriental pickling melon var. Saubhagya	CoH, Vellanikkara
65	VEG-06-02-06- 2004/VKA(1)/ KAU/PG	Microirrigation and polythene mulching in oriental pickling melon (<i>Cucumis melo</i> var. <i>common</i> (L.) Makino)	CoH, Vellanikkara
66	VEG-06-02-08- 93/VKA(14)/KAU	Studies on physiological maturity of seeds in vegetable crops	CoH, Vellanikkara
67	VEG-06-02-09- 93/VKA(14)/KAU	Standardisation of seed extraction and processing to improve storability and quality of seeds	CoH, Vellanikkara
68	VEG-06-02-13- 95/VKA(14)/ KAU/PG	Irrigation management related to subsurface moisture conservation techniques in oriental pickling melon (<i>Cucumis melo</i> var. <i>conomon</i>)	CoH, Vellanikkara
69	VEG-06-02-18- 98/ACV(1)/ KAU/PG	Irrigation scheduling and moisture conservation in watermelon (<i>Citrullus lanatus</i> (Thunb.) Mansf.)	CoA, Vellayani
70	VEG-06-04-01- 2000/VKA(14)/ KAU/PG	Effect of plant growth regulators on growth and productivity in yardlong bean (<i>Vigna unguiculata</i> var. <i>sesquipedalis</i> (L.) Verdcourt.	CoH, Vellanikkara
71	VEG-06-04-02- 2000/VKA(14)/ KAU/PG	Productivity of okra (<i>Abelmoschus esculentus</i> (L.) Moench) as influenced by crop combinations	CoH, Vellanikkara
72	VEG-06-04-03- 2003/VKA(14)/ KAU/PG	Productivity management in yard long bean (<i>Vigna unguiculata</i> var. <i>sesquipedalis</i> (L.) Verdcourt. through crop geometry and nutrition	CoH, Vellanikkara
73	VEG-07-00-01-2004/ ACV(14)/KAU	Grafting in vegetables for biotic stress tolerance	CoA, Vellayani
74	VEG-08-01-01-2000/ VKA(14)/KAU/PG	Productivity of tomato in relation to season and growing conditions	CoH, Vellanikkara
75	VEG-08-01-03-04/ MNY(14)/KAU	Evaluation of vegetables for suitability to protected cultivation	ARS, Mannuthy
76	VEG-08-01-05-2003/ VKA(14)/KAU	Screening of indeterminate tomatoes and cucumbers for rain shelter cultivation	CoH, Vellanikkara
77	VEG-08-01-06- 99/KTR(1)/KAU	Nutrient management in bhindi	FSRS, Kottarakkara
78	VEG-08-01-07-2003/ PTB(14)/KAU	Productivity assessment of solanaceous crops under rain shelter and open conditions	RARS, Pattambi
79	VEG-08-01-08-2003/ PTB(14)/KAU	Productivity assessment of leafy vegetables under rain shelter	RARS, Pattambi
80	VEG-08-01-09-2003/ PTB(14)/KAU	Productivity assessment of cucurbitaceous crops under rain shelter	RARS, Pattambi

81	VEG-09-01-01-95/KYM(4)/KAU	Assessment of the spread, intensity and control of American serpentine leaf minor, <i>Liriomyza trifolii</i> Diptera; (Agromysidae) in vegetable crops	ORARS, Kayamkulam
82	VEG-09-01-01-2001/VKA(4)/KAU/PG	Bionomics and host range of American serpentine leaf minor, <i>Liriomyza trifolii</i> (Bergess) Diptera (Agromyzidae)	CoH, Vellanikkara
83	VEG-09-01-02-2003/VKA(4)/KAU/PG	IPM strategy in bitter gourd using new generation insecticides	CoH, Vellanikkara
84	VEG-09-01-03-2003/ACV(4)/KAU/PG	Bioecology and management of spiraling whitefly, <i>Aleurodicus disperses</i> Russel (Homoptera Aleyrodidae)	CoA, Vellayani
85	VEG-09-01-04-2004/ACV(4)/KAU/PG	Seasonal occurrence and ecofriendly management of pests of amaranthus (<i>Amaranthus tricolor</i> L.)	CoA, Vellayani
86	VEG-09-01-05-2004/ACV(4)/KAU/PG	Evaluation of bait application techniques for the management of fruit flies infesting cucurbits	CoA, Vellayani
87	VEG-09-01-06-2004/ACV(4)/KAU/PG	Major spiders in vegetable ecosystem and their predatory potential	CoA, Vellayani
88	VEG-09-02-01-2001/BAL(5)/KAU	Screening cowpea (<i>Vigna unguiculata</i> ssp. <i>sesquipedalis</i> L.) against fusarial wilt.	CRS, Balaramapuram
89	VEG-09-02-02-2002/VKA(5)/KAU/PG	Leaf spot diseases of bitter gourd and their management	CoH, Vellanikkara
90	VEG-09-02-03-2002/VKA(5)/KAU/PG	Etiology of leaf spot diseases of ivy gourd (<i>Coccinia grandis</i> L. Voigt.) and their management	CoH, Vellanikkara
91	VEG-09-02-04-2002/ACV(5)/KAU/PG	Ecofriendly management of <i>Rhizoctonia</i> leaf blight of amaranthus	CoA, Vellayani
92	VEG-09-02-05-2004/ACV(5)/KAU/PG	Ecofriendly management of collar rot and web blight of cowpea	CoA, Vellayani
93	VEG-09-02-06-2004/ACV(5)/KAU/PG	Variability of <i>Alternaria</i> isolates causing leaf blight diseases of cucurbits	CoA, Vellayani
94	VEG-09-02-07-2004/ACV(5)/KAU/PG	Management of foliar blight of amaranthus using rhizobacteria and chemical activator, acibenzolar-S-methyl.	CoA, Vellayani
95	VEG-10-01-01-2003/VKA(14)/KAU/PG	Seed invigoration studies in ash gourd (<i>Benincasa hispida</i> Thunb.)	CoH, Vellanikkara
96	VEG-10-02-01-91/PTB(1)/NARP	Studies on quality, storage life and seed viability of cucumber as influenced by organic and inorganic forms of fertilizers	RARS, Pattambi
97	VEG-10-02-02-2003/PTB(14)/KAU	Standardisation of packaging and storage conditions for vegetable crop seeds	RARS, Pattambi
98	VEG-13-02-01-2000/ACV(14)/KAU/PG	Morphological, biochemical and molecular characterization in landraces of melon (<i>Cucumis melo</i> L.)	CoA, Vellayani
99	VEG-13-02-02-2003/ACV(14)/KAU/PG	Molecular characterization of ivy gourd (<i>Coccinia grandis</i> (L.) Voigt)	CoA, Vellayani
100	VEG-13-02-03-2003/ACV(14)/KAU/PG	Characterization of landraces of ash gourd (<i>Benincasa hispida</i> (Thunb) Cogn.)	CoA, Vellayani
101	VEG-13-03-01-2004/ACV(14)/KAU/PG	Characterization and evaluation of landraces of amaranthus (<i>Amaranthus</i> spp.)	CoA, Vellayani

102	VEG-13-04-01-2003/ ACV(14)/KAU/PG	Characterization of vegetable cowpea (<i>Vigna unguiculata</i> (L.) Walp.)	CoA, Vellayani
103	VEG-13-05-01-2003/ ACV(14)/KAU/PG	Characterization of landraces of drumstick (<i>Moringa oliefera</i> Lam.)	CoA, Vellayani

ii) Externally aided projects

- a) Concluded experiments : Nil
b) Experiments in progress

Sl. No.	Code No.	Title of the experiment	Location
1	VEG-01-01-10-95/ VKA(14)/KHDP	Identification of chilli varieties for increasing land use efficiency in rain shadow regions of Palakkad district	CoH, Vellanikkara
2	VEG-01-01-16-98/ VKA(14)/ICAR	Heterosis breeding in chilli and brinjal associated with resistance to bacterial wilt	CoH, Vellanikkara
3	VEG-01-02-02-85/ VKA(14)/ICAR	Screening tomato lines resistant to bacterial wilt	CoH, Vellanikkara
4	VEG-01-03-01-89/ VKA(14)/ICAR	Screening brinjal varieties resistant to bacterial wilt	CoH, Vellanikkara
5	VEG-02-02-03-85/ VKA(14)/ICAR	Varietal trial in watermelon	CoH, Vellanikkara
6	VEG-02-02-04-85/ VKA(14)/ICAR	FI hybrid trial in watermelon	CoH, Vellanikkara
7	VEG-02-03-01-87/ VKA(14)/ICAR	Varietal trial in cucumber	CoH, Vellanikkara
8	VEG-02-04-02-89/ VKA(14)/ICAR	Varietal trial in pumpkin	CoH, Vellanikkara
9	VEG-02-05-01-88/ VKA(14)/ICAR	Varietal trial on bittergourd	CoH, Vellanikkara
10	VEG-02-05-07-95/ VZM(14)/KHDP	Breeding for mosaic resistance in bittergourd (<i>Momordica charantia</i> L.)	PRS, Vazhakulam
11	VEG-04-01-03-85/ VKA(14)/ICAR	Screening bhindi varieties resistant to yellow vein mosaic virus	CoH, Vellanikkara
12	VEG-04-02-02-88/ VKA(14)/ICAR	Varietal trial in cowpea	CoH, Vellanikkara
13	VEG-06-01-02-88/ VKA(14)/ICAR	Foliar fertilization in tomato	CoH, Vellanikkara
14	VEG-06-02-15-95/ VKA(14)/KHDP	Effect of micronutrients on growth, yield and qualities in bittergourd (<i>Momordica charantia</i> L.)	CoH, Vellanikkara
15	VEG-07-00-01-89/ ACV(4)/ICAR	Screening for resistance to root knot nematodes in vegetables	CoA, Vellayani
16	VEG-07-00-02-89/ ACV(4)/ICAR	Assessment of yield loss due to root-knot nematode in brinjal	CoA, Vellayani
17	VEG-07-00-03-91/ ACV(4)/ICAR	Evaluation of bare root dip for the control of root knot nematode in brinjal	CoA, Vellayani
18	VEG-07-00-10-87/ VKA(14)/ICAR	Epidemiological studies of tomato diseases	CoH, Vellanikkara

4. TUBERS

Co-ordinator : Dr.R.Pushpakumari

HIGHLIGHTS

- White yam (*Dioscorea rotundata*) var. Sree Priya was found to be a profitable intercrop in coconut garden. The optimum size of planting material was 200 g. with a spacing of 90x90 cm. and NPK recommendation of 80:60:80kg/ha. FYM (10t/ha) could be substituted with either coir pith compost @ 5 t/ha or by the in situ incorporation of green manure (sunhemp)
- Coleus mutants, 352 and 641 were the most stable types well adapted to different locations such as Malappuram, Palakkad, Thrissur and Ernakulam districts.
- In cassava a short duration clone Vellayani selection proved its superiority over other varieties tested and released under the name 'Vellayani Hraswa'.
- The short duration cassava varieties when grown under low lands, needed application of FYM @ 12.5t/ha or poultry manure @ 5t/ha along with 75:50:100 kg NPK/ha.

SUMMARY

Microplot experiment to find out the effect of growth promoting substances on sprouting of white yam tubers revealed that sett treatment using thiourea (2%) induced early, uniform and better sprouting and produced longer sprouts that eventually led to the establishment of a vigorous crop.

An experiment to standardize plant population and sett size for intercropping white yam in coconut garden indicated that planting of white yam setts of size 200g at a spacing of 90x90cm to accommodate 9000 plants/ha in coconut garden resulted in better sprouting and canopy size, higher harvest index, optimum tuber yield (16.52 t/ha), benefit cost ratio (1.31) and higher profit of Rs.19,363 ha⁻¹. The N : K ratio of 1:1 proved ideal for white yam.

In a study with short duration cassava in low lands, different sources of organic manure was found to influence the weight of tuber per plant and tuber yield ha⁻¹. Poultry manure exhibited superior response than FYM and coir pith compost on nutrient equivalent basis.

The cassava varieties Sree Vijaya and local variety Kariyila pothiyan did not exhibit significant variations in their growth and yield response to nutrient levels. Even though starch content did not vary the local variety registered higher protein and lower HCN content.

Stability analysis of selected mutants of coleus indicated that, the ideal plant type for coleus should have optimum tuber number, white coloured, delicious non-groovy tubers, optimum starch and protein content, good texture and medium flavor.

List of experiments

i) KAU Projects

a) Concluded experiments

Sl. No.	Code No.	Title of the experiment	Location
1	TUB-02-01-01-2000/ACV(1)/KAU	Evaluation of the selected local clone of cassava for yield, quality and earliness	CoA, Vellayani
2	TUB-02-01-02-2001/VKA(9)KAU/PG	Stability analysis of selected mutants of coleus (<i>Solenostemon rotundifolius</i> poir J.K. Morton)	CoH, Vellanikkara
3	TUB-03-00-06-98(AC(1)/KAU/PG	Resource management in intercropping white yam (<i>Dioscorea rotundata</i> Poir) in coconut garden	CoA, Vellayani
4	TUB-05-00-02-02/ACV(1)/KAU/PG	Integrated nutrient management of short duration cassava in low lands	CoA, Vellayani

b) Experiments in progress

Sl. No.	Code No.	Title of the experiment	Location
1	TUB-02-01-03-2003/VKA(9)/KAU	Adaptability of photo insensitive and photo sensitive mutants of coleus (<i>Solenostemon rotundifolius</i> poir, Morton)	CoH, Vellanikkara
2	TUB-02-01-04-2003/ACV(1)/KAU	Performance of short duration varieties of cassava in low lands	CoA, Vellayani
3	TUB-02-01-05-2003/ACV(1)/KAU	Screening cassava varieties for partial shade in coconut garden	CoA, Vellayani
4	TUB-04-00-01-2004/ACV(1)/KAU	Nutrient management of arrow root (<i>Maranta arundinaceae</i> L. under partial shade	CoA, Vellayani
5	TUB-04-00-02-2003/PTB(1)/KAU	Tuber development in relation to canopy regulation in coleus	RARS, Pattambi
6	TUB-04-00-03-2004/PTB(1)/KAU	Nutrient management in coleus in single cropped rice land	RARS, Pattambi
7	TUB-04-00-04-2004/PTB(1)/KAU	Growth and productivity of coleus growth with soil amendments	RARS, Pattambi
8	TUB-05-00-03-03/ACV(1)/KAU	Influence of fluorescent pseudomonas and AMF on the grown and yield of coleus (<i>Solenostemon rotundifolius</i>)	CoA, Vellayani
9	TUB-05-00-04-03/ACV(1)/KAU	Integrated nutrient management for Tania (<i>Xanthosoma sagittifolius</i> grown in coconut garden.	CoA, Vellayani

5. FRUITS

Co-ordinator: Dr.C.S. Jayachandran Nair

HIGHLIGHTS

- The different groups of banana differed in the anatomical and biochemical parameters in relation to disease resistance/susceptibility. Variety Manoranjitham (AAA) characterized by thick cuticle and intermediate sized epidermal cells on the ad axial surface is resistant while Grand Naine (AAA) with thinner cuticle and thickened and large sized epidermal cell on the ad axial surface is highly susceptible.
- The exotic banana hybrid introductions evaluated viz. FHIA – 1, FHIA – 3, FHIA – 23, FHIA – 25, TMB 5295/1, FHIA – 21 and CRPB 39 were superior in terms of bunch weight and resistance to Sigatoka leaf spot.
- The first plantain based hybrid progeny resultant from the cross Nendran x Calcutta-4 was evaluated. It had a bunch weight of 13 kg with 8 hands and 90 fruits. It also exhibited very high resistance to Sigatoka leaf spot.
- Accommodating three plants per pit at the spacing of 2m x 3m recorded a B:C ratio of 2.90, as compared to planting one plant per pit at normal spacing (2m x 2m) in Nendran (B:C ratio 1.73).
- Application of a combination of bio-fertilizers (*Trichoderma harzianum* + *Azospirillum* + PSB + VAM) along with 100% recommended dose of fertilizers gave heavier bunches.
- Among the new chemicals for control of Sigatoka leaf spot disease in banana, Companion (Mancozeb + Carbendazim) 75% WP, Tebuconazole (Folicur 250 EW) 1 ml/litre and Propiconazole (Tilt) 1 ml/litre were found to be effective.
- Soil drenching with carbendazim 0.2% or injecting carbendazim 2% (3 ml) solution at 5th, 7th and 9th month after planting was found to be most effective against Panama wilt disease of banana var. Rasthali (AAB).
- The molecular detection of Banana Streak Virus and Cucumber Mosaic Virus were standardized. Their morphological characters were studied under electron microscopy and it was found that BSV particles were bacilliform virus belonging to BADNA group and CMV particles were spherical cucumovirus. Molecular detection of BSV was carried out in PCR using primers specific to RNase H and Replicase gene and perfect amplicon was obtained at 750 bp region. Molecular detection of CMV was done in PCR using primers specific to coat protein.
- The effectiveness of neem based insecticidal preparations in controlling the pseudostem borer was confirmed. Neemazal 1% EC @ 5 ml/l is comparable to the recommended chemical, carbaryl 0.2%.
- In mango mechanical manipulation of the seed by splitting of the endocarp was found to be advantageous in reducing the days taken for germination, enhancing the rate of germination and promoting more number of sprouts in polyembryonic varieties. Based on

anatomical features, the variety Vellaikolamban could be placed in low growth potential (LGP) group while Moovandan was in high growth potential (HGP) group.

- Ocimum trap containing ocimum leaf extract with carbofuran at the rate of four traps per tree and a bait spray with malathion 0.1% and 2% sugar at monthly intervals from initial fruit set upto harvest was found to be very effective in trapping large population of fruit flies in mango.
- Application of N, P and K @ 250: 250: 500 g / plant in six split doses improved growth, yield and quality of papaya.
- Papaya hybrids such as Pusa Dwarf x Coorg Honeydew, Pusa Nanha x Coorg Honeydew, Coorg Honeydew x Sunrise Solo, Sunrise Solo x Pusa Dwarf and Pusa Nanha x Pusa Dwarf were found promising for Kerala conditions.
- In papaya varieties, male plants of Pusa Nanha and Pusa Dwarf yielded one specific band with primer OPA – 03. The hermaphrodite plants of Sunrise Solo and Coorg Honeydew yielded one specific band with primers OPA – 13, OPB – 04 and OPB – 17.

SUMMARY

At Banana Research Station, Kannara, 16 more varieties were added to the existing germplasm of 240 accessions. In preliminary evaluation of the exotic hybrids, TMB – 5295 – 1, FHIA -17, CRPB – 39, FHIA – 21 and FHIA – 25 were found to be superior in bunch weight. Characterization of the germplasm using molecular markers was initiated. Polymorphism in respect of enzymes and RAPD was observed among the distinct cultivars identified based on morphological characterization.

In banana crossing among AA diploids for development of synthetic diploids was carried out. Seedling progenies of four crosses, namely, Matti X Pisang Lilin, Matti x Culcutta – 4, Pisang Jaribuya x Culcutta – 4, and Tongat x Culcutta – 4 were evaluated. From the progenies of Matti x Pisang Lilin, a few superior selections of synthetic diploids could be made. The cross of Nendran x Culcutta – 4 set seeds which could be germinated under mist, and the first plantain based hybrid progeny evaluated.

A clonal selection of Nendran termed 'Manjeri Nendran II' with higher bunch weight, tolerance to Sigatoka leaf spot and suitable for annual cropping has been identified and is under farm evaluation.

In the first ratoon crop of banana variety Rasthali (AAB), the spacing of 2.1 X 2.1 m gave the highest bunch weight followed by 1.5 x 1.5 m. However, the highest yield per hectare was in the spacing of 1.2 x 1.2 x 2.0 m accommodating 5028 plants / ha.

The different planting time (bimonthly interval) significantly influenced the plant height and number of leaves in variety Nendran. The highest bunch weight was recorded in October and December planting. Incidence of Sigatoka leaf spot was lowest in June planting.

For banana variety Rasthali (AAB), application of Nitrogen 200 + 150 g in 4 + 3 splits was found to be effective. Application of Potassium @ 200 g / plant in two equal split doses at 60 and 120 days after planting was the best treatment for high yields. The results indicated that, for high returns, potassium should be applied in the vegetative phase.

The best combination of organic and inorganic nutrients for high yield from first ratoon 'Rasthali' (AAB) was 25% N as FYM + green leaf manure and 75% N as inorganic fertilizers.

Application of different sources of nitrogen in the proportion of 25% CAN + 50% urea + 25% ammonium sulphate was found superior with a B:C ratio of 1.84.

In banana variety Palayankodan (AAB), weed management influenced both yield and crop duration. Raising a single crop of cowpea in the interspaces of banana and its incorporation was an effective weed control measure.

Crop pest and disease calendars developed at the station give concise information on the various pest/disease problems affecting the crop during various times of the year. This is very useful to farmers and extension workers.

The important diseases of banana recorded during the period were bunchy top, sigatoka leaf spot, panama wilt, rhizome rot and banana bract mosaic. The other diseases observed were mosaic, banana streak disease, cigar end rot, anthracnose and fruit rot on variety Rasthali caused by *Botrydiplodia thiobromae* and leaf spot diseases viz, deightoniella leaf spot, cordana leaf spot and freckle leaf spot. The new introductions FHIA - 21, TMB - 5295 -1, FHIA - 18 and FHIA - 25 were found to be highly tolerant to these diseases under field conditions.

Among the treatments to control sigatoka leaf spot disease, Companion (Mancozeb + Carbendazim) 75% WP and Tebuconazole (Folicur 250 EW) 1 ml / litre were equally effective in terms of both infection index and yield.

The causal organism of panama wilt disease of banana viz., *Fusarium oxysporum* f.sp. *cubense* was isolated from the infected rhizome of variety Rasthali. An antagonist, *Aspergillus terreus* which inhibited the growth of the pathogen under *in vitro* conditions was also isolated. Among the treatments for the control of this disease, soil drenching with carbendazim 0.2% or injecting Carbendazim 2% (3 ml) at 5th, 7th and 9th month after planting was found to be most effective.

In rhizome rot affected banana variety Nendran, maximum yield was recorded in the treatment where the suckers were pared and dipped in 0.75 % monocrotophos before planting and later drenched with 1% bordeaux mixture twice at fortnightly intervals.

The four viral diseases of banana recorded in Kerala were banana bract mosaic caused by Banana Bract Mosaic Virus (BBMV), banana bunchy top disease caused by Banana Bunchy Top Virus (BBTV), banana streak caused by Banana Streak Virus (BSV) and infectious chlorosis caused by Cucumber Mosaic Virus (CMV).

Maximum yield reduction due to the incidence of Banana Bract Mosaic Virus was observed in 'Robusta' (70%) followed by 'Nendran' (52.5%). ELISA test done using PVY antiserum showed positive reaction in the crude sap from the bract of infected symptomatic plants and negative reaction for pseudostem.

Banana Streak Virus was not found to be sap transmissible. The morphology of the virus under electron microscope revealed the presence of bacilliform particles confirming that it belonged to BADNA group. Molecular detection of the virus was carried out in PCR using primers specific for RNase H and replicase gene and perfect amplification was obtained at 750 bp region. The phylogenic analysis was carried out and the particular Kerala isolate of Banana Streak Virus was found to be clustered around Australian and Nigerian isolates.

In the case of mosaic disease, the causal agent was confirmed as CMV- banana isolate. Mechanical transmission showed that the virus was sap transmissible to different species of tobacco viz, *Nicotiana tabacum*, *N. glutinosa* and *N. benthiana*. The morphology of the virus particles under electron microscope revealed that they were spherical cucumovirus. The molecular detection of the virus was done in PCR using primers specific to coat protein gene and perfect amplification was obtained at 650 bp region.

The important pests of banana observed in Kerala were pseudostem borer, rhizome weevil, sap sucking insects and leaf feeding caterpillars. Banana varieties Nendran, Palayankodan and Chenkadali were highly susceptible while Njalipoovan was resistant. Maximum infestation of pests was noted during May – July period.

Evaluation of commercially available neem based insecticides for control of pseudostem borer revealed that Neemazal 1% EC @ 5ml / litre was comparable to the recommended chemical Carbaryl 0.2%. Carbaryl 0.2%, was found to be the most economical treatment followed by Neemazal 1% EC.

Pseudostem pieces were the best bait for pseudostem borer. The length of pseudostem pieces and orientation (horizontal / vertical) had some influence on the effectiveness of the trap. These were effective only when the field population of the pest was medium to high.

Evaluation of botanicals against the pseudostem borer revealed that *Acorus calamus* and neem seed kernel extracts are good repellents and feeding deterrents.

Screening of banana germplasm for resistance / tolerance to nematodes showed that the average root necrosis percentage was generally lower at flowering stage than at the harvest stage. The genome AAA showed the maximum number of susceptible varieties. AA genome varieties were poor average hosts. AAB and AB genomes had maximum number of poor hosts. Among the various intercrops tried, sunhemp was found to be the most effective in controlling the nematode population.

Comprehensive survey of jackfruit types revealed wide variation in almost all the characters studied, indicating better chance for selection of superior types.

Among the different grafting methods in jack, inarching gave better results.

At Pineapple Research Centre, Vellanikkara, 25 varieties were collected, evaluated and maintained in the germplasm.

Twenty one pineapple clones were collected from different parts of Kerala and evaluated for yield and quality attributes. Seven were selected for further studies. Large scale multiplication of the selected clones was attempted for conducting farm trials.

Good quality pickling mango types were identified from different parts of Palakkad and Thrissur districts. Planting material production from these types was done for conservation and evaluation. Grafting and production of seedlings and polyembryonic seedlings were utilized for this purpose.

Expression of polyembryony was studied in landraces of mango collected from different locations. Out of the 46 types, 27 types expressed polyembryony in different degrees. Germination percentage varied from 5.0 to 72.8 % in these types. Treatments like removal of seed coat alone, seed coat removal followed by dipping in insecticides were found to improve germination percentage upto 60%.

Based on the survey on jack fruit to locate elite clones in Thrissur, Palakkad and Ernakulam districts, 156 trees were evaluated. Five elite trees were identified for table purpose, two for chips making and another five for culinary purpose.

In jack, rootstocks upto six months old can be successfully used for grafting.

Incidence of pests was higher in the monsoon and winter season compared to summer season. The pests observed were leaf eating caterpillars (*Margaronia bivitalis*), stem borer (*Batocera rufomaculata*) and spittle bug (*Cosmoscarta releta*). The major diseases noted were leaf spot (anthracnose) and rhizopus fruit rot.

Hybridization was done in papaya crossing the varieties Pusa Nanha, Pusa Dwarf, Sunrise Solo and Coorg Honeydew. Based on *per se* performance and combining ability analysis, hybrids such as Pusa Dwarf x Coorg Honeydew (dwarfness and earliness in bearing), Pusa Nanha x Coorg Honeydew (earliness in bearing), Coorg Honeydew x Sunrise Solo (yield and fruit quality), Sunrise Solo x Pusa Dwarf (yield per plant and fruit size) and Pusa Nanha x Pusa Dwarf (yield and disease tolerance) were found promising.

Application of 200: 300: 500 g of N, P and K per plant per year in six equal splits increased the growth of papaya plants. NPK @ 250: 250: 500 g resulted in higher yield. Fruit quality was enhanced by the application of 200: 300: 500 g of N, P and K per plant per year. Overall assessment indicated that application of N, P and K @ 250: 250: 500 g / plant / year in six equal split doses was economically viable for enhancing the growth, yield and quality in papaya.

List of experiments

i) K AU projects

(a) Concluded experiments

Sl. No.	Code No.	Title of the experiment	Location
1	FR-11- 00- 03-2001/ ACV (15)/KAU / PG	Response of papaya (<i>Carica papaya</i> L.) to major mineral nutrients	CoA, Vellayani
2	FR-11- 00- 02-2000/ ACV (15)/KAU / PG	Hybridization and molecular characterization of papaya (<i>Carica papaya</i> L.) varieties	CoA, Vellayani
3		Evaluation of papaya varieties for dessert purpose	CoA, Vellayani

4		Anatomical and biochemical bases of resistance in banana to yellow sigatoka leaf spot disease.	CoH, Vellanikkara
5	FF-09-00-00-01 / 93 KYM (4)/KAU	Breeding mango for high yield and quality types	ORARS, Kayamkulam
6	FF-09- 00-05-99/ VKA(15)/KAU / PG	Dwarfing potential of indigenous mango varieties.	CoH, Vellanikkara
7	FF-02 -00-51-96 / VKA (15)/KAU	Analysis of growth and yield in staggered production of pineapple var.Kew	CoH, Vellanikkara
8		Rapid asexual multiplication of hybrid seedlings of pineapple	PRC, Vellanikkara

(b) Experiments in progress

Sl. No.	Code No.	Title of the experiment	Location
1	FF-02-00-34-95/ KNR (1)/KAU	Standardization of optimum dose and time of nitrogen application in banana var. Palayankodan	BRS, Kannara
2	FF-07-00-06-90/MNY (9)/KAU	Evaluation and description of jack germplasm	ARS, Mannuthy
3	FF- 04 -03- 01- 05 / 80 MNY / KAU	Manurial trial in jack	ARS, Mannuthy
4	.FF- 07 -00 -14 -95 / VKA (15)/KAU/ PG	Growth, flowering, fruit set and fruit development in lovi-lovi (<i>Flacourtia inermis</i> Roxb, and <i>F. cataphata</i> Roxb	CoH, Vellanikkara
5	FF- 07 -00 -01 -91/ VKA (15)/KAU	Variability analysis in <i>Garcinia cambogia</i> Desr. (Malabar tamarind)	CoH, Vellanikkara
6	FF-02 -00 -48 -95 / VKA (15)/KAU/ PG	Influence of size of sucker and method of planting on the growth and yield of pineapple var. Mauritius	CoH, Vellanikkara
7	FF-08 -00 -04 -97 / VKA (15)/KAU / PG	Variability and character association analysis in pickle type mango	CoH, Vellanikkara
8	FR- 02- 00- 02-2002 / ACV (15)/KAU/PG	Screening of banana (<i>Musa</i> sp.) varieties for leaf production	CoA, Vellayani
9	FR-11- 00- 06-2004 / ACV (15)/KAU/PG	In-vitro propagation and RAPD analysis of selected varieties of papaya (<i>Carica papaya</i> L.)	CoA, Vellayani
10	FR-11- 00- 04 -2003 / VKA (15)/KAU	Establishment of mango research centre	CoH, Vellanikkara
11	FR-08- 00- 01 -2003 / VKA (15)/KAU	Strengthening research on fruits	CoH, Vellanikkara
12	FR-09- 00- 06 -2003 / VKA (9)/KAU	Genetic improvement of F1 hybrids in pineapple	CoH, Vellanikkara
13	FR-11- 00- 05-2004 / VKA (15)/KAU / PG	Variability and propagation studies in pummelo (<i>Citrus grandis</i> (L.). Osbeck)	CoH, Vellanikkara
14	FR-14- 00- 01-2004 / VKA (15)/KAU / PG	Variability and vegetative propagation in rambutan (<i>Nephelium lappaceum</i> L)	CoH, Vellanikkara

ii) Externally aided projects

a) Concluded experiments : Nil

b) Experiments in progress

Sl. No.	Code No.	Title of the experiment	Location
1	FF-01-00-01-73/ KNR (10)/ ICAR	Collection, conservation and evaluation of banana germplasm	BRS, Kannara
2	ICAR 1.2.2. (b)	Evaluation of FHIA hybrids for resistance to Yellow Sigatoka	BRS, Kannara
3	ICAR 1.2.3. (a)	Improvement through hybridization	BRS, Kannara
4	ICAR 1.2.3. (b)	Improvement through mutation breeding	BRS, Kannara
5	FF-02-00-63-99 KNR (10)/ICAR	Time of planting trial in banana var. Nendran	BRS, Kannara
6	ICAR 2.2.1 (a)	High density planting and sucker arrangement in banana	BRS, Kannara
7	ICAR 2.2.3	Improving the propagation efficiency of banana	BRS, Kannara
8	ICAR 3.2.1 (d)	Effect of micro nutrients on growth and yield of banana var. Poovan (AAB)	BRS, Kannara
9	ICAR 3.2.1 (b)	Effect of biofertilizers on growth yield and quality of banana	BRS, Kannara
10	ICAR 3.2.1 (c)	Effect of different sources of nitrogen on yield and quality of banana	BRS, Kannara
11	ICAR 3.2.3	Fertigation studies in banana	BRS, Kannara
12	ICAR 3.2.5	Cropping system studies	BRS, Kannara
13	FF-02-00-66-99 KNR (10)/ICAR	Effect of bunch cover on yield and quality of banana var. Nendran(AAB).	BRS, Kannara
14	ICAR 4.2.1(a)	Effect of bio-regulators on yield and quality of banana	BRS, Kannara
15	ICAR 4.2.1(b)	Chemical manipulation for higher yield and quality in banana	BRS, Kannara
16	FF-03-00-09-88/ KNR (4)/ ICAR	Survey studies on insect pests of banana	BRS, Kannara
17	ICAR 5.2.2.	Biology and population dynamics of pseudostem borer of banana	BRS, Kannara
18	ICAR 5.2.3 (a)	Chemical control of pseudostem weevil using acephate	BRS, Kannara
19	ICAR 5.2.3 (c)	Management of pseudostem borer of banana using different bait traps.	BRS, Kannara
20	ICAR 5.2.3 (d)	Evaluation of commercially available neem based insecticides for control of pseudostem borer of banana	BRS, Kannara
21	FF-03-00-06 /83/ KNR (4)/ICAR	Survey and identification of banana nematodes	BRS, Kannara
22	FF -03-00-05-89/ KNR (4)/ ICAR	Control of banana nematodes using inter crops	BRS, Kannara
23	FF- 03-00-04-81/ KNR (4)/ICAR	Screening of banana germplasm against nematode pests	BRS, Kannara
24	ICAR 5.2.3 (e)	Evaluation of botanicals against pseudostem borer of banana (<i>Odoiporus longicollis</i>)	BRS, Kannara
25	FF-03-00-90/KNR (5)/ ICAR	Screening of banana germplasm against leaf spot, bunchy top and Fusarium wilt	BRS, Kannara
26	FF- 03-00-06 -83/ KNR (4)/ICAR	Survey of fungal and viral diseases of banana	BRS, Kannara

27	FF-03-00-21-99 / KNR (5)/ICAR	Studies on <i>Fusarium</i> isolates in relation to Panama wilt of banana	BRS, Kannara
28	FF-01-00-03-90 / KNR(15)/ICAR	Control of Panama wilt of banana	BRS, Kannara
29	FF-01-03-01-75 / KNR/ICAR	Control of sigatoka leaf spot disease of banana	BRS, Kannara
30	ICAR 6.2.3 (a)	Epidemiology of sigatoka leaf spot disease of banana	BRS, Kannara
31	ICAR 6.2.4 (b)	Chemical control of rhizome rot (Tip over) of banana	BRS, Kannara
32	FF-01-03-14 -89/KNR - ICAR	Virus diseases of banana	BRS, Kannara
33	ICAR 6.2.2 (c)	Management of <i>Fusarium</i> and nematode complex in banana	BRS, Kannara
34		Standardization of optimum dose and time of nitrogen application in banana var. Poovan	BRS, Kannara
35	FF-02-00-64-99 / KNR (10)/ICAR	Spacing trial in banana var. Poovan (AAB)	BRS, Kannara
36	FF-02-00-65-94 / KNR (10)/ICAR	Standardization of optimum dose and time of potassium application in banana var. Poovan	BRS, Kannara
37	FF-02-00-67-99 / KNR (10)/ICAR	Standardization of organic and inorganic fertilizer requirement in banana var. Poovan	BRS, Kannara
38	ICAR 3.2.4 (c)	Chemical control of weeds in banana var. Palyankodan	BRS, Kannara
39	ICAR 3.2.4 (b)	Estimating losses from weeds at growth and development of banana and identification of critical stages in banana var. Palyankodan	BRS, Kannara
40		Integrated management of banana pseudostem weevil (<i>Odoiporus longocollis</i> Oliv.)	AMPRS, Odakkali
41	FF-15-00-06-95 / VZM(15)/KHDP	Population density of pineapple var. Mauritius as inter crop in coconut and rubber plantations	PRS, Vazhakkulam
42	FF-10-00-02-95 / VZM(15)/KHDP)	Improvement of pineapple var. Mauritius through hybridization and induced mutation	PRS, Vazhakkulam
43	FF-10-00-01-80 / KNR(9)/ICAR	Pineapple breeding for quality and for canning	PRC, Vellanikkara
44	FF-08-00-03-84/ KNR (9)/ICAR	Breeding new varieties of pineapple	PRC, Vellanikkara
45	FF-08-00-01-80/KNR (9)/ICAR)	Collection and evaluation of available pineapple germplasm for various traits	PRC, Vellanikkara
46	FF-10-00-01-80 / KNR(9)/ICAR	Collection, conservation and evaluation of pineapple germplasm	PRC, Vellanikkara
47	FF-10-00-02-81 / KNR (9)/ICAR	Clonal variation studies in pineapple	PRC, Vellanikkara
48		Intra clonal variability in pineapple var. Mauritius	PRC, Vellanikkara
49	FF-08-00-05-98 / VKA (15)/ICAR	Survey, collection and evaluation of table type mangoes	CoH, Vellanikkara

50	FF-09 -00 -01 -95 / VKA (15)/KHDP	Collection and evaluation of mango varieties / hybrids for commercial cultivation	CoH, Vellanikkara
51		Standardization of agro-techniques in mango for regular bearing	CoH, Vellanikkara
52	FF-11 -00 -02 -95 / VKA (15)/KHDP	Developing high density planting system for mango	CoH, Vellanikkara
53	FF-11 -00 -03 -95 / VKA (15)/KHDP	Effect of growth regulators, nutrients and pacloburazol on inducing flower-ing, earliness and regular bearing in mango	CoH, Vellanikkara
54		Studies on polyembryony and generation of local varieties and land races of mango	CoH, Vellanikkara
55		Collection, conservation and evaluation of pickling types of mango	CoH, Vellanikkara
56		Pruning studies in mango	CoH, Vellanikkara
57	FF-09 -00 -02 -95 / VKA (15)/KHDP	Varietal assessment of table mangoes in Palakkad district	CoH, Vellanikkara
58	NATP	Agro-biodiversity – Collection, characterization and evaluation of banana of Kerala	BRS, Kannara
59	ICAR 1.5.1.	Survey, identification & selection of mother plants to establish high yielding, superior stock of jack	PRC, Vellanikkara
60	ICAR 1.3.2.	Varietal trial in jack	PRC, Vellanikkara
61	ICAR 2.5.1	Standardization of propagation methods in jack	BRS, Kannara
62	ICAR 2.5.2	Effect of rootstocks on the performance of jack fruit	PRC, Vellanikkara
63	ICAR 5.5.1	Survey on incidence of insect pests in jack	BRS, Kannara
64	ICAR 6.5.1	Survey on incidence of diseases in jack	BRS, Kannara

6. FLORICULTURE

Co-ordinator : Dr.P.K.Rajeevan

HIGHLIGHTS

- More genera and species were added to the germplasm of orchids and anthuriums.
- Breeding trials in anthurium indicated the possibility of crossing between cut flower and foliage varieties to evolve dual-purpose varieties.
- The protocol for immature hybrid seed culture (*in vitro*) in anthurium was developed.
- River sand as well as coconut pith along with cow-dung were found to be the superior media for early flowering and improved floral characters in anthurium.
- In the anthurium variety Tropical, NPK @ 30:10:10 as well as NPK @ 0.2 per cent along with GA 200 ppm gave superior growth and flowering.
- Maximum vase life in anthurium was observed in BA 25 ppm solution followed by 50 ppm, showing the significant effect of BA in extending vase life.
- Spraying anthurium plants with a fertilizer mixture containing higher doses of potassium increased the post harvest longevity.
- In anthurium varieties Nitta, Agnithotri, Sunset Orange, Lima and Meringue, 2 to 8 percent sucrose was found to be very efficient for pulsing.
- Anthurium flowers packed in boxes with the spathe kept in polythene sleeves and with $KMnO_4$ in boxes lasted longer without any senescence symptoms
- Good cross compatibility was observed between different varieties of *Dendrobium*. In vitro mutation using low levels of gamma rays proved possible for producing mutants in *Dendrobium*.
- In *Dendrobium* 'Sonia Bom Jo' a treatment combination of tile bits + charcoal as media improved flowering and the floral characters.
- Tissue cultured plants of *Dendrobium* responded positively to high doses (more than double) of fertilizers during the pre-blooming stage.
- In Sonia 17' the plants treated with *Azospirillum* at the time of planting and sprayed with fertilizer solution 20:10:10 @ 0.2 per cent recorded earlier flowering and improved floral characters.
- In *Dendrobium* studies conducted using ^{32}P revealed that translocation occurred from back bulb to younger shoots.
- In *Dendrobium* flowers plugged with BA 125 ppm and HQC 200 ppm showed the longest vase life. This could be extended from 15 days (control) to 32 days by holding in a solution containing 8 HQC 300 ppm + sucrose 6 per cent.
- The monthly planting studies in tuberose revealed that the best planting time was March/April and October/November.
- Tuberose spikes kept in $AgNO_3$ 25 ppm + sucrose 2 per cent as well as in citric acid 300 ppm + sucrose 2 per cent gave good vase life.
- Twenty seven foliage plants belonging to ten different families were evaluated and they exhibited wide variation in their growth pattern and leaf characters.
- Techniques of dehydration of flowers of rose, carnation, gerbera, golden rod, zinnia aster, globe amaranth and various grasses and tree species were standardized.
- The technique for preserving foliage by different methods, viz. airdrying, microwave oven drying, press drying, skeletonizing, and glycerining were also developed.

- Developed protocol for post harvest handling of orchid and anthurium from harvest to the final consumer by a combination of treatments including pre-harvest nutrient management, harvesting at the correct stage of maturity, pre cooling, pulsing, plugging, waxing, packing, keeping in holding solution and storage at low temperature.

SUMMARY

Among the ten varieties of *Dendrobium* evaluated, the variety New Pink had the maximum shoot number, length, largest flower, and longest vase life. Pollen output was maximum for Emma White. Anthesis was observed between 9.30 am and 2.30 pm and stigma receptivity period ranged from 2nd day to 10th day of flower opening. Genotypic correlation coefficient was found to be higher than phenotypic correlation coefficient. Selfing and crossing were attempted in all the ten varieties. All the varieties, except Hieing Beauty were found self-compatible. Emma White had the maximum cross compatibility as the female parent. In green pod culture, 90-110 days old pods gave the best results.

For developing new hybrids of *Dendrobium* with novel, commercial cut flower qualities for the export market, hybridization in all possible combinations was carried out among selected parents. Hybrid seeds were cultured *in vitro*, providing all the necessary culture conditions. They were deflasked at the appropriate stage and established *ex vitro*. The seedlings belonging to different successful cross combinations were nurtured in the green house, giving optimum conditions for rapid growth. Out of these, 223 hybrids belonging to 16 combinations flowered, exhibiting a wide range of variations. Considerable novelty, distinctiveness and uniformity were exhibited by these hybrids. As such, 40 hybrids were selected as promising from these 16 combinations. Out of these, 25 hybrids had the potential for development into new commercial hybrids after micro propagation and further agronomic trials.

Investigation on improvement of *Anthurium andreanum* by *in vivo* and *in vitro* methods were carried out to evolve new varieties of *A. andreanum* and to standardize the age of seed and media for *in vitro* seed culture. Six commercial varieties of *A. andreanum*, viz, 'Nitta', 'Candy Queen', 'Lima', 'Red Dragon', 'Eureka Red', 'Agnihothri' and three species of *Anthurium* viz., *A. crystallinum*, *A. ornatum* and *A. amnicola* were selected for the study. Out of the 42 combinations of hybridization tried, 17 were found compatible. Among all the combinations, 'Lima' produced the largest number of compatible crosses as well as high seed set and germination percentage (compatibility score 28). The varieties 'Candy Queen', 'Red Dragon' and 'Eureka Red' also performed well as good female parents. Comparing the performance of male parents, the most successful variety was 'Lima' with a total compatibility score of 31 from 5 successful cross combinations, followed by the varieties 'Red Dragon' and 'Eureka Red'. Out of the 17 successful combination, the highly compatible crosses were that of 'Candy Queen' x 'Lima', 'Lima' x 'Red Dragon', 'Lima' x 'Eureka Red' and 'Eureka Red' x 'Red Dragon'.

The protocol for immature hybrid seed culture (*in vitro*) in anthurium was developed. Seeds, 40-45 days before field maturity, could be used for *in vitro* culture, thus reducing the time lag for the production of hybrid seedlings. Germination and further development were good in $\frac{1}{2}$ MS + 1 mg l⁻¹ BA. For callus initiation, $\frac{1}{2}$ MS with BA 6 mg l⁻¹, NAA 3 mg l⁻¹ was effective. For rooting and growth enhancement, $\frac{1}{2}$ MS with BA 0.5 mg l⁻¹ and IAA 1 mg l⁻¹ proved good.

Genetic variability studies were conducted on fifty different genotypes of *Anthurium andreanum* Linden, generated from a previous hybridization programme. The analysis of variance revealed significant variation among the fifty genotypes for all the seventeen quantitative characters studied. This revealed the high genetic potential for the improvement of this crop. Variability studies indicated high phenotypic and genotypic coefficients of variation for total anthocyanin content, pollen fertility, inclination of candle to spathe and duration of interphase. Except for leaf area and number of flowers per candle, all the other characters were highly influenced by genotypic variation. High heritability with a good genetic advance was found for all characters except for suckering ability and number of spadices/plant/year which exhibited medium heritability and high genetic advances. These results indicated that selection of plants which were phenotypically superior with respect of fifteen of the characters studied will certainly result in a significant improvement in the next generations.

The plant height was found to have significant positive phenotypic correlation with internode length, leaf area and days from emergence to maturity of inflorescence. Candle length showed significant positive correlation with leaf area, number of flowers per candle, life of spadix and duration of female phase. The genotypic correlations were higher and for most of the characters it showed high positive correlations. Most of the estimates of the environmental correlation coefficients for the characters were low and insignificant indicating the least effect of environment in the expression of the characters studied.

The pollen fertility ranged from 7.03 per cent in PR x FR (2) to 50.80 per cent in LJ x MW. The protogynous nature of the flower and low pollen fertility suggested the hybrid nature of the crop. During the months from March to July, the pollen emergence pattern was less when the maximum and minimum temperature were relatively high.

Path coefficient analysis revealed that the characters of leaf and duration of female phase were more associated with number of flower per candle and 40 per cent variation in flower production was attributed by the environment. High selection index values were recorded by the genotype LR x DT followed by Fr x MW(1), PR x LR(3), MW x FR(1). If parents were selected based on selection index value, 45 per cent genetic gain can be expected in the next generation.

Attempts were made to study the factors responsible for changes in growth and development of *Dendrobium* var. Soina 17 and Sonia 28. The influence of endogenous factors indicated that the variety Sonia 17 was superior to Sonia 28 with number of shoots and florets. The concentration and uptake of all the nutrients were at par during all the stages of growth. The concentration of N and K showed a decrease in the contents which indicated their utilization for vegetative growth whereas phosphorous concentration was reduced during emergence of spike such that it was required for flower emergence.

Different shade levels significantly influenced the morphological characters of *Dendrobium* varieties Sonia Bom Jo and Renappa. Maximum plant height, internode length and leaf production were noticed for 50 per cent of double level shading. Shoot production was more in 25 per cent and 35 per cent of double level shades. The longevity of the spikes on the plant was more in 50 per cent shade even though 25 per cent shade gave earlier flowering. Vase life was significantly high in 25 per cent and 50 per cent double levels of shade. Longest spikes and maximum number of florets were obtained in 50 per cent double level shading which also had the highest anthocyanin content in the flowers.

In the study using *Dendrobium* var. Sonia 17, to determine the effect of biofertilizers on growth and flowering it was found that the plants which were inoculated with *Azospirillum* at the time of planting and sprayed with 20:10:10 NPK at 0.2 per cent concentration twice a week came to flowering early, produced large flowers, lengthy spike and more number of flowers per spike. The plants inoculated with both *Azospirillum* and phosphobacteria and sprayed with 20:10:10 NPK at 0.2 per cent concentration recorded higher values for the nutrients analyzed. The microbial population estimated at the post experimental stage also recorded the presence of *Azospirillum* and phosphobacteria even after 12 MAP in soil less media but AMF spores were found to be absent.

In tuberose, higher levels of NPK induced more height. Maximum number of leaves was in the treatment with NPK @ 150:100:200 kg/ha. Spike length was significantly superior in treatments with NPK @ 150:150:200 and 100:150:150 kg/ha. Flower number, flower size, spike weight and vase life were maximum in the treatments receiving P and K 200:200 kg/ha. Earliest flowering was obtained in the plots with NPK @ 100:150:200 kg/ha followed by 200:100:200 kg/ha NPK.

Twenty seven foliage plants belonging to ten different families were evaluated as cut foliage and they exhibited wide variation in their growth pattern and leaf characters. Considering the quantitative and qualitative characters, *Asparagus setaceus* has an immense potential for use as cut foliage together with ferns (*Nephrolepis cordifolia* and *N. exaltata*) and grass species (*Scirpus cernuus* and *Ophiopogon jaburnan*) which would make good fitters in arrangements.

In the post harvest evaluation for use as cut foliage, the pulsing treatments were on par and among the holding solutions, distilled water and acidified water proved to be best, eliminating the use of chemicals. Storage at low temperature (17°C) was beneficial. Plugging with wet cotton and packing without tinning materials was enough to transport foliage.

The performance of five gerbera varieties viz, Essandra, Javena, Lindessa, Tamar, and Yanar were evaluated under low cost green house. The influence of method of planting was also compared. The variety differed significantly with respect to vegetative and floral characters. Variety Essandre produced maximum number of flowers/plant. Planting gerbera in the ground was found to be better for maximum growth and flower production as compared to pot culture.

Spikes of tuberose var. Double were harvested when the two basal florets opened and kept in different vase solutions. Silver Nitrate 25 ppm + Sucrose 2% gave the maximum vase life (8.7 days) which was significantly superior to all the other treatments except citric acid 300 ppm + sucrose 2%. More water uptake was also noticed in this treatment. The percentage of flower opening was more in $Al_2(SO_4)_3$ 300 ppm + Sucrose 2% followed by citric acid 300 ppm + sucrose 2%. When the different packing materials were used, spikes kept in brown paper for 24 hours recorded maximum vase life (6.73 days), which was significantly better than other treatments.

Among the different shade levels tried 80 per cent improved flower production and quality of flowers in anthurium.

When anthurium grown in a medium rich in organic matter, application of N, P and K at lower levels (0.25%) was as effective as their application at higher levels (1.00%). Similarly, weekly application was not found significantly better than biweekly application. The addition

of Ca, Mg or vitamin B12 also did not have any added advantage with respect to the quality characters of the plants and flowers. Regarding the vase life of flowers, application of these nutrients significantly influenced the vase life of flowers i.e., the vase life was enhanced by these treatments by 1 to 1 ½ weeks. Here the highest vase life was obtained for the treatment involving the application of 20:20:40 of NPK complex @ 0.25% at weekly interval, i.e., at the lower level of N and higher level of K and this was significantly better than the other treatments.

The schedule of nutrient application was standardized for the commercial varieties of *Dendrobium* during the vegetative and flowering stages. The treatments during the vegetative phase included 0.2 to 0.5% 30:10:10 NPK sprays twice in a week. For near flowering plants, 0.2% each, NPK 20:20:20 (T₁), NPK 30:20:20 (T₂), NPK 10:30:30 (T₃), NPK 20:30:30 (T₄), NPK 10:20:20 (T₅), Orchid care and Vermi wash were applied twice in a week. The performance of the plants were evaluated with respect to vegetative character, floral character and vase life of the spike. In *Dendrobium* 'Sonia 17' earliest flowering (240 DAP) was recorded in plants (just hardened stage), which received a treatment combination of NPK 30:10:10 at 0.3 per cent applied weekly twice. BA 50 mg/l increased the number of side shoots. Maximum number of spikes per year (12.98) and number of florets per spike (10.50) in *Dendrobium* were produced by NPK 20:30:30 at 0.2 per cent weekly twice. BA 100 ppm and GA₃ 50 ppm increased spike length. Among the treatments, maximum vase life was observed in plants sprayed with nutrient solution containing higher ratio of phosphorous and potassium and lower ratio of nitrogen i.e. (10:30:30 NPK and 10:20:20 NPK)

Data on the effect of pre harvest sprays of nutrients, showed that the post harvest longevity of flowers was extended to 21 days by the application of nutrient solution (0.2%) containing low proportion of N and high proportion of P and K (10:30:30 and 10:20:20), compared to 15 days in 20:20:20 and 17 days in 30:10:10.

Orchid and anthurium flowers collected from three districts viz, Kozhikode, Thrissur and Ernakulam did not differ significantly with respect to post harvest longevity. Organic farming significantly reduced the incidence of disease both in anthurium and orchid.

The effect of holding solutions containing AgNO₃, BA, CCC and sucrose on the post-harvest life of cut flowers of anthurium varieties was studied with respect to physiological loss in weight, water uptake, electrolyte leachate and total vase life. The treatments significantly influenced all the characters. BA at 25 ppm recorded the maximum total vase life of 22 days. The flowers kept as such without any treatment lasted for 9 days. Water uptake and electrolyte leachate was directly correlated with vase life.

Pulsing treatments in orchids improved the longevity of flowers harvested at all the stages of maturity. In flowers harvested at one bud stage, the time taken for showing the first symptom of wilting was extended in Sonia 17, 7.5 days in Renappa and 6 days in Fairy White by the best treatments as compared to control. In flowers harvested at one bud stage, the time taken for showing the last symptom of wilting was also increased in Sonia 17 Renappa and Fairy White by the best treatments, compared to control.

In anthurium, inflorescence was harvested with 25%, 50%, and 75% true flowers open on the spadix. In varieties Lima, Meringue and Nitta inflorescence with 75% flowers opened on spadix showed the longest vase life whereas in varieties Sunset Orange and Agnihotri inflorescence with 50% flowers opened on spadix showed the longest vase life.

In orchid spikes with one or two buds lasted for a longer time than spikes with three buds. Pre-cooling at 4 - 6°C for 3 - 4 hours increased post harvest longevity of orchid and anthurium.

To standardize the concentration of sucrose for pulsing, the flowers were kept in solutions containing different concentration of sucrose for 8 hrs. The varieties used for the study were Lima, Nitta, Meringue, Agnihotri and Sunset Orange. In case of variety Nitta it was observed that vase solution without sucrose was performing better than the other treatment. But in variety Lima and Meringue the holding solution with sucrose was found to give the longest vase life though the concentration varied, i.e. 2% sucrose for meringue and 8% for Lima. Thus, it was found that the white varieties need of sucrose for holding solution while coloured varieties, holding solution without sucrose was found to give the longest vase life.

Pulsing treatments given to anthurium flowers revealed that pulsing with BA 150 ppm for 8 hours was the best treatment (19.50 days to appear the first symptom of senescence) and it was significantly better than all the other treatments.

Pulsing with sucrose 6% and BA 75 ppm improved the vase life in all the orchid varieties. Among the orchid varieties studied, Renappa (pure purple) had the longest vase life after pulsing. The vase life was maximum for inflorescence with one bud lasting for 18 days.

Waxing of spathe and spadix in anthurium took maximum number of days (12.33) for the symptoms of spadix necrosis to appear. Regarding spathe blueing, flowers with spathe and spadix waxed showed the symptom only after 14.17 days and the symptom was first manifested (within 12.33 days) in flowers which were given waxing to the cut ends.

The basal portions of flowers in anthurium immediately after harvest, were plugged with a piece of cotton dipped in different chemicals like Triadimefon, Bavistin and BA and observations were taken on the symptoms of senescence. Flowers plugged with BA 50 ppm took maximum number of days (10.44) for the spadix necrosis to appear and differed significantly from all the other treatments in anthurium. The symptom was first manifested (within 5.67 days) in flowers plugged with tap water alone.

In orchids cotton saturated with sucrose 6%, BA-125 ppm and 8-HQC 200ppm and plugged to the cut end of flower stalks during storage at 13°C delayed floret fading, shedding and wilting and further increased the vase life by 2-3 days over control in all the four varieties used.

The experiment on the effect of storage temperature on post harvest quality of orchid cut flowers was carried out in four varieties viz., Sonia 17 and 28 (Purple and white mixture), Emma White and Fairy White. Among the four varieties evaluated var. Emma was found better than the other three varieties at all the storage treatments. Storage temperature of 13°C was found more beneficial for extending the vase life by 6 days as compared to storage at 10°C.

The experiment on the effect of storage temperature on post-harvest quality of anthurium cut flowers was carried out in six varieties. The observations on glossiness of spathe, discolouration of spadix, fresh weight and vase life revealed that flowers stored at 13°C for 2 days had enhanced vase life and display quality over control in all the varieties tried.

Maximum vase life of 21 days was obtained in var. Lima white followed by var. Nitta orange (20 days).

Covering anthurium flowers in polythene sleeves / cover and packing in cardboard cartons increased the post harvest longevity of flowers by five days compared to control. Keeping potassium permanganate as ethylene absorbent in cartons further extended post harvest longevity.

Cotton saturated with sucrose 6%, BA-125 ppm and 8-HQC 200ppm plugged to the cut end of flower stalks during storage at 13°C delayed floret fading, shedding and wilting and further increased the vase life by 2-3 days over control in *Dendrobium* varieties.

Attempts were made to develop floral craft using locally available materials as fetters. From the benefit cost analysis, it has been observed that there is quite high margin of profit in this venture.

List of experiments

i) KAU Projects

a) Concluded experiments

Sl.No.	Code No.	Title of the experiment	Location
1.	FL-05-06-10-96 /VKA(15)/KAU/PG	Improvement of <i>Dendrobium</i> through hybridization and <i>in vitro</i> mutagenesis	CoH, Vellanikkara
2.	FL-06-00-29-98/ ACV(9)/KAU/PG	Intra and inter specific hybridization in <i>Dendrobium</i> spp.	CoA, Vellayani
3.	FL-05-00-14-99 / VKA (15)/KAU/ PG	Improvement of <i>Anthurium andreanum</i> Lind by <i>in vivo</i> and <i>in vitro</i> methods	CoH, Vellanikkara
4.	FL-03-00-02-2001/ ACV(9)/KAU/PG	Genetic variability and character association in <i>Anthurium andreanum</i> Linden	CoA, Vellayani
5.	FL-01-00-2002/ ACV(15)/KAU/PG	Morphological and cyto-molecular characterization of <i>Dendrobium</i> cultivars	CoA, Vellayani
6.	FL-01-00-2002/ ACV(15)/KAU/PG	Evaluation, molecular characterization and <i>in vitro</i> propagation of Heliconias	CoA, Vellayani
7.	FL-03-00-2002/ ACV(9)/KAU/PG	Compatibility studies of three way cross in <i>Anthurium andreanum</i> Linden	CoA, Vellayani
8.	FL-06-08-32-99/ VKA(15)/KAU/PG	Endogenous and exogenous regulation of growth and development in <i>Dendrobium</i> var Sonia 17 and Sonia 28.	CoH, Vellanikkara
9.	FL-09-00-01-2000/ VKA(15)/KAU/PG	Standardization of shade requirement in <i>Dendrobium</i>	CoH, Vellanikkara
10.	FL-09-00-02-2001/ VKA(15)/KAU/PG	Varietal evaluation of gerbera (<i>Gerbera jamesonii</i> Bolus) under low cost green house	CoH, Vellanikkara
11.	FL-04-00-01-2002/ VKA(15)/KAU/PG	Evaluation of tropical plant species for use as cut foliage	CoH, Vellanikkara
12.	AICFIP	Standardization of post harvest technology in tuberose	CoH, Vellanikkara
13.	FL-10-00-01-2001/ VKA(15)/KAU/PG	Post harvest management of cut flowers of orchids and anthurium	CoH, Vellanikkara
14.	FL-15-00-01-2002/ VKA(15)/ICAR	Standardization of techniques for commercial production of dry flowers and plants	CoH, Vellanikkara

b) Experiments in progress

Sl. No.	Code No.	Title of the experiment	Location
1.	FL-01-00-03-2003/ VKA(15)/KAU	Strengthening research on floriculture	CoH, Vellanikkara
2.	FL-01-00-04-2003/ VKA(15)/KAU	Introduction and evaluation of new ornamentals	CoH, Vellanikkara
3.	FL-09-00-03-2004/ VKA(15)/KAU/PG	Micro climatic relation on the growth, yield and quality of anthurium (<i>Anthurium andreaeanum</i> Linden) under different growing systems	CoH, Vellanikkara
4.	FL-03-00-05-2004/ ACV(15)/KAU/PG	Standardization of growing media and organic nutrition of juvenile Anthurium plants (<i>Anthurium andreaeanum</i> Lind)	CoA, Vellayani
5.	FL-13-00-03-2004/ ACV(15)/KAU/PG	Floral biology and compatibility studies in heliconia	CoA, Vellayani

ii) Externally aided projects

a) Concluded experiments

Sl.No.	Code No.	Title of the experiment	Location
1.	FL-15-00-01-2002/ VKA(15)/ICAR/PG	Standardization of techniques for production of dry flowers and plants	CoH, Vellanikkara
2.	FL-10-00-01-2001/ VKA(15)/NATP/PG	Post harvest management of cut flowers of orchids and Anthurium	CoH, Vellanikkara
3.	FL-13-00-01-2002/ ACV(9)/DBT/PG	Compatibility studies in monopodial orchids	CoA, Vellayani
4.	FL-03-00-2002/VKA (15)/AICRP/PG	Supplementary effect of biofertilizers in <i>Dendrobium</i>	CoH, Vellanikkara
5.	AICFIP	Standardization of planting time in tuberose	CoH, Vellanikkara
6.	AICFIP	Standardization of nutritional requirement in tuberose	CoH, Vellanikkara
7.	AICRP	Standardization of agro techniques in orchids	CoH, Vellanikkara
8.	AICRP	Standardization of biofertilizer doses in orchids	CoH, Vellanikkara
9.	AICRP	Standardization of agro techniques in anthurium	CoH, Vellanikkara
10.	AICRP	Standardization of biofertilizer doses in anthurium	CoH, Vellanikkara
11.	AICRP	Collection, evaluation and maintenance of germplasm of tuberose	CoH, Vellanikkara
12.	AICRP	Breeding and testing of new cultivars of tuberose	CoH, Vellanikkara
13.	AICRP	Standardization of agro techniques in tuberose	CoH, Vellanikkara
14.	AICRP	Standardization of post harvest technology in tuberose	CoH, Vellanikkara

b) Experiments in progress

Sl. No.	Code No.	Title of the experiment	Location
1.	DST	Micro climatic relations in the commercial production of cut flowers and foliage in the humid tropics	CoH, Vellanikkara
2.	NHB	Transfer of technology in commercial production of orchids	CoH, Vellanikkara
3.	NHB	Transfer of technology in commercial production of anthurium	CoH, Vellanikkara
4.	FL-13-00-03-2004 /ACV(15/ICAR/PG	Collection and evaluation of Heliconias as potential cut flower crop and standardization of agro techniques	CoA, Vellayani
5.	DBT	Breeding for commercial orchid hybrids	CoA, Vellayani
6.	BARC	Crop improvement in orchid via. <i>In vitro</i> mutagenesis	CoA, Vellayani
7.	AICRP	Collection, evaluation and maintenance of orchid germplasm	CoH, Vellanikkara
8.	AICRP	Standardization of post harvest technology in orchids	CoH, Vellanikkara
9.	AICRP	Collection, evaluation and maintenance of anthurium germplasm	CoH, Vellanikkara
10.	AICRP	Breeding and testing of new varieties of anthurium	CoH, Vellanikkara
11.	AICRP	Standardization of propagation techniques (field propagation and tissue culture) of anthurium	CoH, Vellanikkara
12.	AICRP	Production technology of anthurium	CoH, Vellanikkara
13.	AICRP	Integrated nutrient management (INM) studies in anthurium	CoH, Vellanikkara
14.	AICRP	Standardization of pre and post harvest technology	CoH, Vellanikkara
15.	AICRP	Control of bacterial blight (<i>Xanthomonas campestris</i> pv. <i>diffenbachiae</i>) and <i>phytophthora</i> rot of anthurium	CoH, Vellanikkara
16.	AICRP	Collection and evaluation and maintenance of gerbera germplasm	CoH, Vellanikkara
17.	AICRP	Production technology of gerbera	CoH, Vellanikkara
18.	AICRP	Standardization of growing structures for gerbera for different agro climatic regions.	CoH, Vellanikkara

7. SPICES

Co-ordinator : Dr. E.V.Nybe

HIGHLIGHTS

- Germplasm collection and evaluation of pepper genotypes carried out at PRS, Panniyur and College of Horticulture, Vellanikkara found that Valiyaramundi, Chendayar, TMB IV and TMB X were the promising genotypes.
- Evaluation of 13 pepper varieties revealed that Panchami, Panniyur-4 & Panniyur 3 are suitable for high ranges of Kerala.
- Black pepper variety Karimunda was found to be the most popular one in southern districts of Kerala. Under high elevation, the maximum coverage was recorded by the variety Neelamundi (91.6%).
- Morphological, physiological, biochemical and anatomical character studies showed that varieties Poonjarmunda, Panniyur 5 and Padarpan are water stress tolerant, Kalluvally, Uthirankotta and Kumbakodi are moderately tolerant and Panniyur 1 as sensitive.
- Six local varieties viz., Karimunda, Neelamundi, Kottanadan, Kotta, Karuvalli and Vadakkanmunda were selected for further studies to identify low input responsive varieties of black pepper.
- Pepper plants irrigated @ 10 litres per vine per week by basin method up to March showed 48 per cent enhancement in dry yield per vine compared to un-irrigated plants.
- Substitution of 50 per cent of the recommended inorganic fertilizer dose with FYM on equivalent N basis and the remaining 50 per cent of the dose met through inorganic N and P recorded the highest yield in pepper.
- Studies indicated the feasibility of minimizing input use by 50% in respect of mineral fertilizers and lime without sacrificing yield, provided it is substituted either by growing cowpea in the interspace and basins or by applying composite cultures of *Azospirillum*, *Phosphobacterium* and VAM.
- The active root zone of bush pepper for irrigation and fertilizer application is at 30 cm radius and 40 cm depth from the base of the plant.
- Optimum percentage of allowable depletion of soil moisture for irrigating bush pepper is 50 per cent.
- The lateral shoot and spike production were high in bush pepper irrigated with water spray than without water spray.
- Drip irrigation @ 2 litres/ day/ vine from January-April contributed more towards spike number, green berry yield and spike length of pepper.

- Metalaxyl Gold MZ + *Trichoderma* was found effective in controlling the foot rot disease of black pepper
- In the nursery, *Phytophthora* disease incidence was very low, when pepper cuttings were planted in solarized soil amended with *Trichoderma* and arbuscular mycorrhizal fungi (AMF) and the drenching with (0.3%) Potassium phosphonate. Application of *Trichoderma* @ 1g + AMF 100 cc in 1 kg of potting mixture also effectively controlled *Phytophthora capsici* in pepper nursery.
- Maximum percentage reduction of *Phytophthora* foot rot disease incidence (24.33%) was observed in *Trichoderma harzianum* + AMF and Akomin drenched plot than control. The application of Potassium phosphonate / Ridomil MZ along with *Trichoderma harzianum* + neem cake was also effective in controlling the foot rot disease in pepper.
- Spraying of Bordeaux mixture (1%) at the time of flowering did not affect the berry setting in black pepper.
- Foliar anthracnose (pollu) disease has become a threatening disease in black pepper in the high altitude pockets of cardamom hill reserves. Spraying with Carbendazim @ 0.05% or combination of Carbendazim + Mancozeb @0.05% was effective in the management of pollu disease. Karimunda variety was found tolerant to the disease.
- In the high ranges of Idukki district five new insect pests of black pepper viz., leaf miner, aphid, bagworm, stem borer and leaf gall midge were reported. Three species of scale insects viz., mussel scale, soft scale and coconut scale caused more than 30% yield loss in black pepper.
- Two sprayings of either Dimethoate (0.05%) or Monocrotophos (0.05%) at fortnightly intervals after the harvest of berries were effective in the management of black pepper mussel scale, *Lepidosaphes piperis*.
- Cardamom variety PV2 was recommended for release for the high ranges of Idukki district. The variety is bold capsuled Vazhukka type with yield potential of 2500 kg/ha. S-1 (Malabar type) and PS 27 (Vazhukka) are in the pipeline for release.
- A fertilizer schedule of 100:100:175 kg NPK ha⁻¹ gave highest number of panicles and yield in cardamom. Neem cake application had not much influence on yield.
- Seven rounds of insecticide application per year are being recommended for the management of cardamom thrips (*Sciothrips cardamomi*) and stem borer (*Conogethes punctiferalis*). Bee safe insecticides such as Phosolone (0.07%) and Quinalphos (0.05%) are advised during peak flowering period (June-September) and skipping of insecticide application coinciding monsoon is also recommended.
- Yellow sticky traps on shade trees as well as spraying of neem oil @ 0.5% on the leaves suppressed the cardamom whitefly (*Kanakarajiella cardamomi*) population. An entomopathogenic fungus *Verticillium* sp. infecting on cardamom whitefly was reported from Pampadumpara panchayat, Idukki district, Kerala for the first time.

- Spraying of Nimbecidine 0.2% and Fish Oil Insecticidal Soap (FOIS 2.5%) resulted in reduced cardamom yield and increased itch symptom on cardamom capsules.
- Root mealy bug of cardamom is spreading very fast in the plantations of Idukki district. Evaluation of various insecticides revealed that drenching with Chlorpyrifos @ 0.03% was very effective in the management of this pest.
- Bordeaux mixture (1%) as spray or drench or both was very effective method to control capsule rot of cardamom.
- Stem rot, root tip rot and *Katte* virus infection are spreading very fast in the cardamom plantations of Idukki district. It is found that the infestation by the root mealy bug or root grub of cardamom predispose the plants to root rot infection. Spray and drenching of Carbendazim @ 0.05% is recommended for the management of fungal diseases.
- One dry ginger type viz. PGS-35 and one dual purpose ginger type V2E5-2 are recommended for farm trial.
- Ginger accession 204 and IISR-Varada were ideal for intercropping in coconut garden with high yield and tolerance to soft rot.
- Autotetraploids of ginger were superior to diploids in quality attributes. *In vitro* placental pollination gave ovule development using tetraploids as females and diploids as males.
- 43 turmeric cultivars are maintained in the germplasm collection at the College of Horticulture, Vellanikkara. Three varieties viz., VK-29, VK-31 and PCT-19 were found good and were recommended for farm trial.
- Cinnamon types SL 203 and SL 53 recorded higher yield and found suitable for Wayanad. Maximum leaf oil of 4% was obtained in SL 44 and bark oil of 2% was obtained in SL 53.
- Seventeen elite types of garcinia were identified through a field survey.
- Approach grafting and soft wood grafting were found to be the most suitable technique for the propagation of garcinia.
- Application of Kinetin @ 100 ppm and Kinetin + IAA @ 100 ppm each, was the most ideal for enhancing graft union in cardamom.
- For breaking seed dormancy in garcinia, direct sowing of processed seed, after removing the seed coat, was the most suitable practice.

SUMMARY

In the germplasm collection, 137 accessions of cultivated types of black pepper and 10 wild types are being maintained at PRS Panniyur. During the year 2001-02, survey and collection

were carried out in northern most regions of Kerala-Karnataka border. Twenty four black pepper genotypes were collected from northern most side of Kannur district and 29 from Kanamvayal forest of Karnataka state. During the year 2002-03 also, the genotype Valiyaramundi recorded the maximum green berry yield of 6.87 kg / vine followed by TMB X (5.7 kg). The maximum spikes /vine was also recorded by Valiyaramundi (1936 nos.) and TMB X (1700 nos). In 2003-04, the genotype Vadiyaramundi recorded the maximum green berry yield of 6.420 kg / vine followed by Chendayar (4.075 kg). The maximum spikes /vine was also recorded by Valiyaramundi (2366 nos.) and Chendayar (1790 Nos.).

Germplasm collection at College of Horticulture, Vellanikkara, contains ten species of *Piper* and 135 accessions of *Piper nigrum*. One high yielding cultivar was added to the collection during 2003-04. *Piper nigrum* accessions were evaluated for yield, spike and berry characters and quality attributes. Spike length was maximum in accession Pn 36 (14.5 cm). Number of berries were maximum in P 38 (80.3), a wild collection from Peechi. Thousand berry weight was highest in accession Pn 99 (202 g) followed by Pn 51 (200 g). Thousand berry volume was maximum in two accessions Pn 131 and Pn 133 (180 ml). Accessions Pn 97 and Pn 106 recorded the highest dryage of 48 per cent. Dryage was as low as 22.7 per cent in accession Pn 111. Among the quality attributes, oil content varied from 1.0 (Pn 97) to 3.75 per cent (Pn 30), oleoresin from 6.83 (Pn 50) to 12.79 per cent (Panniyur 1) and piperine from 2.82 (Pn 74) to 6.4 per cent (Pn 75). Average yield per vine was maximum in Pn 77 (5.87 kg green) followed by Pn 128 (5.34 kg) and Pn 129 (5.16 kg). Highest per vine yield was recorded in accessions Pn 77-1 (16.3 kg green).

RAPD profile of the 13 species of *Piper* were compared for genetic similarity index (using Jaccard's coefficient), with all 20 selected primers separately. Pooled similarity of the twenty primers put together was found out for 9 species which gave amplification for all the 20 selected primers. The results of pooled analysis was subjected to cluster analysis (SAHN) and phenetic dendrogram was constructed employing UPGMA. Four clusters were obtained, comprising of two accessions of *P. nigrum* in the first, two accessions of *P. longum* in the second, *P. colubrinum* and *P. attenuatum* forming the third cluster and *P. chaba*, *P. betle* and *P. arboreum* forming the fourth.

In a multilocational trial, cultivars showed significant difference for all the characters studied. Panchami (0.801 kg) Panniyur 4 (0.584 kg), ACC 2445 (0.514 kg), Panniyur 3 (0.469 kg) and ACC 2426 (0.399 kg) were significantly superior to other cultivars with respect to wet weight of berries per standard. Regarding the dry weight of berries per standard, Panchami (0.254 kg), Panniyur 2 (0.180 kg), Panniyur 4 (0.166 kg), Panniyur 3 (0.165 kg), ACC 2445 (0.162 kg), Panniyur 1 (0.138 kg), ACC 2426 (0.127 kg) and Cul 239 (0.126 kg) showed their superiority over other cultivars. Panchami (189.43), Panniyur 4 (147.53), ACC 2445 (125.12) and Panniyur 2 (112.35) were significantly superior to other cultivars with respect to the number of spikes per standard. Spike length showed significant variation among the cultivars and Panniyur 5 (9.69 cm), Panniyur 3 (9.31 cm), Panniyur 1 (9.22 cm), Panchami (9.21 cm), Cul 15 5 8 (8.77 cm), ACC 2426 (8.34 cm) and ACC 2445 (8.28 cm) were significantly superior to other cultivars. With respect to number of berries per spike, Panchami (62.15), PN-3 (58.34), ACC 2426 (53.36) and Panniyur 4 (51.42) were on par and superior to other cultivars. Cul 5128 (170.56g, 144.38cc) and Panniyur 1 (146.76g, 124.38 cc) showed their superiority over other cultivars with respect to thousand berry weight and berry volume. Panchami, Panniyur 4, Panniyur 3, ACC 2445, ACC 2426 and Panniyur 2 were found promising for the high range regions of Kerala.

Intervarietal hybridization was carried out at PRS, Panniyur during the year 2001-02 and sixteen crosses were made. Open pollinated progenies of 11 varieties were also raised during this period. Interspecific hybridization of promising pepper varieties with *Piper colubrinum* was carried out during the year and the hybrids were planted in the field and are being evaluated. During the year 2002-03, fifteen cross combinations were made and the seeds were sown in pots. Seeds of sixteen germplasm accessions were sown for OP progeny evaluation. Among the hybrids planted during 2000, KM III x P 5 was found to be promising with regard to number of laterals, early spiking, more number of spikes and compact setting of berries.

Nine released varieties viz., Sreekara, Subhakara, Panchami, Pourmami, Panniyur 1, 2, 3, 4, 5 and four promising cultures Kottanadan ACC. 2426, ACC.2445, culture 1558, culture 5128 and Karimunda as local check were evaluated in a CVT. During the year 2001-02, Panniyur 3 recorded the highest green berry yield of 1.920 kg/vine and this variety was statistically on par with the varieties Subhakara, Panniyur 4, and Karimunda. During the year 2002-03, Cul 1558 recorded the highest green berry yield of 3 kg/vine followed by Cul 5128 (2.9 kg/vine). The number of spikes/vine was maximum for Panchami (835) followed by P 4 (705) and Cul 1558 (685). The maximum number of berries / spike was recorded by P 1 (55) followed by Cul 239 (45). The spike length was maximum for Cul 1558 (16.60 cm) followed by P1 (15.50 cm). The 100berry weight was maximum for Cul 5128 (17 g).

Among the four cultures evaluated for green berry yield from 1998-2002, Panniyur cultures, Cul 1559 and Cul 5128 recorded the maximum yield of 2.438 kg/vine and 1.858 kg/vine. Among the varieties tested, the highest mean yielder was Panniyur 4 (2.234 kg / vine) followed by Panniyur 5 (2.163 kg / vine). The top yielder, Cul. 1559 was statistically on par with P4, P5, Cul 5128, Kottanadan 2445, Panchami, P2 and P3. The results of the trial indicated the superiority of the cultures 1559 and 5128. The Culture 1558 has been released as Panniyur 7. This experiment was concluded as per the decision of XVII AICRP workshop.

In the experiment CVT on black pepper, 12 black pepper entries were evaluated to assess the performance of released varieties as well as promising selections of black pepper. The results showed that all the entries survived to more than 55% and the survival percentage was highest in Cul 5489 (100%). Significant and highest number of leaves was observed in Cul 1041 (90.07) and lowest in HP 105 (22.13). Infection by foliar anthracnose as well as foot rot diseases was highest for HP 105 and the accession Panniyur1 recorded the least incidence for both the diseases. In the clonal variability trial on Panniyur 1, clone No. 32 was found promising which registered a spike length of 13.25cm, berry weight of 51.8 g/ spike, oleoresin 10.98% and piperin 7.1%. Among the newly planted clones, clone No.19 recorded maximum dry weight (230 g/vine) followed by clone No. 35 (180 g/vine). The clone No. 32 recorded maximum values for spike length (13.5 cm) and number of berries per spike (70.6).

During the year 2000-01 mist chamber was constructed and the laterals of Panniyur varieties P1 to P 7 and Karimunda were kept for rooting. Survival rate of laterals were generally poor inside mist chamber, compared to the condition outside mist chamber. During the year 2001-02, germinated laterals of varieties Panniyur 1, Panniyur 2, Panniyur 3, Panniyur 4, Panniyur 5, Panniyur 6, Panniyur 7 and Karimunda were planted individually in each pot and experiment was laid out in CRD design, one set with water spray and the other set without water spray.

During the year 2002-03, the lateral shoot and spike production were recorded and the results indicated that the laterals and spike production were high in bush pepper irrigated with water

spray than without water spray. During the year 2003-04, the yield data were recorded. The water spray treatment was significantly superior to the treatment without water spray with regard to green berry yield and number of spikes. Among the varieties tested, the variety Panniyur 4 recorded more yield.

In a CVT at PRS Panniyur, during the year 2003, few of the vines produced spikes. Karimunda produced the maximum spikes 250 g / vine followed by HP 813 (145g/vine).

Based on the survey to identify low input responsive varieties of black pepper, the following local varieties were selected for further trials - Karimunda, Neelamundi, Kottanadan and Kotta. Black pepper variety Karimunda was found to be the most popular one in southern districts of Kerala. The other important varieties are Panniyur 1, Neelamundi, Kaniyakkadan, Narayakodi and Perumkodi. Under high elevation, the maximum coverage was recorded by the variety Neelamundi (91.6%).

With an objective to develop a black pepper variety resistant/tolerant to *Phytophthora* foot rot disease, breeding trials were undertaken. In the inter specific crosses, even though seeds were set and seedlings were obtained using *P. nigrum* as female parent, the seedlings were found apomitic and not hybrids. Inter specific crosses involving *P. colubrinum* as female parent had not resulted in seed set. Disease tolerant/resistant plants from inter varietal crosses are field planted and are being evaluated for horticultural characters and level of resistance. Among the cultivars of northern Kerala collected and screened against *Phytophthora capsici*, none was found to be resistant/ tolerant.

From a field survey, it was observed that the application of chemical fertilizers to pepper in general is very low in all the southern districts of Kerala. Farmers usually resorted to the use of organic manures (89.1 %). The use of bio-fertilizers was found on the increase in all the districts surveyed. Maximum adoption of bio-fertilizer application was in Pathanamthitta district (13.6 %). In general, adoption of control measures against pests and diseases were low. Soil drenching against foot rot was adopted by 61.7 % of pepper farmers in Idukki district. In other districts, the adoption ranged from 16.3 % to 34.6 %.

Summer irrigation was found to improve the production of spike bearing laterals and well developed berries, spike compactness, weight and volume of green berries, green yield and dry yield per vine. The plants irrigated @ 10 litres per vine per week by basin method up to March showed 48 per cent enhancement in dry yield per vine compared to unirrigated plants. Significant effect of irrigation treatments was also observed on biochemical parameters like chlorophyll 'a', total chlorophyll, polyphenol oxidase activity (PPO), nitrate reductase activity (NRA), total C and total N. Among quality parameters, only oleoresin content was influenced by the application of irrigation treatments with maximum content in plants treated with fogger irrigation up to February. With respect to physiological parameters, the plants treated with basin irrigation up to March registered highest photosynthetic rate. The maximum BCR was recorded with the treatment of basin irrigation up to March. Basin irrigation @ 10 litres week⁻¹ vine⁻¹ up to March was concluded as the best among the treatments given. Since continuous irrigation did not have much pronounced effect on yield, compared to basin irrigation up to March, it was concluded that a short span of dry period just before flushing and flowering is needed for better yield in black pepper.

The experiment aimed at improving the yield and quality of black pepper with the application of different growth regulators at spike initiation period showed that most of the

Partial substitution of nitrogen requirement of black pepper through organic manures revealed that the treatment 100% N+ full P&K recorded a spike yield of 5097g/vine followed by 50% N+vermicompost @ 2 kg/vine with an yield of 4792g/vine.

In the experiment to study the efficacy of biofertilizer using *Azospirillum* on black pepper, it was observed that the treatments of N 100% as inorganic + *Azospirillum* 50g+10 kg FYM recorded the maximum spike yield of 2679g/vine. In the study on using P-solubilizers on black pepper, the treatment N 100% as inorganic + P-solubilizers 50g +10 kg FYM recorded the maximum spike yield of 3460 g/vine.

Quality attributes like essential oil, oleoresin and piperine contents were significantly higher in integrated nutrient management with biofertilizer + organic + inorganic combination. Foliar N, P and K contents recorded higher values with FYM + inorganic treatments while Ca and S uptake were better with biofertilizer treatments. Uptake of Mg and micronutrients exhibited no significant treatment differences. Biofertilizer applied plots also registered higher soil microbial population of fungi, bacteria and actinomycetes.

Significant positive correlations with yield were exhibited by plant height, canopy spread, number of laterals, number of spikes, spike length and number of berries per spike in Panniyur 1 and Panniyur 2. Higher benefit cost ratio was recorded by control plots in both the varieties. Excluding control, most economic treatments were FYM + 50% N and 100% P and K as inorganic and all the three bio-fertilizers + FYM + NPK as inorganic in Panniyur 1 (BCR - 2.52) and FYM + bio- fertilizer + inorganic combination in Panniyur 2 (BCR - 3.92).

The results of the study to find out the influence of organic manures and bio-fertilizers on yield of pepper revealed that the treatment involving substitution of 50 per cent of the recommended inorganic fertilizer dose with FYM on equivalent N basis and the remaining 50 per cent of the dose met through inorganic N and P recorded the highest yield in all the southern districts.

The results of the study to formulate agronomic technologies, which may require only minimum investment but can ensure comparatively high yield and profit in black pepper indicated the feasibility of minimizing input use by 50% in respect of mineral fertilizers and lime without sacrificing yield, provided it is substituted either by growing cowpea in the inter-space and basins or by applying composite cultures of *Azospirillum*, *Phosphobacterium* and VAM. Marginal increase in yield, over POP recommendation was observed in respect of the treatment receiving 50 per cent POP and application of zinc sulphate. It was also observed that yield reduction was negligible when the application of phosphorus was skipped from the recommended fertilizer dose.

Metalaxyl Gold MZ (5g/l) and *Trichoderma harzianum* was found effective in controlling the foot rot disease followed by application of Akomin (3ml/l) and *Trichoderma harzianum*. The disease incidence was very low when Metalaxyl Gold MZ fungicide was combined with the soil application of *Trichoderma harzianum*.

A trial was laid out during 2001 at PRS, Panniyur and pepper cuttings were planted as intercrop in arecanut garden at four levels of population using arecanut palms as standard. Maximum number of plant establishment was observed when pepper was planted in 25 % population of areca. The maximum vine length was also observed in 25% population of

areca. In general, the disease incidence in pepper was less in arecanut - pepper intercrop system.

Out of the 32 fungi isolated from various pepper fields, the fungi viz. *Trichoderma* spp., *Aspergillus* sp., *Penicillium* sp., *Fusarium* spp., *Pythium* sp., *Cunninghamella* sp., and *Rhizopus* sp. showed antagonistic property against foot rot pathogen *Phytophthora capsici*. The local sp. showed maximum inhibition against the foot rot pathogen identified were *Trichoderma koningii* (Kollam); *Trichoderma longibrachiatum* (Idukki) and *Trichoderma polysporum* (Thrissur & Ernakulam). The plants which received *Trichoderma* local isolate and Potassium phosphonate (0.3 %) showed minimum disease incidence. In severely affected grown up plants, drenching Fytolan and spraying Bordeaux mixture gave maximum control. In newly planted pepper garden, minimum wilt incidence was noticed in the plot which received *Trichoderma* local isolate and Potassium phosphonate (0.3 %). The oleoresin content varied from 8.8 to 11.9 %, whereas piperine from 3.6 to 4.5 % which shows that the quality remains good and unchanged due to various treatments. For controlling *Phytophthora* rot in black pepper nursery, the treatment combination consisting of soil solarization for 30 days, addition of native antagonists and spraying Ridomil MZ was found promising. This treatment was followed by the standard recommendation of PoP of KAU. The native antagonists of *Trichoderma* spp. selected from different districts are *T. Koningie*, *T. viride*, *T. harzianum* and *T. longibrachiatum*.

An experiment conducted at CRS, Pampadumpara on the biological control of *Phytophthora* foot rot of black pepper in nursery revealed that planting in solarized soil fortified with *Trichoderma* and VAM gave maximum number of sprouted cuttings, number of roots and length of roots. Incidence of nursery rot was also less in this treatment. The soil temperature under the polyethylene cover raised up to 52 °C compared to 41 °C in the control. Fungi population was very low in solarized soil and this helped in the multiplication of *Trichoderma* due to less competition from the natural flora. The compatibility studies of these antagonists with fungicides, insecticides and fertilizers revealed that they were compatible with Indofil M 45, Akomin, Phorate, Carbofuran, Urea, Rajphos, Ammonium Sulphate and MoP.

The survey conducted for the incidence of insect pests in black pepper at high altitudes showed a new species of unidentified scale insect in some of the gardens. Scale insects (mussel scale and coconut scale) and marginal gall thrips were found predominant insect pests at high ranges of Idukki district and were recorded from all panchayats surveyed. Incidence of marginal gall thrips ranged from 8.87% in Vandenmedu to 30.93% in Erattayar. Infestation by scale insects (mussel scale) was very severe occurring to a maximum of 100% at Nedumkandam. Foliar two-tailed mealy bug was observed in eight panchayats, the maximum being at Vandenmedu (6.93%). Though the intensity of leaf miner and leaf gall incidences were lower, those of which were registered in seven and five panchayats, respectively. Bagworm and aphids were also recorded from some localities.

Survey conducted on the foliar infection of anthracnose of black pepper at high ranges of Idukki district showed that disease incidence ranged from 0.7 to 13.6%. Disease occurred more prevalent at altitudes 1100 meters above MSL. Percentage reduction of foliar anthracnose ranged from 16.8 to 95.3%. Highest reduction of the disease was recorded with Carbendazim @ 0.1% foliar spray (95.30%) followed by Mancozeb @ 0.2% (twice) foliar spray (92.7%), which is reflected from reduced spike infection also. However, the least spike

infection was recorded in combination of Carbendazim and Mancozeb 0.1% foliar spray (3.83%). The survey indicated that both anthracnose and stunted disease of black pepper are on the increase in Idukki district. In some panchayats like Chackupallom and Vandenmedu, anthracnose is more severe superceding even foot rot.

Studies on the control of *Phytophthora* foot rot disease in black pepper in farmer's fields showed least reduction in disease incidence in vines sprayed with Metalaxyl. Disease reduction was highest in vines treated with *T. harzianum* 50 g (cfu 10⁷) and neem cake applied @ 1 kg/vine. A combined application of *T. harzianum* and Potassium phosphonate resulted in the highest yield (1444 g plant⁻¹).

In the experiment on germplasm collection and description of types and varieties of small cardamom, a total of 121 accessions are maintained in the gene bank at present. The highest wet yield (3054 g/plant) and dry yield (588 g/plant) of capsules was recorded in S-1, which was also found to be tolerant to thrips (6.5%). PS-27 stood second in terms of green yield (2964 g/plant) and dry yield (552g/plant) of capsules. Infestation by borer was found to be lowest in PS-22 (0.2%) and BEP-2 (0.3%) and highest in MBP (3.8%). The volatile oil content was maximum in accessions S-1 (7.2%) and PPK-2 (7%). The oleoresin concentration was high in accessions PS-27 (11.2% and BEP-1(11%).

The cardamom variety PV-2 was recommended for release in the cardamom hill reserve of Idukki district. This is a bold capsuled *Vazhukka* variety with an average yield of 916 g / plant.

In the CYT trial on cardamom, 20 high yielding accessions and two checks namely Green Gold and PV 2, the high yielding accessions from germplasm lines (PS 27, PS 3, BEP 1, BEP 2 and PPK 2), two hybrids (HY6 and HY 9) and 13 accessions that exhibited marked variability in farm (NS 24, NS 29, NS 18, NS 20, NS 25, NS 50, NS 34, NS 39, Pl. No. 1,4,10,14, 19) are under evaluation.

In the biofertilizer trial using *Azospirillum* on cardamom, the treatments, FYM 10 kg + *Azospirillum* 50g, FYM 5kg alone, FYM 10 kg alone and inorganic nitrogen 100% + *Azospirillum* 50g + 5kg FYM were on par with each other in producing significantly higher yield than others. The highest dry yield of cardamom was reported in FYM 10 kg + *Azospirillum* 50g (0.361 kg plant⁻¹) followed by FYM 5kg alone (0.337 kg plant⁻¹)

The efficacy of various insecticides including newer generation neonicotinoids was evaluated against cardamom root grub. The population was found to be lower in those plots treated with insecticides at higher concentration. All the insecticide treatments significantly reduced the grub population compared to that of control. The maximum reduction was observed in Carbofuran @ 150 g plant⁻¹ treated plots (80.73%) followed by those plots treated with Chlorpyrifos 0.07% (78.86%) and Imidacloprid 0.75ml litre⁻¹ (73.15%). At lower concentration of insecticides, Carbofuran @ 100 g plant⁻¹ treated plots recorded the maximum suppression of root grub and plots drenched with Chlorpyrifos 0.05% recorded the minimum. Therefore, all the insecticide treatments were effective in reducing the population of cardamom root grub to more than 50%.

In the studies on the bio-ecology of natural enemies of major insect pests of cardamom, two ichneumonid larval-pupal parasitoids and two dipteran parasitoids were recorded against cardamom shoot and capsule borer, *Conogethes punctiferalis*. The two ichneumonids were

identified as *Agrypon* sp. and *Temelucha* sp. These parasitoids were found gregarious in nature that deformed the parasitized pupae of *Conogethes punctiferalis* typical to that of puparium. Three entomopathogenic fungi were isolated from cardamom whitefly. These were (a) orange coloured *Aschersonia placenta* (b) white coloured *Verticillium* sp. (c) black coloured unidentified fungi.

Green lacewing fly, *Chrysoperla carnea* was recorded from cardamom plantations subjected to minimum insecticide application. Pedicellate eggs were observed from leaf tips of cardamom and the neuropteran fly was actively searching for the prey (*Sciothrips cardamomi*) on cardamom leaf sheaths.

The percentage parasitization of cardamom shoot and capsule borer on different months showed highest parasitization in July (91.7%) and lowest in September (50%). Parasitization of cardamom shoot borer larvae by the dipteran house fly-like parasitoid ranged from 30.8 to 100% and occurred during all months under investigation. The incidence of parasitization was highest during October (100%). Parasitization by dipteran mosquito-like parasitoid was registered only during four months viz., March, April, May and August. The occurrence of this parasitoid during monsoon phase was minimum, while the highest incidence was observed in August (53.8%). Except during October, parasitization by ichneumonid parasitoid was observed in all months ranging from 5 to 40%. Least incidence was recorded during June (5%).

Comparative yield trials conducted at RARS Kumarakom with 20 accessions of ginger revealed that Accession 204 and Varada were ideal for intercropping in coconut garden. In raw ginger yield, Accession 204 and Varada were on par with an average yield of 35.79 tons and 34.43 tons/ha respectively. The above two entries were found to be tolerant to soft rot disease under field conditions. Based on the results of CYT, the above entries were tested in farm trials at five locations in the major ginger belt of Kottayam district with farmers' variety as check. In farm trials also accession 204 proved its superiority.

In the experiment on the effect of biofertilizer, *Azospirillum* on ginger, the treatments T1 (Inorganic N (100 %) + *Azospirillum* (50g) + 5 kg FYM), T2 (Inorganic N (75%) + *Azospirillum* (50g) + 5kg FYM), T3 (Inorganic N (50%) + *Azospirillum* (50g) + 5 kg FYM) and T6 (FYM (10kg) + *Azospirillum* (50g)) were on par with each other and superior to others.

Among the 22 ginger accessions in the germplasm, PGS-667 recorded the highest yield (34.33t/ha) followed by PGS-35 (32 t/ha) and Maran (31.167 t/ha).

Germplasm collection consisting of 25 ginger varieties is maintained at RARS, Ambalavayal. Varieties, Maran (46.25 t/ha) and Jamaica (43.75 t/ha) were found to be higher yielders.

Evaluation of seven induced variants along with three check varieties of ginger indicated the superiority of the autotetraploids V2 and V1 in quality attributes. V2, an autotetraploid from Rio-de-Janeiro was notable for lowest fibre content, highest oil and oleoresin content and increased dryage and high cuticle thickness than its diploid counterpart. V1, an autotetraploid from Himachal Pradesh exhibited highest dryage, high oleoresin content and highest cuticle thickness. V2 was more vigorous in growth exhibiting maximum yield contributing characters such as number of tillers per plant, number of leaves per plant, leaf area and also leaf area index and root length. V1 showed maximum plant height and pseudostem height

which are correlated with yield. The fresh and dry yield of rhizomes of V1 and V2 were found to be on par with Vs the highest fresh rhizome yielder and V10 the highest dry rhizome yielder. V3, a variant from Himachal Pradesh also produced yield on par with the highest yielder. The yielding capacity of the autotetraploids especially V2 was found superseded by the incidence of diseases like soft rot and bacterial wilt. V1 was least susceptible to leaf spot and had low incidence of soft rot and bacterial wilt.

The high pollen fertility and viability of the autotetraploids V1 and V2 and the highest pollen size and tube length observed in V2 make them ideal as pollen parents in hybridization programmes.

None of the various *in vivo* pollination techniques such as stylar, stigmatic, intra ovarian was effective for inducing fruit set or seed set in ginger. *In vitro* placental pollination with pollen grains suspended in ME3 medium was found best with maximum ovule swelling and maximum percentage of cultures with developed ovules (90 %).

The experiments on culture establishment in ginger showed that MS semi solid medium at half strength supplemented with NAA (0.5 mg/l) + BAP (2.5 mg/l) along with 3% sucrose + 2H (200mg/l) or CW (15%) v/v supported maximum development of ovules. Addition of double the quantity of the vitamin stock of the MS medium to the culture establishment medium and incubation under dark conditions also favoured more ovule development. Semi solid medium was advantageous in obtaining maximum seed set and size at maturity.

Controlled selfing and crossing among the autotetraploids and diploid cultivars of ginger using *in vitro* placental pollination were successful and influenced ovule development. Mid season of flowering favoured maximum culture establishment and ovule development compared to early and late season in both selfing and crossing. Crossing enabled production of maximum number of developed ovules compared to selfing.

In ginger ovules/seeds developed *in vitro* were creamy white during the initial stage of development which changed to purple red colour within a period of 30 - 35 DAP and to black within a period of 55 - 80 DAP. The small arillate seeds had two seed coats, outer one being thick and inner one being thin. The seed coat encloses a cavity, which is typical of monocots. In the cavity, endosperm with embedded embryo is seen. Tetrazolium staining of well developed seeds of ginger revealed that the embryos were viable, staining red, which was more intense at 40 DAP than at 80 DAP seeds.

In ginger, seed germination studies indicated that subjecting the seeds to embryo rescue (embryo culture) and *in vivo* seed treatments failed to induce germination. Under *in vitro* conditions, the seed of 80 DAP obtained from the cross diploid (Rio-de-Janeiro) x tetraploid (Z-0-78) germinated after seed priming treatment (50 ppm KNO₃ for 8 h) and also the cross of tetraploid (Z-0-86) x diploid (Maran) after seed inhibition in water for one day when cultured in half MS + 2, 4 - D (0.5) mg l⁻¹, BAP (6.0) mg l⁻¹ and GA₃ (5.0) mg l⁻¹ along with 3 per cent sucrose, showing good root development. Seed of the cross between diploid (Rio-de-Janeiro) x diploid (Maran) and diploid (Rio-de-Janeiro) x tetraploid (Z-0-86) germinated showing radicle emergence after culturing in solid medium of half MS + 2, 4 - D (0.25) mg l⁻¹ and BAP (9.0) mg l⁻¹ along with 3 per cent sucrose.

Somatic embryoids of ginger were developed from seeds cultured in media combinations of half MS + 2, 4 - D (0.5) mg l⁻¹, BAP (6.0) mg/l and GA₃ (5.0) mg /l along with 3 per cent

sucrose and also in half MS + 2, 4 - D (0.1) mg l⁻¹, BAP (8.0) mg l⁻¹ along with 3 per cent sucrose in crosses between diploid and tetraploid. Plant regeneration from the somatic embryoids was not observed even after subjecting to media with different concentrations of various growth regulators.

In ginger callus growth was also observed after 25 days of seed germination in the seed culture medium containing half MS + 2, 4 - D (0.5 mg l⁻¹), BAP (6.0 mg l⁻¹) and GA3 (5.0 mg l⁻¹) along with 3 per cent sucrose.

Among the forty collections in the turmeric germplasm, VK-31 registered the highest yield of 42.5 t/ha. Kanthi, Sobha, Sona and Varna were added to the germplasm collection.

In CVT 1991 in cinnamon, SL-203 recorded the highest wet (9.035kg) and dry (3.835 kg) weight of quills /12 plants. Samples of cinnamon types were given to IISR, Calicut for quality analysis.

Seventeen elite types of garcinia were identified through a survey conducted in Kottayam and Pathanamthitta districts. Among different vegetative propagation methods tested, side and softwood grafting techniques were found most suitable for the propagation of the crop. For breaking seed dormancy in this species, direct sowing of processed seeds, after removing the seed coat, was the most suitable practice. Similarly, for enhancing the percentage of success in softwood grafting, application of Kinetin @ 100 ppm or Kinetin + NAA @ 100 ppm each was most ideal.

General observations on garcinia grafts planted in the field revealed that grafts start bearing 3-4 years after planting. Dry rind yield obtained from different clones during the period indicated that clones GC 64/90 (4.32 kg/tree), GC 13/90 (2.80 kg/tree) and GC 2/90 (2.70 kg/tree) were the top yielders.

In the fertilizer trial in clove to study the response to nitrogen and potash, the level N2 K1 (400g N + 250 g K₂O/plant/year) recorded the highest mean yield of 1.350 kg/plant followed by the level N1K2 (200g N+500 g K₂O/plant/year) with a mean yield of 1.106 kg/plant.

Nutmug grafts, A9/4, A9/20, A9/25, A9/71 and A9/50 were planted in the field to find the suitability to high ranges.

Four cultures of cassia obtained from IISR, Calicut viz., C1, D1, D3 and D5 were planted.

List of experiments

- i) KAU Projects
 - a) Concluded experiments : Nil
 - b) Experiments in progress

Sl. No.	Code No.	Title of the experiment	Location
1	SPC-05-00-07/93 PMP(1)/KAU	Fertilizer requirement of black pepper	CRS, Pampadumpara
2	SPC-05-00-04/92 KTR(1)/KAU	Effect of irrigation and fertilizer application on the growth and yield of pepper	FSRS, Sadanandapuram
3	SPC-02-00-01/2000/ VKA(10)/GOK	Testing of the released pepper varieties in various tracts of Kerala	CoH, Vellanikkara

4	SPC-01-00-02/ 2000/VKA (16)/GOK	Identification of low input responsive varieties in relation to local technology in black pepper	CoH, Vellanikkara
5	SPC-01-00-01/ 2000/VKA (1)/ GOK	Use of organics and bio-fertilizers in black pepper for quality improvement	CoH, Vellanikkara
6	SPC-14-00-02/ 2000/VKA (1)/ GOK	Standardization of low input technology for black pepper	CoH, Vellanikkara
7	SPC-01-00-05- 2004/VKA (16)/ KAU	Performance of different varieties of bush pepper in coconut garden	CoH, Vellanikkara
8	SPC-14-00-05- 2004/VKA (16)/ KAU	Performance of bush pepper in coconut garden under different nutrient management systems	CoH, Vellanikkara
9	SPC-07-00-04-2002/ VKA (16)/KAU/PG	Crop-standard interactions in black pepper (<i>Piper nigrum</i> L.)	CoH, Vellanikkara
10	SPC-01-001-07-92/ AMB(04)/KAU	Multi-locational trial on black pepper	RARS, Ambalavyal
11	SPC-12-00-10-99/ AMB(10)/ KAU	Clonal variability analysis in black pepper var. Panniyur I	RARS, Ambalavyal
12	SPC-14-00-16-99/AMB (10)/ KAU	Survey, selection and screening of black pepper varieties/ cultivars of northern Kerala for high yield and tolerance/ resistance to <i>Phytophthora capsici</i>	RARS, Ambalavyal
13		CVT on black pepper	RARS, Ambalavayal
14	SPC/01-00-98/ PNR (16)/ KAU	Evaluation of black pepper varieties for growing as bush pepper	PRS, Panniyur
15	SPC/05-00-03/98/ PNR (1)/ KAU	Partial substitution of nitrogen requirement of black pepper	PRS, Panniyur
16	SPC/05-00-12-99/ VKA (1)/ KAU/ PG	Effect of biofertilizers on early rooting, growth and nutrient status of black pepper (<i>Piper nigrum</i> L.)	CoH, Vellanikkara
17	SPC-03-00-01/90 VKA (16)/KAU	Species relationship in the genus <i>Piper</i> and scope of related taxa in the improvement of <i>Piper nigrum</i> L.	CoH, Vellanikkara
18	SPC-01-00-01/ 2000/VKA (10)/GOK	Identification of location specific varieties of black pepper	CoH, Vellanikkara
19	SPC-03-02-01/ 2000/VKA (16)/GOK	Breeding for resistance to <i>Phytophthora</i> foot rot in black pepper	CoH, Vellanikkara
20	SPC-03-02-02-2003/ PNR (9)/KAU	Compatibility of grafting <i>Piper nigrum</i> on <i>Piper colubrinum</i>	PRS, Panniyur
21	SPC-03-02-03-2003/ PNR (9)/KAU	Creation of genetic variability in black pepper for foot rot resistance and drought resistance through mutation.	PRS, Panniyur
22	SPC-03-02-04- 2003/PNR (5)/ KAU	Anatomical and biochemical basis of disease resistance/tolerance against foot rot disease of black pepper	PRS, Panniyur
23	SPC-03-02-05-2003/ PNR (5)/KAU	Investigations on viral diseases of black pepper	PRS, Panniyur
24		Biological control of <i>Phytophthora</i> foot rot of black pepper (nursery trial)	RARS, Ambalavyal
25		Use of biocontrol for checking <i>Phytophthora</i> disease	PRS, Panniyur
26		Incorporation of biocontrol in nursery plants for checking <i>Phytophthora</i> disease	PRS, Panniyur

27	SPC-08-06-10-95/PMP (9)/KAU	Evolution of bold capsule variety from PV-1	CRS, Pampadumpara
28	SPC-09-00-11-96/PMP (9)/KAU	Breeding high yielding varieties of cardamom	CRS, Pampadumpara
29	SPC-01-001-07-92-MB(04)/KAU	Efficacy of bio-fertilizer in ginger with <i>Azospirillum</i>	RARS, Ambalavyal
30	SPC-12-00-03/9-82 VKA (16)/ KAU	Germplasm collection and evaluation of ginger	CoH, Vellanikkara
31	SPC-12-00-02-85/AMB/NARP	Maintenance of germplasm in ginger	RARS, Ambalavyal
32	SPC-12-00-05/90 VKA (2)/KAU	Isoenzyme variation in zingiberaceous spice crops	CoH, Vellanikkara
33		Nematodes specific asurvey (burrowing nematode, <i>Radopholus similis</i> on ginger and turmeric	CoA, Vellayani
34	SPC-12-00-04/82 VKA (16)/KAU	Germplasm collection and evaluation of turmeric	CoH, Vellanikkara
35	SPC-13-00-02-85/AMB/NARP	Maintenance of germplasm in turmeric	RARS, Ambalavyal
36		Nematodes specific asurvey (burrowing nematode, <i>Radopholus similis</i> on ginger and turmeric	CoA, Vellayani
37	SPC-01-00-07-89/AMB/NARP	Response of clove to different levels of nitrogen and potash	RARS, Ambalavyal
38		Multi-locational trial on cinnamon	RARS, Ambalavyal
39		Nutrient management of Garcinia grafts in the reclaimed alluvial soils of Kuttanad	RARS, Kumarakom
40	SPC-06-00-01-2002/ VKA (16)/ KAU/PG	Micropropagation of Malabar Tamarind (<i>Garcinia gummigutta</i> var. <i>gummigutta</i>)	CoH, Vellanikkara
41	SPC-11-00-KUM (9)/ 90/NARP	Collection, maintenance and evaluation of the germplasm of <i>Garcinia cambogia</i> Desr.	RARS, Kumarakom
42	SPC-13-00-02-2003/ CLY (1)/KAU	Nutrient management in vanilla (<i>Vanilla planifolia</i> Andrews)	ARS, Chalakudy
43	SPC-13-00-03-2004/VKA (16)/ KAU	Developing improved production and processing technologies for <i>Vanilla planifolia</i> Andrews	CoH, Vellanikkara
44	SPC-12-02-02-2004/ ACV(5)/KAU/PG	Viral diseases of vanilla (<i>Vanilla planifolia</i> Andrews) in Kerala	CoA, Vellayani

ii) Externally aided projects

- a) Concluded experiments : Nil
- b) Experiments in progress

Sl. No.	Code No.	Title of the experiment	Location
1	SPC-05-00-02/ 96/PNR(1)/ ICAR	Trial on drip irrigation in black pepper varieties	PRS, Panniyur
2	SPC-01-00-01/72/ PNR (9)/ICAR	Germplasm collection and screening of pepper genotypes	PRS, Panniyur
3	SPC-01-00-04/ 72/PNR (9)/ICAR	Intervarietal hybridization in pepper	PRS, Panniyur

4	SPC-01-00-07/93/ PNR (9)/ICAR	Multi-locational trial in black pepper	PRS, Panniyur
5		Co-ordinated varietal trial in black pepper (CVT 2000-Series V)	PRS, Panniyur
6	SPC-01-00-07/93/ PMP (9)/ICAR	Co-ordinated varietal trial in black pepper	CRS, Pampadumpara
7	SPC-01-00-03/ 2001/PMP/AICRP	Co-ordinated varietal trial in black pepper	CRS, Pampadumpara
8	SPC-07-00-03/96/ PMP (4)/ICAR	Control of scale insects in black pepper	CRS, Pampadumpara
9	SPC-12-02-01/2001/ PMP (5)/ AICRP	Incidence, epidemiology and management of anthracnose of black pepper	CRS, Pampadumpara
10	SPC-09-00-03/2001/ PMP (5)/ ICAR	Biological control of foot rot of black pepper – nursery trial	CRS, Pampadumpara
11	SPC-07-00-02/96/ PMP (4)/ICAR	Survey for the incidence of insect pests in black pepper in high altitude	CRS, Pampadumpara
12	SPC-09-00-02/ 2000/VKA (1)/GOK	Use of bio control for checking <i>Phytophthora</i> disease in black pepper	CoH, Vellanikkara
13	SPC-09-00-01/ 2000/VKA (5)/ GOK	Incorporation of bio-control in nursery plants for checking <i>Phytophthora</i> disease	CoH, Vellanikkara
14	SPC-09-00-01-93/ PMP/ICAR	Manurial experiment in cardamom	CRS Pampadumpara
15	SPC-07-00-02-2001/ PMP (3)/ AICRP	Efficacy of bio-fertilizer on cardamom yield (<i>Azospirillum</i>)	CRS, Pampadumpara
16	SPC-09-00-01- 82/PMP (9)/ICAR	Co-ordinated varietal trial in cardamom	CRS, Pampadumpara
17	SPC-09-00-05- 86/PMP(9)/ICAR	Germplasm collection and description of types and varieties of small cardamom	CRS, Pampadumpara
18	SPC-01-00-03- 2001/PMP/AICRP	Co-ordinated varietal trial in cardamom	CRS, Pampadumpara
19	SPC-12-01-01-2001/ PMP (4)/ AICRP	Bio-ecology of natural enemies of major insect pests of cardamom	CRS, Pampadumpara
20	SPC-12-01-02-2001/ PMP(4)/AICRP	Management of cardamom root grub through insecticides	CRS, Pampadumpara
21	SPC-13-00-01/89/ ACV (4)/ICAR	Assessment of yield loss due to nematode complex in ginger and turmeric	CoA, Vellayani
22	SPC-13-00-02/89/ ACV (4)/ICAR	Integrated control of root knot nematode in ginger	CoA, Vellayani
23	SPC-13-00-01/89/ ACV (4)/ICAR	Assessment of yield loss due to nematode complex in ginger and turmeric	CoA, Vellayani
24	SPC-13-00-02/89/ ACV (4)/ICAR	Integrated control of root knot nematode in ginger	CoA, Vellayani
25	SPC-07-00-06/2004/ PNR(9)/AICRP	Effect of bio-fertilizer, <i>Azospirillum</i> on the yield of black pepper	PRS, Panniyur
26	SPC-07-00-05/2004/ PNR(9)/AICRP	Effect of bio-fertilizer using P-solubilizers on the yield of black pepper	PRS, Panniyur
27	SPC-08-00-01/2004/ PNR(7)/AICRP	Organic farming in black pepper	PRS, Panniyur
28	SPC-09-00-12/2004/ PNR(5)/AICRP	Control of <i>Phytophthora</i> foot rot disease management in black pepper in farmers field	PRS, Panniyur
29	SPC-09-00-13/2004/ PNR(5)/AICRP	<i>Phytophthora</i> foot rot incidence in black pepper under different plant densities in an arecanut garden	PRS, Panniyur

8. CASHEW

Co-ordinator: Dr. P.S.John

HIGHLIGHTS

- The application of nitrogen @ 1kg per tree significantly increased the tree height, canopy spread, number of flushes per m² and nut yield. Phosphorus application at 250g per tree reduced the number of days to flowering and improved the ascorbic acid content of the apple and protein content of kernels. Potassium application at 250g per tree resulted in improving the kernel weight and apple yield.
- The cashew varieties were grouped into 4 different clusters based on the physico-chemical and nutritional composition of cashew apple. Fourteen varieties were selected for preparing candy and tully fruity.
- Entry No.II 1593 with an yield of 16.5 kg/tree/annum and Hybrid-7 (H-7) with an yield of 20 kg/tree/annum were proposed for variety release.
- Lambda-cyhalothrin (20 and 25 ppm) can be used as an effective and cheap insecticide for TMB management. It is safe to predators such as ants and spiders and not phytotoxic at 4N dose.

SUMMARY

For the successful production of root stocks, a potting mixture with sand: soil: cow dung was better and the best growth was observed when the potting mixture received microbial inoculation of *Azospirillum*, PSB and AMF in combination. Eventhough, poultry manure had better nutrient content, it was less suitable in the preparation of potting mixtures for cashew. Towards grafting stage, it was seen that the performance of seedlings was better even in poultry manure applied treatments as compared to coir pith compost.

The soil application of 100ml of decanted extract of groundnut cake + 17: 17: 17 mixture at three months after grafting improved the growth and vigour of cashew grafts.

List of experiments

- i) KAU projects
a) Concluded experiments

Sl. No.	Code No.	Title of the experiment	Location
1.	CASH-03-00-03-2002/ VKA(1)/KAU/PG	Nutrient management in cashew nursery	CRS, Madakkathara
2.		Evaluation and management of pest complex in cashew grafts	CRS, Madakkathara

- b) Experiments in progress

Sl. No.	Code No.	Title of the experiment	Location
1.		Increasing productivity of cashew through breeding and management	CRS, Madakkathara

		1. Evaluation of promising Madakkathara accessions and hybrids for yield and resistance to biotic stress	CRS, Madakkathara
		2. Growth and yield characters of cashew as influenced by chemical retardants	CRS, Madakkathara
2.		Evolving photo-insensitive varieties of coleus for central zone of Kerala	CRS, Madakkathara

ii) Externally aided projects

a) Concluded experiments

Sl. No.	Code No.	Title of the experiment	Location
1.	CC-05-00-01/87/ MDA/ICAR	Cashew pest complex 1. Chemical control of major pest-tea mosquito bug 2. Control of minor pests	CRS, Madakkathara
2.	NATP	Developing integrated production package for enhancing productivity of cashew	CRS, Madakkathara
3.	Syngenta Co. Ltd.	Evaluation of Karate SEC (lambda-cyhalothrin)	CRS, Madakkathara
4.	ICAR	Soil test based productivity linked approach for cashew nutrition	CRS, Madakkathara
5.	CASH-03-00-01- 2000/VKA(3)/ AICRP/PG	Effect of major nutrients on the yield and quality of nuts in graft based cashew (<i>Anacardium occidentale</i> L.)	CRS, Madakkathara

b) Experiments in progress

Sl. No.	Code No.	Title of the experiment	Location
1.	CC-01-02-88/MDA/ (90)/ICAR	Germplasm collection, conservation, evaluation, characterization and cataloguing in cashew	CRS, Madakkathara
2.	CC-01-00-04-73/MDA (90)/ICAR	Hybridisation and selection of cashew	CRS, Madakkathara
3.		Multilocal trial II (MLT 1992) in cashew	CRS, Madakkathara
4.		Multilocal trial III (MLT 2002) in cashew	CRS, Madakkathara
5.	CC-05-00-01/ 87/MDA/ICAR	Evaluation of insecticides for control of Tea Mosquito Bug (TMB) and other insect pests of cashew	CRS, Madakkathara
6.	CC-05-00-02/87/ MDA/(4)/ICAR	Prophylactic trial for the control of cashew stem and root borers	CRS, Madakkathara
7.	CC-05-00-02/87/ MDA/(4)/ICAR	Curative trial for the control of cashew stem and root borers	CRS, Madakkathara
8.	CC-05-00-03/87/ MDA/(4)/ICAR	Bio-ecology of pests of regional importance and survey of pest complex and natural enemies in cashew	CRS, Madakkathara

9.	CC-02-00-01/88/ MDA/(4)/ICAR	Screening of cashew germplasm to locate tolerant/ resistant types for major pests of the region	CRS, Madakkathara
10.		NPK fertiliser experiment in cashew	CRS, Madakkathara
11.		Fertiliser application in high density cashew plantation	CRS, Madakkathara
12.		Intercropping in cashew	
13.		Onfarm fertiliser trial in cashew	CRS, Madakkathara
14.	TSI-FAI-IFA	Sulphur in balanced fertilization	CRS, Madakkathara
15.	NHB	Commercial production of hybrid vegetable seeds	CRS, Madakkathara

9. BEVERAGES

Co-ordinator : Dr. V.K.Mallika

HIGHLIGHTS

- Six lots of cocoa bud wood were introduced from the University of Reading, U K. enhancing the number of accessions in germplasm VI to 525.
- Evaluation of germplasm showed that the top yielding clones of cocoa were G VI 35, G VI 44, G VI 50 and G VI. The clone G VI 35 consistently recorded the highest yield for the last thirteen year period.
- Inbreeding depression in cocoa varied with genotype.
- Top worked plants registered yield decline after a very high yield during the initial years.
- Pre-emergence herbicides such as oxyfluorfen @0.3 kg/ha and pendimethalin @1.5 kg/ha were very effective for weed control in the cocoa nursery.
- Studies on small-scale fermentation and drying using heap, box, basket and tray methods showed that the heap method (50kg) produced commercially acceptable cocoa beans. When the quantity of the ferment is smaller than 50kg, basket method was the best.
- The acidity of cured beans could be reduced by soaking the beans in sodium bicarbonate (0.5 – 2%) for different duration (1-3h) and by increasing the pH from 4.97 to 5.5.
- Roasting duration varied markedly with the size of beans. Small beans (100g) took only 3 minutes under 100% microwave power as against 4 minutes by big beans for roasting.
- The method of extracting cocoa butter on farm scale (up to 31%) was standardized. The cocoa powder separated by cocoa butter extractor fabricated for farm level processing contained 26-35% cocoa butter. The use of beans of smaller bean count (76.3) recorded the highest butter yield of 31.5 per cent and less shell (10.03%).

SUMMARY

Three high yielding and vascular streak die back tolerant hybrids of cocoa, CCRP8, CCRP9 and CCRP10 were evolved. The CCRP8 (PI 1.21) was a hybrid between M 16.9 (CCRP1) x G VI 56 (CCRP7). The average yield of pods per tree was 90 with a potential yield of 131 pods/tree/year. The pods were medium sized (389 g) with bean weight per pod of 126 g. The oven dry weight of peeled bean was 0.9 g. CCRP9 (SII H 7.1) was a hybrid between M16.9 (CCRP1) x GII 19.5 (CCRP4) with an average pod yield of 105. Under favourable situations the yield went up to 358 pods/tree/year. The pods were medium sized (370 g). CCRP10 (SII H 4.13) was a hybrid between GI 5.9 (CCRP3) x GVI 68. The average yield of pods per tree was 79 with a potential yield of 154 pods/tree/year. The pods were medium sized (332g) with average bean weight of 102 g and peeled bean oven dry weight of 1.1 g.

The yield data of 26 clones in CYT I for the last eleven years showed that M 9.16, M 16.9 and G IV 18.5 were the highest yielding clones.

The assessment of yield of 45 clones since 1993 in CYT II indicated that the highest yielding clones were G IV 1.2, G VI 17 and G IV 35.7.

The evaluation of the VSD tolerant hybrids planted during 1998 showed that some of these picked up the disease during the year. However, the degree of incidence of the disease was lower. Out of 29 cross combinations, 15 did not show any symptoms. These precocious and high yielding hybrids with tolerance to the disease were multiplied clonally and subjected to nursery screening.

Genetic analysis of 25 hybrids in progeny trial II showed that the estimates of PCV were higher than GCV for all the traits indicating high influence of environment of trait expression. Moderate heritability combined with high genetic advance was evident for pod weight, precocity of bearing and number of pods per tree (8YFP). Yield was significantly and positively correlated at genotypic and phenotypic levels with number of pods per tree (8YFP) and precocity of bearing. The traits like yield, number of pods per tree, precocity of bearing and pod weight showed high heterotic expression in most of the hybrids.

Estimation of genetic parameters in 22 hybrids in progeny trial III indicated that the hybrids recorded wide variability for plant height (2YAP), pod length, pod width, pod weight, wet bean weight per pod, number of beans per pod, dry weight per bean, bean length, bean width, pericarp thickness, number of ovules per ovary, pod value, pod index and efficiency index. The PCV estimates were higher than GCV for all traits. Yield showed the highest phenotypic coefficient of variation of 41 with a lowest genotypic coefficient of variation of 0.79 indicating very high influence of environment for this trait in the population. Pod weight was the only trait that recorded moderate heritability combined with high genetic advance. It also showed the highest genetic gain. Hence, this trait provides scope for improvement through selection. The other traits recorded moderate heritability coupled with low genetic advance.

In progeny trial IV, genetic analysis of 29 hybrids suggested that the estimates of PCV were higher than GCV for all the traits indicating high influence of environment on trait expression. The *per se* performance of the biparental pair crosses suggested the performance of these hybrids was superior when compared to those of parents (biclinal crosses) and grand parents (clones). The pod weight and wet bean weight recorded moderate heritability with moderate genetic gain offering moderate response to selection. All the other traits recorded low to moderate heritability with low genetic gain offering little scope for improvement through selection.

Analysis of inbreeding depression in the S_1 , S_2 and S_3 generations indicated that the S_2 generation of GI 3.16 was the most vigorous among the generations studied (S_2 & S_3). In the genotype GII 7.4, S_3 generation was the most vigorous among the generations studied. In fact, it was better than open pollinated parent (S_0) generation for growth traits and pod weight. In the genotypes GII 7.2 and G IV 35.7, S_1 generation was the most vigorous and it performed better than the open pollinated parent (S_0) for growth traits.

The top worked plants registered yield decline during the past two to three years. The experience gained over the years suggested that for better performance of the top worked plants, it is necessary to undertake budding all around the cut back stem. This will ensure

development of branches on all sides. The top worked plants with branches on one side of the stem gradually exhibited dieback symptoms from the cut portion with gradual death of the tree.

In the shade trial, the highest yielder during the year was S 53.6 with 232 pods/tree/year. The cumulative yield and mean yield over the last ten years were highest in S 47.20 with values 2317 and 231.7 respectively. Twentythree trees produced an average of more than 100 pods over the last ten years.

Studies were conducted on weed control of cocoa seedlings in the nursery. Solarization for 30-45 days was a promising non-chemical method for preventing the germination and growth of weeds in cocoa nursery. Fumigation with dazomet (30g m^{-2}) was also very effective in weed control. Solarization reduced the population of soil fungi, bacteria and actinomycetes substantially. There was also an increase in the availability of available phosphorus, exchangeable potassium, calcium and magnesium due to solarization in the potting medium. The combination treatment of 45 days solarization with VAM + *Azospirillum* was more effective not only in controlling weeds but also in increasing the growth of cocoa seedlings. Pre-emergence herbicides such as oxyfluorfen (0.3 kg ha^{-1}), pendimethalin (1.5 kg ha^{-1}) and diuron (2kg ha^{-1}) were effective in maintaining a weed free condition up to 90 days after sowing in the nursery. Besides, cocoa seedlings applied with oxyfluorfen (0.3kg ha^{-1}), pendimethalin (1.5 kg ha^{-1}) and atrazin (2.0 kg ha^{-1}) showed better growth than other herbicides indicating some phytotonic effects. Considering the above aspects, oxyfluorfen (0.3 kg ha^{-1}) and pendimethalin (1.5 kg ha^{-1}) could be recommended for weed control in cocoa nursery.

The antagonistic effect of 16 fungi, 24 bacteria and 5 actinomycetes against *Phytophthora palmivora* was tested under *in vitro* conditions. Fifteen efficient antagonists were selected and these were tested on detached pods. The results indicated that two fungal and three bacterial isolates were effective.

By using microwave oven small quantities up to 500g could be roasted effectively. When the quantity ranged from 500g to 5kg, roasting could be done using traditional kitchen pans. The time for roasting varied with the quantity. Uruli roaster was most suitable for roasting beans upto 10kg. Grading and use of beans of uniform size helped to retain the quality of cocoa products.

The germplasm collection and clones planted under CYTI were screened for resistance to VSD. The results showed that out of the 239 clones of germplasm VI screened for VSD, one clone GVI 7 did not show any symptoms of VSD. GVI 54 and GVI 55 showed minimum incidence of VSD.

List of experiments

- i) KAU Projects
 - a) Concluded experiments

Sl No.	Code No.	Title of the experiment	Location
1	BEV-05-00-01-2000/ VKA(1)/KAU/PG	Weed management in nursery and in early years of bearing	CoH, Vellanikkara

b) Experiments in progress

Sl. No.	Code No.	Title of the experiment	Location
1	BEV-04-00-01-2003/ VKA(10)/KAU	Post harvest handling & value addition of cocoa	CCRP, Vellanikkara
2	BEV-01-00-01-2003/ VKA(1)/KAU	Identification of drought tolerant cocoa types	CoH, Vellanikkara
3	BEV-08-02-00-2003/ VKA(5)/KAU/PG	Biological management of <i>Phytophthora</i> pod rot of cocoa	CoH, Vellanikkara

ii) Externally aided projects

a) Concluded experiments

Sl. No.	Code No.	Title of the experiment	Location
1		Genetic analysis of cocoa (<i>Theobroma cacao</i> L.) hybrids	CCRP, Vellanikkara

b) Experiments in progress

Sl. No.	Code No.	Title of the experiment	Location
1	ICAR	Development of technology for farm level secondary processing of cocoa	CCRP, Vellanikkara
2	DBT	Women empowerment through farm level value addition of cocoa	CCRP, Vellanikkara
3	CC-07-00-01-84/VKA(16) Cad India Ltd.	Germplasm collection and maintenance of cocoa	CCRP, Vellanikkara
4	CC-07-00-02-84/VKA(16) Cad India Ltd.	Cocoa breeding	CCRP, Vellanikkara
5	CC-08-00-04-84/ VKA(16) Cad India Ltd.	Standardization of procedure for top working	CCRP, Vellanikkara
6	CC-09-00-01-87/ VKA(16) Cad India Ltd.	Survey of cocoa diseases in Kerala	CCRP, Vellanikkara
7	CC-09-00-02-87/ VKA(16) Cad India Ltd.	Studies on vascular streak die back	CCRP, Vellanikkara
8	CC-09-00-03-89/ VKA(16) Cad India Ltd.	Screening of cocoa types for susceptibility to VSD	CCRP, Vellanikkara

10. PULSES AND OILSEEDS

Co-ordinator : Dr. Sverup John

HIGHLIGHTS

- A new cowpea variety **Shubhra** with grain yield of 1239 kg/ha was released.
- The seed coat thickness was found to be a major factor in providing resistance to bruchid attacks in cowpea. Genotypes having bruchid resistance could be effectively utilized in recombination breeding programme for producing hybrid derivatives possessing both bruchid resistance and high yield.
- Soaking of cowpea seeds in 500 ppm thiourea followed by two sprays (500 ppm) at vegetative and flowering stages increased the yield of cowpea by 26 per cent and net return by 50 per cent.
- In cowpea soil application of farmyard manure (2t/ha) + *Pseudomonas fluorescence* seed treatment (10 g/kg of seed) was found effective in controlling the dry rot of cowpea
- In green gram, the hybrid IIPRM.3 X CO.2 was the best specific combiner for yield which can be carried forward to evolve high yielding shade tolerant varieties
- Sumanjana' a new high yielding (933 kg/ha) black gram variety with 75 days duration was released for cultivation in summer rice fallows.
- Spray application of Bavistin 50 WP @ (0.1%) followed by the application of Contaf 0.2% D @ 25 Kg/ha was effective in reducing the powdery mildew incidence in black gram.
- In horse gram, input management significantly increased the yield. Recommended fertilizers + weed control + plant protection recorded significantly higher yield compared to fertilizer application alone.
- In horse gram, seed soaking in Thiourea (500 ppm) followed by two sprays (500 ppm) one at vegetative and one at flowering stage recorded the highest yield (57% more yield).
- By combination breeding (Thilak X Kayamkulam I) an early maturing sesame variety Thilarani with an yield potential of 580 kg / ha was evolved.
- Fertilizer and weed control are the most important production constraints of scsamum. Application of 50% N in the organic form (FYM) and the remaining 50% N and full P&K as inorganic fertilizers recorded the highest yield of sesame
- Two hand weedings at 15 DAS and 30 DAS were effective in controlling weeds in sesame. Among the weedicide treatments Alachlor @ 1.5 kg/ha with hand weeding at 30 DAS was most effective.

SUMMARY

Cowpea accessions collected from NBPGR, Vellanikkara and RARS, Pattambi were screened against the pulse beetle (*Callosobruchus* sp). A total of 127 entries were identified as resistant / tolerant to bruchus based on laboratory screening. Types identified as resistant/ tolerant were further evaluated in the field. The following crosses were made between resistant/ tolerant types and high yielding varieties - C152 X IC 291892, C152 X 367711, Kanakamoni X IC 291092, Kanakamoni X EC 367711, Kanakamoni X EC 390231, V16 X IC 201092, V 240 X EC 390231, V 240 X IC 201092, V 240 X EC 367711, V 16 X EC 367711, V 16 X EC 390231.

The F2 plants raised in the field were evaluated for their resistance as well as yield. It was found that majority of the types did not show any resistance. The parental types are again raised for further evaluation, crossing and hybridization.

In the AICRP cowpea experiment (Advanced varietal trial), during 2000 Kharif, among the NMG varieties, V-240 recorded the highest yield (955 kg ha⁻¹) and among the EMG varieties V-625 recorded the highest yield of 689 kg/ha.

A total of 259 accessions were maintained under the project on Maintenance and evaluation of cowpea germplasm.

There was significant difference in yield of cowpea by the application of micronutrients. The treatment combined spraying of 0.5 % FeSO₄ and 0.5% ZnSo₄ at 45 DAS recorded the highest yield (616 kg/ha) followed by combined spraying of 0.5% FeSO₄ and Zn So₄ at 25 DAS (526 kg/ha). But combined spraying of 0.5% FeSO₄ and 0.5% ZnSO₄ both at 25 DAS and 45 DAS was found to reduce the yield of cowpea.

In the agronomic evaluation of promising genotypes of cowpea started during 2001 rabi, the variety GC-3 recorded the highest yield (882 kg/ha), which was found on par with GC-9732 (849 kg/ha). Treatments receiving full dose of fertilizers produced significantly higher yield (926 kg/ha) when compared to half the recommended dose of fertilizer. Spacing was also significant and closer spacing recorded significantly superior yield compared to wider spacing.

Seed treatment with Thiram (3g/kg of seed) followed by one or two rounds of spray with Carbendazim (0.1%) was found on par in reducing seedling rot of cow pea followed by seed treatment with carbendazim (2g/kg seed) which was equally effective as that of Copper oxy chloride (3g/kg of seed) and *Trichoderma viride* (4g/kg of seed).

For the development of black gram varieties with high nitrogen fixing capacity for rice based cropping system a CYT with 7 selections and Sumanjana as check was conducted during summer 2003.

In the urd advanced varietal trial conducted during 2001 rabi with 14 entries, the yield was significantly different. The entry RU 1-1 (625 kg/ha) recorded the highest yield followed by RU1-2 (502 kg/ha).

During Rabi 2001 among the varieties tested under the mung advanced varietal trial, the yield was significantly different. The entry RMI-7 recorded the highest yield of 387 kg/ha followed by RMI-1 (332 kg/ha).

A large number of sesame germplasm under the project Germplasm maintenance in sesame were maintained and evaluated during summer 2001(476 Nos.), 2002(501 Nos.), 2003 (183 Nos.) and 2004 (207 Nos.) at ORARS, Kayamkulam.

High genotypic coefficient of variation, high heritability and moderate genetic advance were recorded for the number of capsules / plant and seeds / capsule. The cause effect relationship analysis (path analysis) recorded that capsules/ plant and seeds / capsule had high direct effect on seed yield. Based on genetic distance six divergent parents were selected for hybridization in diallel pattern. The gca of parents and sca of hybrids were studied. Seed yield / plant, seed protein and saponification value showed significant additive gene action. Plant height, height upto first capsule, capsule/main axis, capsules/plant, seeds/capsule, seed oil percentage and iodine value showed preponderance for non-additive gene action.

Significant heterobeltiosis and standard heterosis were observed for different characters in the hybrids. The parents IVTS-5 and AVT-16 were good general combiners. The two hybrids IVTS-5 X AVTs-8 and IVTS-5 X AVTS-16 showed significant superiority for all economic traits and quality characters such as seed oil and protein percentage.

Under the AICRP varietal evaluation of sesame, the varieties IVTS 21 (669 kg/ha), IVTS-2001-5 (863 kg/ha) and AVTS-2002-1 (790 kg/ha) performed well with highest seed yield.

In the study on genetic basis of seed yield and seed quality in sesame (*Sesamum indicum* L), six parents were selected for crossing in half diallel pattern. The hybrid seeds were collected and the F1 of 15 cross combinations were raised along with parents and standard check in the field with 3 replications. All the observations were recorded.

Three wild species of sesame viz. *S.malabaricum*, *S.mulayanum* and *S.radiatum* were identified. Back cross breeding was conducted to transfer the abiotic stress tolerance to cultivated one.

An initial evaluation of groundnut (normal duration) was conducted during 2001 Summer (AVT- Spanish), 2002 Kharif (IVT-1 Virginia and AVT-1 Spanish, 2003 Kharif (IVT-1 Virginia), AVT (Virginia) and AVT (Spanish). The following varieties performed well with the highest pod yield INS-1-2001 (2167 Kg/ha), IVK-1-2002-2 (5448 kg/ha), TG-3 (2125 kg/ha), IVK-1-2003-1 (2730 kg/ha, TG-3 (2061 kg/ha), ASK-2003-4 (3233 kg/ha)

A varietal trial on spanish bunch early groundnut was conducted during 2001 summer, IVT-1 (Spanish), 2002 summer (IVT-1 Spanish)-2002 Kharif (IVT-1 Spanish) '2003 summer and 2003 Kharif (IVT-1 Spanish). The following varieties performed well with the highest pod yield ie. TG-3 (1499 kg/ha), INS 2001-7 (2858 kg/ha), TG-3 (2112 kg/ha), INS1 2002-1(3896 Kg/ha), ISK-1-2003-1 (2722 kg/ha).

The application of moderate levels of organic meal (1000 Kg/ ha) in groundnut resulted in higher yield in terms of dry pod and haulms yield.

Five varieties namely AK-21, DPL-2278, DPL7278, DPE 1584 and PHG-9 were used for the study on agronomic management of promising horse gram genotypes. Two row spacings 30 cm and 45 cm and two-fertilizer doses- recommended fertilizer dose and 50% of recommended dose were tried. There was no significant difference among the treatments.

List of experiments

i) KAU Projects

a) Concluded experiments

Sl. No.	Code No.	Title of the experiment	Location
1.	POS-03-00-06/93/ KYM(3)/KAU	Integrated nutrient supply and management in sesame	ORARS, Kayamkulam
2	POS-03- 00-12/93 KYM (3)/KAU	Optimization of sesame production under resource constraints	ORARS Kayamkulam
3	POS-04-01-01-2000/ ACV(9)/KAU/PG	Combining ability for shade tolerance and yield in green gram (<i>Vigna radiata</i> (L) Wilszek)	CoA, Vellayani
4		Genetics of bruchid (<i>Callosobruchus</i> sp.) resistance and yield in cowpea	CoA, Vellayani
5		Genetic evaluation of F2 generation of inter varietal crosses in green gram. (<i>Vigna radiata</i> (L.) Wilszek)	CoA, Vellayani

b) Experiments in progress

Sl. No.	Code No.	Title of the experiment	Location
1	POS-01-00-12/91 KYM(9)/NP	Evolution of high yielding variety of cowpea with synchronized maturity suited to the rice fallows of Onattukara.	ORARS, Kayamkulam
2	POS-01-00-23/93/ PTB(9)/KAU	Maintenance and evaluation of cow pea germplasm	RARS, Pattambi
3	POS-01-00-23/93/ PTB(9)/KAU	Maintenance and evaluation of horsegram germplasm	RARS Pattambi
4	POS-01-00-36-7/ ACV(9)/KAU	Development of black gram varieties with high nitrogen fixing capacity for rice based cropping system	CoA, Vellayani
5	POS-01-00-38-9/MNY (9)/KAU	Evolution of cowpea varieties resistant to pulse beetle (<i>Callosobruchus</i> sp.)	ARS Mannuthy
6	POS-02-00-08/ KYM(9)/KAU	Germplasm maintenance in sesame	ORARS Kayamkulam
7	POS-02-00-09 KYM(9)/KAU	Breeding programme to develop early maturing groundnut varieties for summer rice fallows in Onattukara	ORARS Kayamkulam.
8	POS-06-01-01-2002- ACV(9)/KAU/PG	Genetic analysis of legume pod borer (<i>Maruca vitrata</i> (Fab.) resistance and yield in cowpea (<i>Vigna unguiculata</i> (L) Walp.)	CoA, Vellayani
9	POS-07-00-01- 003/KYM(9)/KAU	Genetic improvement of the local sesamum variety 'Ayali' (<i>Sesamum indicum</i>) suited to the drought conditions of Onattukara.	ORARS, Kayamkulam

10	POS-08-00-05-2002/VKA(1)/KAU	Nutrient source efficiency relations on the productivity of cowpea in summer rice fallows	CoH, Vellanikkara
11	POS-08-00-06-2002/PTB(1)/KAU	Management of water stress in summer pulse crops	RARS Pattambi
12	POS-08-00-07-2003/PTB(1)/KAU	Effect of different methods of inoculation of <i>Rhizobium</i> on modulation and yield of cowpea	RARS Pattambi
13	POS-08-00-08/2004/VKA(1)/KAU/PG	Nutrient source efficiency relations on the productivity of cowpea in summer rice fallows	CoH, Vellanikkara
14	POS-09-00-01-001/VKA(1)/KAU/PG	Water-nutrient interaction on productivity of groundnut	CoH, Vellanikkara
15	POS-09-00-02-2002/VKA(1)/KAU/PG	Water-nutrient interaction on productivity of groundnut in summer rice fallows	CoH, Vellanikkara
16	POS-10-01-01-003/KYM(4)/KAU	Management of storage pests in groundnut under stored conditions	ORARS Kayamkulam
17	POS-10-02-03-2003/PTB(5)/KAU	Management of yellow mosaic disease of horse gram in summer rice fallow	RARS Pattambi
18	POS-10-02-04-2003/PTB(5)/KAU	Screening of cowpea germplasm against anthracnose (<i>Colletotricum lindemuthianum</i>) and collar rot (<i>Rhizoctonia solani</i>) diseases	RARS, Pattambi
19	POS-10-02-05-2003/PTB(5)/KAU	Screening of germplasm for dry root rot and mosaic diseases of cowpea	RARS Pattambi
20	POS-10-02-06-2003/PTB(5)/KAU	Screening of horse gram germplasm for powdery mildew disease	RARS Pattambi
21	POS-10-02-08-2003 KYM(5)/KAU	Management of leaf spot diseases caused by <i>Mycosphaerella arachidis</i> and <i>M.berkeleyi</i> in groundnut	ORARS Kayamkulam

ii) Externally aided projects

a) Concluded experiments

Sl No	Code No.	Title of the experiments	Location
1	POS-08-00-01-2001/PTB(1)/AICRP	Agronomic management of promising horse gram genotypes	RARS, Pattambi
2	POS-08-00-02-2001/PTB(1)/AICRP	Effect of thiourea application on horse gram	RARS, Pattambi
3	POS-08-00-03-2001/PTB(1)/AICRP	Assessment of advantage of various inputs in horse gram.	RARS, Pattambi
4	POS-08-00-04-2001/PTB(1)/AICRP	Effect of thiourea application on cowpea	RARS, Pattambi
5	POS-10-02-02-2001/PTB(1)/AICRP	Effect of different soil amendments and biocontrol agents on dry root rot of cowpea	RARS, Pattambi
6	AICRP	Effect of humic substances in cowpea	RARS, Pattambi
7	AICRP	Arid legumes based inter cropping system	RARS, Pattambi
8	Company trial	Evaluation of Contaf 0.2% dust against black gram powdery mildew	RARS, Pattambi

b) Experiments in progress

Sl No	Code No	Title of the experiment	Location
1	POS 01 00 09/77/PTB(9)/ICAR	Co-ordinated varietal trial on cowpea	RARS, Pattambi

2	POS-01-00-22/93/ PTB(9)/ ICAR	Horse gram advanced varietal trial	RARS, Pattambi
3	ICAR	Effect of micronutrients on cowpea	RARS, Pattambi
4	POS-03-00-21/94/ PTB (1)/ICAR	Agronomic evaluation of promising genotypes of cowpea	RARS, Pattambi
5	POS-10-02-01/2001/ PTB (5)/AICRP	Efficiency of different seed treatment fungicides and biocontrol agents to control seedling rot of cowpea	RARS, Pattambi
6	ICAR	Seed micro flora studies on cowpea (fresh seed) obtained from kharif crop	RARS, Pattambi
7	POS-01-00-07/89/ PTB(9)/ ICAR	Urd bean advanced varietal trial	RARS, Pattambi
8	POS-01-00-08/77/ PTB(9)/ ICAR	Mung bean advanced varietal trial	RARS, Pattambi
9	POS-02-02-01/87/KYM (9)/ICAR	Varietal evaluation of sesame	ORARS, Kayamkulam
10	POS-02-00-02 KYM (9)/87/ICAR.	Initial evaluation of groundnut (normal duration)	ORARS, Kayamkulam
11	POS-02-00-03/KYM(9)/ 88-ICAR	Varietal trial- spanish bunch early on groundnut	ORARS, Kayamkulam
12	ICAR	Breeding and <i>in vitro</i> techniques for incorporating stress tolerance in sesame	ORARS, Kayamkulam

11. FORAGE CROPS

Co-ordinator : Dr.S.Janardhanan Pillai

HIGHLIGHTS

- In summer rice fallows, application of 5t ha⁻¹ of vermicompost and 100 percent of chemical fertilizers as per package of practices recommendation recorded highest green fodder and dry fodder yield in fodder bajra, fodder sorghum, *Sesbania rostrata* and fodder cowpea.
- Intercropping fodder maize and fodder cowpea in 3:1 combination yielded maximum green and dry fodder yield under rainfed conditions.
- The fodder cereal and legume combinations, maize + cowpea and fodder bajra + fodder cowpea were found to be performing well in rice fallows.
- The seed yield of signal grass (*Brachiaria decumbens*) was highest when potassium @ 150 kg ha⁻¹ was applied.
- Dual inoculation of rhizobium + AMF produced significantly higher green fodder and dry fodder yields for hedge lucerne (*Desmanthus virgatus* (L.) willd.) under rainfed condition.
- Guinea grass (*Panicum maximum* J.) variety Hamil was a high yielder in open and shaded conditions. Application of potassium @150 kg ha⁻¹ significantly increased the yield and uptake of potassium under shade. Economic yield was obtained in shade intensities upto 50 percent.
- Application of FYM, vermicompost or glyricidia leaves @ 5 t ha⁻¹ along with 100 percent recommended dose of fertilizers (150:50:50 kg NPK ha⁻¹) recorded highest fodder yield in congosignal (*Brachiaria ruziziensis*).

SUMMARY

The seed production potential of signal grass (*Brachiaria decumbens*) as influenced by the foliar application of KNO₃, ZnSO₄, and cycocel revealed that the highest seed yield of 140.5 q ha⁻¹ was produced by the application of KNO₃ @ 4 kg ha⁻¹. The green fodder yield (95.27 q ha⁻¹) and dry fodder yield (27.6 q ha⁻¹) were also significantly high for this treatment. Application of ZnSO₄ @ 2.0 and 4.0 kg ha⁻¹ and cycocel @ 0.5 and 1.0 kg ha⁻¹ were found to record significantly higher seed weight and seed germination percentage (54.93 and 52.63% respectively.) The seed production was not influenced by cutting management practices viz, seed collection after 1 cut and after 2 cuts and nitrogen levels (100, 150 and 200 kg ha⁻¹).

Fifty one diverse genotypes of fodder cowpea were evaluated for yield and quality attributes. A discriminant function was fitted with 12 variables to derive a selection index for all the 51 accessions based on their yield and yield attributes. The top ranking seven accessions, IFC 95102, IFC 8401, UP 9001, EC 4216, EC 240744, EC 241027 and HES 82 were selected as lines (female parents) for hybridization. Another discriminant function was fitted to derive a selection index to evaluate the quality parameters viz crude protein content and crude fiber content. Three top ranking accessions not selected as lines were selected as testers (EC 241044, N 311 and UPC 953). Crosses were done between seven lines and three testers and 21 crosses were produced. The 21 crosses and their parents were evaluated during Kharif 2001. Two superior crosses viz MES 82 x FC 241044 and EC 241027 x UPC 953 were selected based on heterosis and combining ability for further selection and evaluation.

A study was conducted during 2000-02 to develop bajra-napier hybrids possessing the desirable economic and quality attributes of bajra and the high yield and perennial nature of napier grass. Line x tester analysis was done involving seven accessions of bajra as lines and three accessions of napier grass as testers. The 21 hybrids along with their parents were evaluated for mean performance, combining ability, heterosis and gene action for 11 characters. Based on gea effects the lines HES-4, TNSC-4, IP 15814 and FD 1917 were found to be good general combiners for green fodder yield and other related characters. Based on mean performance, sca-effects and standard heterosis, TNSC-4 x FD 471 and HES-4 x FD 467 were found to be superior for leaf number per plant, leaf weight per plant, green and dry fodder yields and hence these two hybrids are advanced for further trials to develop bajra-napier hybrids with good quality and high fodder yields.

Sixty accessions of fodder rice bean were evaluated in a replicated trial to estimate the variability, genetic advance and correlation of various traits of economic importance and to assess the genetic divergence among the accessions in order to cluster them based on their multiple traits. Data were collected from five plants collected at random from a population size of 844 plants per entry on eleven characters. Analysis of variance showed significant difference among the accessions for all the characters except duration of the crop. Correlation value of green fodder yield with all the characters were positive both at phenotypic and genotypic level. On the basis of genetic distances computed with respect to 10 characters studied, the 60 accessions of fodder rice bean were grouped into 5 clusters while accessions LRB 235, LRB 221, LRB 225 RBL 118 and LRB 145 remained as single. Maximum divergence was obtained between C4 and C10 and hence, the selection of parents from the divergent clusters C4 and C10 will be effective in improving green fodder yield.

Fifty accessions of fodder sorghum collected from ICRISAT were evaluated during 2002-03 for nine quantitative and qualitative characters. Green fodder yield had positive correlation with all the characters except leaf/stem ratio. Path coefficient analysis was carried out using five characters viz, plant height at harvest, leaf/stem ratio, leaf area index, leaf weight per plant and tiller number per plant. Leaf weight per plant exhibited the maximum direct effect on green fodder yield. Plant height at harvest showed maximum indirect effect via leaf area index followed by leaf weight per plant. Both leaf weight per plant and leaf area index had high positive direct effect along with high genotypic correlation. Selection of these characters will be effective for developing high yielding varieties of fodder sorghum.

List of experiments

- i) KAU projects
 - a) Concluded experiments.

Sl. No.	Code No.	Title of the experiment	Location
1	FC-01-00-01/2000/ ACV(9) KAU/PG	Quantitative variation and genetic divergence in fodder rice bean (<i>Vigna umbellata</i> (Thunb.) Ohwi and Ohashi)	CoA, Vellayani
2	FC-01-00-05-2000/ ACV(9)KAU PG.	Genetic analysis of yield and quality attributes in fodder cowpea (<i>Vigna unguiculata</i> (L.) walp)	CoA, Vellayani
3	Fc-01-00-08-2001/ ACV(9) KAU/PG	Heterosis and gene action in bajra-napier hybrids	CoA, Vellayani

4	FC-01-00-09-2002/ ACV(9) KAU/PG	Genetic variability in fodder bajra	CoA, Vellayani
5	FC/02-00-08-2001/ ACV(1)	Shade response of guinea grass (<i>Panicum maximum</i> J.) under varying levels of potash	CoA, Vellayani
6	FC/02-00-35-99/ KAU/PG	Evaluation and nutritional management of fodder crops in summer rice fallows	CoA, Vellayani
7	FC/02-06-2000- ACV(1)KAU/PG	Integrated nutrient management in <i>Desmanthus virgatus</i> (L.) Willd under rainfed condition	CoA, Vellayani

b) Experiments in progress

Sl. No.	Code.No.	Title of the experiment	Location
1.	FC-01-00-03-2000/ ACV(9)/KAU	Development of fodder rice bean varieties with yield potential and adaptability for summer rice fallows.	CoA, Vellayani
2	FC-01-00-04-2000/ ACV (9)/ KAU	Identification of fodder rice bean for southern region.	CoA, Vellayani
3	FC-01-00-10-2003/ ACV(9)/ KAU/PG	Interspecific hybridization in sorghum.	CoA, Vellayani
4	FC-02-00-09-2003/ ACV(1)/NATP/PG	Nutrient management of guinea grass (<i>Panicum maximum</i> J.) under open and shaded condition.	CoA, Vellayani

ii) Externally aided projects

a) Concluded experiments

Sl. No.	Code. No	Title of the experiment	Location
1.	FC-02-00-01-2000/ ACV(1)/ ICAR	Intensive fodder production of congosignal under irrigated condition in partial shade	CoA, Vellayani
2.	FC-02-00-02-2000/ ACV(1)/ICAR	Fodder based intercropping with annual cereal forages and legumes under rainfed condition	CoA, Vellayani
3.	FC-02-00-03-2000/ ACV(1)/ ICAR	Performance of food forage intercropping system in rice fallows	CSRC, Karamana
4.	FC-02-00-04-2000/ ACV(1)/ICAR	Effect of foliar application of KNO_3 , $ZnSO_4$ and cycocel on seed production of signal grass (<i>Brachiaria decumbens</i> stapf.)	CoA, Vellayani
5.	FC-02-00-05-2000/ ACV (1)/ICAR	Forage and seed production of signal grass (<i>Brachiaria decumbens</i>) Stapf.)	CoA, Vellayani
6.	FC-03-00-01-98 ACV(1)/ ICAR	Evolving a biofarming technique for congosignal grass intercropped in coconut garden	CoA, Vellayani

b) Experiments in progress

Sl. No.	Code No	Title of the experiment	Location
1	FC-01-00-02-2000 ACV(1)/ICAR	Evaluation of stylosanthes accessions for yield and disease resistance	CoA, Vellayani
2	FC-01-00-06/2000	Development of hybrid derivatives in	CoA,

	ACV(9)/AICRP	fodder cowpea	Vellayani
3	FC-01-00-07/2000-ACV (9)/AICRP	Development of hybrid derivatives in fodder cowpea.	CoA, Vellayani
4	FC-01-00-10/89-ACV (9)/ICAR	Advanced varietal trial on guinea grass.	CoA, Vellayani
5	FC-01-00-12-91- ACV(9)/ICAR	Breeding trials with forage bajra	CoA, Vellayani
6	FC-01-00-17-94/ ACV(9)/ICAR	Germplasm collection and evaluation of stylosanthes.	CoA, Vellayani
7	FC-03-03-01-87/ICAR	Germplasm collection maintenance and evaluation of guinea grass.	CoA, Vellayani

12. AROMATIC AND MEDICINAL PLANTS

Co-ordinator : Dr.Samuel Mathew

HIGHLIGHTS

- Pathogenicity of plant pathogenic nematodes, *Meloidogyne incognita* and *Radopholus similis* to chethikoduveli (*Plumbago indica*) showed that the pathogenicity level of the former was >1000 and of latter was 100 per plant. Both these nematodes produced more than 25% reduction in yield of the crop. The biocontrol agents like *Glomus fasciculatum*, *Pseudomonas fluorescens* and *P. lilacinus* performed as efficient as the nematicide carbosulfan in controlling the infestation and improving crop yield.
- *Pseudomans fluorescens* @ 3% w/w was the best rhizome treatment for reducing nematode population and increasing the yield of kacholam. However, for soil application, neem cake @ 200g/ sq.m and AMF @ 10g/sq.m were the best treatments. Mulching with the leaves of neem, chromolaena and glyricidia also proved to be equally effective.
- In *Curcuma aromatica*, a spacing of 60x40 cm with FYM application at 20 t/ha as basal followed by NPK at 100:50:50 kg/ha was found to be beneficial for realising maximum yield of rhizome, essential oil and oleoresin.
- Agrotechnology for optimum yield realization in *Saraca asoka*, *Holostemma adakodien*, *Strychnos nux-vomica* and *Curculigo orchioides* was standardised.
- Large collection of lemongrass germplasm (450) was maintained at Aromatic and Medicinal Plants Research Station, Odakkali. Accession OD-23 was identified as the best type in terms of yield of grass, oil and its quality.
- A germplasm of 16 accessions of palmarosa and 17 accessions of vetiver are being maintained at Aromatic and Medicinal Plants Research Station, Odakkali.

SUMMARY

Two species of *Curculigo* were identified. The commonly used species *Curculigo orchioides*, is seen in midlands where the soil is generally lateritic and the other species, *Curculigo trichocarpa* is present exclusively in forests and prefers rich humus soil for its growth. A method was developed to differentiate the crude drug of the species by microscopical observation and thin layer chromatographic examination.

Physiological aspects of growth and yield of nilappana (*Curculigo orchioides*) was studied. The plant had an active growth phase till 7 months after planting (MAP), followed by a reproductive phase of around 3-4 months. The crop yield was maximum when harvested 7 months after planting. The rhizome development in *C. orchioides* is upward and has got special agronomic significance in that it requires deep planting and regular earthing up for higher yields.

Shade tolerance of nilappana (*Curculigo orchioides*) was studied. The dry matter production and yields of *C. orchioides* were highest at 25 per cent shade and 10 x 10 cm spacing due to

higher growth characteristics such as plant height, number of leaves, canopy spread and also higher chlorophyll content and higher harvest index. The application of FYM 30 t ha⁻¹ produced high yields. The yields were high when 25 per cent of the above dose was substituted with inorganic fertilizer on NPK equivalents. FYM also improved the quality of the produce.

Studies on the quality of the crude drug showed that there was large variation in the quality parameters among different biotypes of nilappana (*Curculigo orchoides*).

An HPLC method was developed for the estimation of curculigoside content of *C. orchoides* roots. The system consisted of a C18 column with 0.01 M phosphate buffer (pH 6.0) as eluent. The peaks were monitored spectrophotometrically at 205 nm. Similarly, a HPLC method was developed for the estimation of major alkaloids in the root and bark of the strychnine tree (*Strychnos nux-vomica*). Strychnine and brucine contents varied with plant part as well as age of the plant.

List of experiments

- i) KAU Projects
 - a) Concluded experiments : Nil
 - b) Experiments in progress

Sl. No.	Code No.	Title of the experiments	Location
1	AMP-01-00-14/93 ODL(9)KAU	Yield and chemical characterization of selected accessions of lemongrass germplasm at Aromatic and Medicinal Plants Research Station, Odakkali	AMPRS, Odakkali
2	AMP-01-00-10/ 95 ODL (9) KAU	Germplasm collection, maintenance and evaluation of lemongrass and palmarosa	AMPRS, Odakkali
3	AMP-03-00-01/2000 VKA(1)KAU-PG	Agrotechnological practices for quality crude drug production in Nilappana (<i>Curculigo orchoides</i> Gaertn)	CoH, Vellanikkara
4	AMP-04-00-03/96 ACV(4)KAU-PG	Bio-ecology and management of root-knot nematode of kacholam (<i>Kaempferia galanga</i> Linn.)	CoA, Vellayani
5	AMP-04-02-01/2000 ACV(4)STED-PG	Eco-friendly management of root-knot and burrowing nematode associated with kacholam, <i>Kaempferia galanga</i> L	CoA, Vellayani
6	AMP-04-02-02/2001 ACV(4)ICAR-PG	Host parasite relationship and management of root-knot nematode and burrowing nematodes associated with <i>chethikoduveli</i> (<i>Plumbago rosea</i>)	CoA, Vellayani
7	AMP-05-00-06/95 ODL(3)KAU	Isolation and characterisation of principal constituents of <i>Piper longum</i> , <i>Alpinia sp.</i> and <i>Coleus aromaticus</i>	AMPRS, Odakkali
8	AMP-02-00-03/2004 VKA(9)KAU-PG	Characterisation of long pepper (<i>Piper longum</i>) genotypes using morphological, anatomical and molecular markers	CoH, Vellanikkara
9	AMP-02-00-04/2004 VKA(9)KAU-PG	Standardisation of <i>in vitro</i> propagation techniques in thathiri (<i>Woodfordia fruticosa</i>)	CoH, Vellanikkara

10	AMP-03-00-10/2004 ACV(1)KAU-PG	Agrotechniques for safed musli (<i>Chlorohytum borivilianum</i>) in Kerala	CoA, Vellayani
11	AMP-03-00-11/2004 ACV(1)KAU-PG	In situ rain harvest, conservation and utilisation for establishment and early growth of sappan wood (<i>Caesalpinia sappan</i>)	CoA, Vellayani
12	AMP-03-00-12/2004 ACV(1)KAU-PG	Organic nutrient management in chethikkoduveli (<i>Plumbago rosea</i>)	CoA, Vellayani
13	AMP-01-00-05/2003 ACV(16)KAU-PG	Characterisation of kasturi turmeric (<i>Curcuma aromatica</i>)	CoA, Vellayani
14	AMP-02-00-02/2003 ACV(21)KAU-PG	Effect of abiotic stress on the physiology and andrographolide content in <i>Andrographis paniculata</i>	CoA, Vellayani
15	AMP-03-00-07/2003 ACV(16)KAU-PG	Performance of mint (<i>Mentha spp.</i>) under the humid tropical conditions of Kerala	CoA, Vellayani
16	AMP-04-01-01/2003 VKA(5)AICRP-PG	Major diseases of kacholam (<i>Kaempferia galanga</i>) and their management	CoH, Vellanikkara
17	AMP-03-00-08/2003 VKA(16)KAU-PG	Performance analysis of safed musli (<i>Chlorophytum borivilianum</i>) in Kerala	CoH, Vellanikkara
18	AMP-05-00-01/2003 VKA(16)KAU-PG	Phytochemistry and antimicrobial property of panikoorka (<i>Coleus ambinicus</i>)	CoH, Vellanikkara
19	AMP-01-00-03/2001 VKA(6)KAU-PG	Morphological and phytochemical investigations on St. Johnswort (<i>Hypericum spp.</i>), a potential source of anti-HIV compounds	CoH, Vellanikkara
20	AMP-03-00-03/2001 ACV(1)KAU-PG	Soil-plant-atmosphere interactions on productivity of kacholam -(<i>Kaempferia galanga</i>)	CoA, Vellayani
21	AMP-05-00-06/95 ODL(3)KAU	Isolation and characterisation of principal constituents of <i>Piper longum</i> <i>Alpinia spp.</i> and <i>Coleus aromaticus</i>	AMPRS, Odakkali

ii) Externally aided projects : Nil

13. SOILS AND AGRONOMY

Co-ordinator : Dr V.K. Venugopal

HIGHLIGHTS

- Allelochemicals present in purple nutsedge (*Cyperus rotundus* L) were identified as p-hydroxy benzoic acid, p-coumaric acid, m-coumaric acid, vanillic acid and gentisic acid.
- Weeds that could be used as indicators of soil conditions were identified as *Aeschynomene indica* (Low nitrogen) *Seirpus juncoides* (Low P) *Monochoria Vaginalis* (High organic matter) *Eleocharis duleis* (Acidity) *Leptochloa chinensis* (Alkalinity) *Diplachne fusca* (High salinity).
- Herbicides butachlor, pretilachlor and 2,4 D applied at recommended dose did not leave any detectable residues in rice straw and grains. Concurrent growing of cowpea and horse gram in semidry rice reduced the weed problems and increased yields.
- Almix-20 WP at 4 g a.i/ha at 20 DAS controlled broad leaved weeds, sedges and Marselia in rice.
- Sub surface drainage using clay tile drains at spacing of 30 m significantly improved the leaching and removal of toxic iron, sulphates, chlorides and drastically improved the N use efficiency and it significantly improved the productivity of the area and the over all increase in rice yield was 1.1 t/ha over ill drained areas.
- K₁₈ rice culture was the best among the varieties tested in kari soils under subsurface drainage conditions. Fertilizer dose of 120:60:60 N P K ha⁻¹ and a seed rate of 100 kg ha⁻¹ were the best to achieve high yields.
- Economic analysis for a 100 ha farm revealed that sub surface drainage is economically feasible with a B-C ratio of 2.45. The system can economically support if it can realize an additional yield of 0.41 t/ha from the present level.
- Phosphogypsum as an amendment for acidic upland laterite soils significantly increased yield and uptake of nutrients by cowpea. Greater mobility of Ca to the sub surface layers decreased the exchangeable aluminium content. The residual effect on the subsequent crop was pronounced which was reflected in the yield and available nutrient content of soil.
- For rice cyst nematode, *Heterodera orydicola*, the hot spot areas identified were Pullari in Kannur, Karimbil and Kodancherry in Wyanad, Alathur, Pattambi and Palancode in Palakkad, Puttadi and Anakkara in Idukki district. In banana, the hot spot areas of rice cyst nematode identified were Cheemeni in Kanhangad of Kasargod district, Kakkavayal and Kodencherry in Kannur, Pattambi and Alathur in Palakkad. The population of *R. similes* was uniform in different districts.
- Vermi compost @ 2.5 t/ha can substitute FYM @ 5t/ha.in the Onattukkara area for rice.
- Studies on integrated nutrient management in banana (Nendran) showed that organic inputs with VAM were superior to inorganic sources. Cowpea as an intercrop in banana was found to be economical.
- Suitability of forage grasses in Veroor, watershed showed that gamba grass thrived well without irrigation and was the best alternative for hilly areas. The best grass – legume mixture were grass + cowpea for the first season and grass + horse gram for the second season under water scarcity.

- Vermi composting of medicinal plant waste product from Oushadi using *Eisenia foetida* indicated its importance as a promising bioagent for enrichment of organic wastes. The compost obtained was a good source of organic manure. Oushadi compost at 5 t/ha and full dose of NPK as per POP recorded maximum yield and nutrient uptake in Amaranthus.
- Compaction with four passes of 400 kg roller along with 2.5 t/ha of FYM and 5t/ha coir pith significantly improved the physical properties, nutrient uptake and yield of crops in rice based cropping system in Onattukkara.

SUMMARY

Permanent manurial trials with tall indica varieties so far confirmed that the productivity can be maintained on a long term basis by combined application of organic manures.

PMT with Dwarf indica varieties indicated that the productivity can be maintained at a substantial level through the application of organic manure to the tune of 50% of the N requirement either as cattle manure or green leaves and P (45kg/ha) and K (45kg/ha) as fertilizers.

In the PMT on cereal based cropping system started in Karamana in 1985-86, it was found that for both Kharif and Rabi seasons substitution of fertilizers to the tune of 25 or 50% by organics as FYM, crop residue or green manure, gave higher yield than 100% fertilizer alone, bringing about savings in fertilizer. System productivity was higher in this treatment.

The studies on the long range effect of continuous cropping and manuring in rice on soil fertility and productivity carried out at Karamana showed that the decreasing levels of P from 80 to 0 kg/ha resulted in delayed flowering in the experiment. Treatments receiving no P took more days to mature. Increasing levels of P resulted in significant increase in grain and straw yield.

In the PMT at Moncombu higher yields were recorded during kharif than Rabi. The response of N and P was significant while K did not give response for the past 15 years. Allowing silting during monsoon enhanced productivity by one to two t/ha PMT at Kayamkulam showed that the optimum dose of nitrogen for maximum rice production was 80 kg ha⁻¹ of which 25% was in the form of FYM and the rest as chemical fertilizers.

Fertility investigation of Orumundakan and Onattukara soils showed that Mannar and Cherukol series had low pH, EC, organic carbon available P, K and micronutrients. CEC was also low. Soils under Adoor series were moderately acidic with medium N, P and K.

The PMT at Vyttila is continuing without change in treatments. The entire quantity of lime applied at sowing was the best treatment. There was no response to added fertilizers. Pokkali soils are highly suitable for organic farming.

The frequency of occurrence of nematodes in banana was *R. similis*, followed by cyst nematode in Kollam, Thiruvananthapuram and Thrissur disitriacts. The hot spots identified during the survey conducted in the year 2000 for cyst nematode of rice and banana were Podukutty and Pampadumpara in Idukki, Konni in Pathanamthitta and Onnamkutty in Kayamkulam areas. Cyst nematode infestation was high in reclaimed paddy lands in mounts.

Weed management in okra with 12 treatments indicated that alachlor @ 1.5 kg ai/ha plus hand weeding or Pendimethalin @ 0.75 kg/ha + hand weeding recorded lowest weed infestation and high yields. The chemicals had no phytotoxic effect on the crop.

Mimosa invisa, an introduced spiny weed is seen spreading and becoming a major problem in Kerala. *Merrimia vitifolia* (Burn I) Hallifer, a climber belonging to family convolvulaceae, is also seen fast spreading in Kerala.

Application of glyphosate at 2 kg ai/ha (5 l product/ha) resulted in 100% control of *Eichornia crassipes* at 45 DAS.

Almix 20 WP (Metsulfuron methyl 10% + Chlorimuron ethyl 10%) at 4 g ai/ha at 20 DAS selectively controlled broadleaved weeds, sedges and Marsilia in rice.

Studies on the weed competitiveness of upland rice varieties showed that early vigour, height, tiller number and LAI were the characters contributing to weed competitiveness. Among the 26 varieties screened, Karanellu was the most effective in suppressing the weeds.

Translocation studies with labeled carbon (^{14}C) on loranthus revealed that carbon compounds are translocated from the host to loranthus and *vice versa*, indicating that if non selective systemic herbicides like 2,4-D and glyphosate are applied to loranthus it may adversely affect the host plant also.

Screening of herbicides for the control of loranthus showed that ethrel at a concentration of 3000 ppm and above resulted in the defoliation of leaves and drying of twigs of the parasite.

For controlling the giant sensitive weed, *Mimosa invisa*, spraying of glyphosphate at 0.4 to 0.8 kg/ha was found to be effective.

Application of high dose of potassium (120 kg/ha) with 250 kg/ha silica as sodium silicate and 150 kg/ha lime plus N and P as per POP gave an increased yield ranging from 20 to 80% in rice in on farm trials in Chalakudy command area. Reduction in pest and disease incidence was also noted.

On farm trials on comparative study of bubbler irrigation system was carried out in coconut gardens in command areas in Trivandrum, Pathanamthitta, Ernakulam, Thrissur and Calicut District. The water use efficiency was significantly improved and was well appreciated by farmers.

Studies on the effect of irrigation and mulching on moisture conservation, water requirement, growth and yield of coconut was carried out at Vellanikkara farm. Observations were recorded.

Irrigation experiment carried out in cashew at Chalakudy also did not reveal any significant effect due to treatments, as the yield was not stabilized.

An experiment to standardize the method and schedule of irrigation in a coconut based cropping system, consisting of coconut, nutmeg and pepper was carried out in Chalakudy. Irrigation treatment was started in 2004. The general performance of the crop was satisfactory.

The effect of mulching and water regime on growth and yield of betel vine trailed on dead and live standards was carried out in Chalakudy. Irrigation treatments were started during 2004. The performance of crop was satisfactory.

The influence of irrigation and organic manure on growth and yield of Long pepper (Thippale) under partial shaded conditions in coconut gardens was started in 2003 in Chalakudy. The lay out and planting was completed.

The study on response of coconut to different methods of irrigation was started in 1996. The effect of treatment can be assessed only after the yield of the palms has stabilized.

List of experiments

i) KAU Projects

a) Concluded experiments

Sl. No.	Code No.	Title of Experiment	Location
1	SSA-00-01-2000/ VKA(1)/KAU/PG	Effect of nutrient inter relations on productivity of rice in laterite soils	CoH, Vellanikkara
2	SSA-01-00-02-2000/ VKA(3)/KAU/PG	Critical analysis of soil plant atmosphere conditions for increasing productivity of rice in laterite soils	CoH, Vellanikkara
3	SSA-01-00-03-2000/ ACV(1)/KAU/PG	Integrated management of purple nutsedge	CoA, Vellayani
4	SSA-01-00-04-2000/ VKA(3)/KAU/PG	Efficiency of Jhabuo rock phosphate in rice based cropping system in laterite soils of Kerala	CoH, Vellanikkara
5	SSA-01-05-2002/ ACV(3)/KAU/PG	Feasibility of phosphogypsum as an ameliorant for acidity in laterite soil	CoA, Vellayani
6	SSA-02-00-02/ VKA(3)/KAU/PG	Biotic enrichment of organic wastes from ayurvedic preparations	CoH, Vellanikkara
7	SSA-03-00-03-2003/ CLY/KAU	Evaluation of different kinds of organic and inorganic nutrients under Bubbler irrigation system (BIS) for cucurbits	ARS, Chalakudy
8	SSA-04-00-01-2001/ ACV(3)/KAU/PG	Taxonomy, productivity potential and erodibility of soils under different land use systems on selected watersheds of the Western ghat region of Kerala	CoA, Vellayani
9	SSA-09-00-02-2001/ VKA(1)/KAU/PG	Assessment of selective retention sites of cadmium and lead in tomato (<i>Lycopersicon esculentum</i> Mill)	CoH, Vellanikkara
10	SSA-09-00-03-2002/ ACV(3)/KAU/PG	Evaluation of lake sludge as a phosphorus source in crop production	CoA, Vellayani
11	SSA-09-00-04-2002/ VKA(3)/KAU/PG	Availability indices of stressed nutrients for cocconut (<i>Cocos nucifera</i>) in an ultisol	CoH, Vellanikkara
12	SSA-09-00-06-2003/ ACV(3)/KAU/PG	Synergistic effect of Na and K on yield and nutrient uptake in coleus (<i>Coleus parviflorus</i> L)	CoA, Vellayani
13	SSA-09-00-07-2003/ VKA(3)/AICRP/PG	Soil test crop response studies in (<i>Arachis hypogea</i>) laterite soils of Kerala	CoH, Vellanikkara

14	SSA-10-00-05-2001/ ACV(1)/KAU/PG	Investigations on the allelopathic influence of <i>eupatorium (Chromolaena odorata)</i> and its utilization as organic manure	CoA, Vellayani
15	SSA-10-00-06-2001/ ACV(1)/KAU/PG	Shade response and nutrient management of common rainfed intercrops of coconut	CoA, Vellayani
16	SSA-10-00-07-2002/ VKA(1)/KAU/PG	Biology and movement of <i>Mimosa invisa Mart</i> in Kerala	CoH, Vellanikkara
17	SSA-10-00-08-2003/ ACV(3)/KAU/PG	Fertilizer scheduling for short duration cassava variety Vellayani Hraswa	CoA, Vellayani
18	SSA-11-00-01- 2000/ACV(3)/KAU/PG	Yield maximization in banana CV Nendran through systematic approach of fertilizer use in red loam	CoA, Vellayani
19	SSA-11-00-02-2000/ VKA(3) AICRP/PG	Soil test crop response studies on ginger in laterite soils of Kerala	CoH, Vellanikkara
20	SSA-11-00-03-2002/ VKA(3) AICRP/PG	Soil test crop response studies on coleus (<i>Solenostemon rotundifolius</i> Poir J.K Morton) in the laterite soils of Kerala	CoH, Vellanikkara
21	SSA-11-00-04-2003/ VKA(3) KAU/PG	Soil properties and produce quality of cardamom (<i>Elettaria cardamom</i>) under organic farming	CoH, Vellanikkara
22	SSA-12-00-02-2002/ VKA(3)/KAU/PG	Aerobic composting and enrichment of ayurvedic waste	CoH, Vellanikkara
23	SSA-12-00-03-2002/ ACV(1)/KAU/PG	Phosphorus nutrioperiodism in rubber	CoA, Vellayani
24	SSA-13-00-02-97/ ACV(3)/KAU/PG	Impact of soil compaction on the productivity of Onattukara soils	CoA, Vellayani
25		Standardization of fertilizer requirement for shortest duration cassava variety KMC-1 grown in Kuttanad	RARS, Kumarakom
26		Weed management in okra	ARS, Chalakydy
27		Irrigation cum nutrient requirement of sesamum	ARS, Chalakydy
28		Irrigation cum nutrient requirement of cowpea	ARS, Chalakydy
29		Efficiency of vermi compost as an organic source for rice in Onattukara region	ORARS, Kayamkulam

b) Experiments in progress

Sl. No.	Code No.	Title of experiment	Location
1	SSA-01-00-13/61 PTB(3)/KAU	Permanent manurial trial (Tall indica)	RARS, Pattambi
2	SSA-01-00- 05/64/KYM(3)/KAU	Permanent manurial trial	ORARS, Kayamkulam
3	SSA-01-00- 11/73/PTB(3)/KAU	Permanent manurial trial (Dwarf indica)	RARS, Pattambi
4	SSA-01-00- 19/77/VTL(3)/KAU	Permanent manurial trial on rice in acid saline soils under flooded condition (Pokkali Tract)	RRS, Vytila
5	SSA-01-00-04/87 MON (1)/KAU	Permanent manurial trial	RRS, Moncompu
6	SSA-01-00-06-2003 CLY(1)/KAU	Management techniques for productivity and sustainability of rice in wetland	ARS, Chalakydy

7	SSA-07-00-02-2003/VKA(3)/KAU/PG	Assessment of reaction sites of cadmium and lead in tomato (<i>Lycopersicon esculentum</i> Mell)	CoH, Vellanikkara
8	SSA-07-00-03-2004/ACV(3)/KAU/PG	Dissipation of cloropyriphos in red loam soil and its effect on soil organisms	CoA, Vellayani
9	SSA-09-00-02-2001/VKA(1)/KAU/PG	Weed dynamics in rice fields and its influence on soil reaction and fertility	CoH, Vellanikkara
10	SSA-09-00-05-2002/ACV(3)/KAU/PG	Yield maximization in rice (<i>Oryza sativa</i> L) in the acid sulphate soils of Kuttanad through systematic approach in fertilizer use	CoA, Vellayani
11	SSA-09-00-08-2004/VKA(3)/KAU/PG	Phosphorus dynamics in an Ultisol	CoH, Vellanikkara
12	SSA/09-00-09-2004/VKA(3)KAU/PG	Zinc and boron availability in soils and impact of carriers on crop productivity	CoH, Vellanikkara
13	SSA-10-00-10-95/KYM(3)/KAU	Fertility investigations and characterization of Onattukara and Orumundakan soils of the problem zone	ORARS, Kayamkulam
14	SSA-10-00-09-2003 ACV(1)/KAU/PG	Soil and crop management for organic carbon sequestration in a coconut based cropping system	CoA, Vellayani
15	SSA-10-00-10-2004/VKA(1)/KAU/PG	Nutrient management of yellowing in arecanut	CoH, Vellanikkara
16		Integrated nutrient management for rice based cropping systems	ARS, Chalakudy
17		Response of coconut to different methods of irrigation	ARS, Chalakudy

ii) Externally aided projects

a) Concluded experiments

Sl. No.	Code No	Title of the experiment	Location
1	GOK, NWDPR	Performance studies on promising forage crops in Velloor water shed	RARS, Kumarakom
2	GOK, NWDPR	Performance studies on promising grass legume mixtures in Velloor watershed	RARS, Kumarakom

b) Experiments in progress

Sl. No.	Code No.	Title of the experiment	Location
1	SSA-01-00-10-7/KAU(3)/ICAR	Long range effect of continuous cropping and manuring on soil fertility and crop productivity	CSRC, Karamana
2	SSA-01-00-12-85/KAU/ICAR	Permanent plot experiment on integrated nutrient supply system in cereal based crop sequence	CoA, Vellayani
3	SSA-03-00-01-2001/CLY(1)/ICAR	Comparative study of drip method of irrigation on soil water status, growth and yield response of coconut. Response of nutmeg to drip and hasin method of irrigation	ARS, Chalakudy
4	SSA-03-11-01-2001/CLY(1)/ICAR	Effect of irrigation and mulching on growth and yield of coconut	ARS, Chalakudy

5	SSA-03-00-02-2004/CLY(1)/ICAR	Studies on fertilization through bubbler irrigation system on Ladies finger	ARS, Chalakudy
6	SSA-10-00-04-2001/CLY(1)/ICAR	Comparative study of drip method of irrigation on soil water status, growth and yield response in coconut	ARS, Chalakudy
7		Comparative study of irrigation in coconut garden using bubbler irrigation system	ARS, Chalakudy
8		Detailed profile studies in the distributory command at representative sites of the Balachira branch canal, under different levels of irrigation and wetting	ARS, Chalakudy
9		Effect of irrigation on growth and yield of cashew	ARS, Chalakudy
10		Response of nutmeg to drip and basin method of irrigation	ARS, Chalakudy
11		Water management for coconut based cropping system	ARS, Chalakudy
12		Effect of irrigation and organic manure on the growth and yield of Long pepper (<i>Piper longum Linn</i>) as intercrop in coconut	ARS, Chalakudy
13		Studies on the effect of mulching and water regime on growth and yield of betel vines	ARS, Chalakudy
14	STED Project	Utilization of aquatic weeds for composting and vermicomposting	RARS, Kumarakom
15	ICAR-AICRP	Long term fertilizer experiments	RARS, Pattambi
16	AICRP-ICAR	Identification of hot spots and agro-ecologically conducive areas for key nematode pests <i>Horizicola</i> in paddy and banana	CSRC, Karamana
17		Production potential of rice as influenced by potassium and silica under different moisture regimes in farmers field	ARS, Chalakudy
18	SSA-06-00-01-2002/ACV(3)/NATP/PG	Land evaluation and crop suitability rating of the acid sulphate soils of Kuttanad for sustainable land use planning	CoA, Vellayani

14. PLANT PROTECTION

Co-ordinator : Dr. T. Nalinakumari

HIGHLIGHTS

- Triazophos (Hostathion 40 EC) @ 0.13% spraying and 0.04% root feeding were found to be effective against coconut eriophyid mite. A safe interval of 45 days is fixed as the waiting period.
- Cashew apple extract (20%), pheromone or triferon were found effective for the management of red palm weevil. A dipteran predator, *Pipizia* sp., a predatory bird *Dendrocitta vagabunda parvula* and a fungus *Beauvaria* sp. were recorded as natural enemies of red palm weevil. Male weevils could be sterilized by gama radiation at 1.5 Krads.
- Ferrolure was very efficient for mass trapping the red palm weevil of coconut with an effective period of 9-10 weeks.
- Coconut eriophid mite infestation caused reduction of 18-42 per cent copra content, 47-53 per cent fibre content and the seedlings emerged from these nuts were unfit for planting. Five predatory mites viz., *Amblyseius nucifera*, *A. largoensis*, *A. alstoniae*, *Hypoaspis karameri* and *Pachygnathous* spp. were identified. *Trigona irridipenis* and *Apis cerana indica* were reported as potential agents for vectoring *Pseudomonas fluorescens* to coconut. A new chemical Fenazaquin 0.05% (Magister 10 EC) was found effective against mites under laboratory conditions.
- Coccinellids were found to be the most efficient predators of cowpea aphids. Integrated method involving neem kernel suspension 5% + mechanical + cultural control was found to be promising in terms of their effectiveness against major pests, safety to natural enemies, highest yield and low level of terminal residue.
- Chlorpyrifos (0.05%), profenofos (0.05%), acetamiprid (0.002%) and acephate (0.05%) could effectively manage the major pests of cowpea. Against aphids and other sucking pests, Imidacloprid (0.025%) was effective with safety to predators.
- *Chrysonotomyia rexia* and *Asecodes* sp. were the predominant larval parasitoids recorded on *Liriomyza trifolii*. IPM strategies for this pest in cowpea include cultivation of tolerant accession VU-12, destruction of weed host plants, judicious application of nitrogen and need based application of neem oil/marotti oil/illupai oil @ 2.5 per cent.
- Infestation of pulse beetle in cowpea could be managed by field application of quinalphos 0.03% before harvest and post harvest seed treatment with *Acorus calamus* 1 per cent.
- Nimbecidine 0.2% was effective against leaf and pod webber, pod borer and phyllody of sesamum
- Application of vermiculate formulation of AMF @ 250 spores per plant or *Trichoderma* sp. 5 per cent at planting is recommended for integrated nematode management in chilli.

- Combined application of *Trichoderma* and *Pseudomonas* were more effective against *Rhizoctonia solani* in tomato.
- All parts of *Plumbago rosea* showed inhibitory effect against pumpkin mosaic virus.
- Three sprays of either 2% neem oil - soap - garlic or neem oil + soap + garlic + karanji oil 1% at spike emergence, berry formation and berry maturation are recommended for ecofriendly pest management in black pepper.
- Neemazal 1% was found effective against pseudostem borer in banana.
- Extract of *Allium sativum*, and *Tagetes erecta* (2:1), neem cake extract (2%), neem oil (1%) and coconut oil (1%) could be used as a substitute for antibiotics in the management of bacterial blight of anthurium.
- *Fusarium pallidoroseum* was developed into an effective mycoherbicide against water hyacinth.
- Five species of fruit flies viz. *Bactrocera cucurbitae*, *B. dorsalis*, *B. correcta*, *B. zonata* and *B. verbascifolia* were reported for the first time from trap catches. Methyl eugenol could be effectively used for trapping *B. dorsalis* and cue lure could be used against *B. cucurbitae* trapping.
- Residue studies in vegetables indicated that 72.2 per cent of the samples were found to be contaminated with pesticides. Quinalphos was the main insecticide contaminant whose residue exceeded MRL value in 10% samples.
- Twenty three per cent of the surface and ground water (Trivandrum, Pathanamthitta, Kasaragod) samples were contaminated with traces of lindane, dicofol and endosulfan.
- Samples of grapes and mango showed contamination with mancozeb residues below MRL values.
- Milk samples collected from Thiruvananthapuram district indicated contamination with isomers of HCH in 32.25 per cent. 18.75 per cent exceeded MRL values.
- Fishes from local markets in Thiruvananthapuram district indicated the presence of methyl parathion, endosulfan, lindane and fenvalerate below MRL values.
- Monitoring of total diet samples analyzed indicated the presence of HCH isomers in 80% of the samples with a range of 0.34 to 1.65 ppm. 11.5 per cent samples showed 0.02-0.25 ppm of chlorpyrifos residues wherein cowpea was one of the food components.
- Endosulfan, quinalphos and monocrotophos were the major contaminants in cardamom, of which only 11.3 per cent samples exceeded MRL values. None of the pepper samples were contaminated with pesticide. The samples of chilli powder showed the presence of dicofol, but their levels were below the MRL value.

- Pesticide residue studies in meat samples revealed that 30.2 per cent samples contained residues of alpha HCH and 10.1 per cent contained dicofol. In liver samples, 18.2 per cent contained alpha HCH and 6.8 per cent contained dicofol. Blood samples were free from residues.
- Studies on the effect of decontamination techniques for the removal of residues in vegetables indicated that the removal of residues due to washing ranged from 15.16 to 56.2 per cent and washing followed by cooking ranged from 22.15 to 75.8 per cent.
- Of the five samples collected from endosulfan aerial sprayed cashew plantations of Kasaragod during February 2001, endosulfan residues were detected in two samples (0.11 to 0.224 ppm) while alpha endosulphan in three samples with a range of 0.025 to 0.29 ppm. Among the four samples of leaf analyzed (cashew-3 and betel vine-1) residue of alpha endosulfan was below detectable level in all samples while beta endosulfan was detected in cashew leaves with a range of 0.0507 to 0.858 ppm. Samples collected during August 2001 from suranga, tube well, open well or rivulet, soil, bovine milk, blood, butter, ghee and egg were free from endosulfan residues.
- Translocation studies of carbosulfan in coconut palms treated by root feeding with Marshal 20 EC indicated that residues did not persist in tender coconut water. Traces of carbosulfan could be detected in tender coconut pulp on seven days after treatment.
- Carbofuran @ 1kg a.i./ha at 7 DAT was effective in controlling rice root nematode.
- Seed dressing with carbosulfan (25 ST) @ 3% (w/w) was found effective in managing the nematodes in bhindi. An yield increase of 8 to 35 per cent due to nematode control was obtained by nursery treatment with *Pseudomonas fluorescens* in brinjal,
- Basal application of carbofuran @ 1kg a.i./ha or neemcake 1 t/ha and application of carbofuran at 45 DAP significantly reduced the nematode population and increased the yield from 17 – 38 per cent in ginger and turmeric.
- In cowpea, 15 to 47 per cent yield increase was obtained due to carbosulfan 0.1% seed soaking for 4 h by controlling the nematodes.
- Among the three rice ecosystems surveyed, predators were dominated in Pokkali area and pests were dominated in Kuttanadu and double-cropped area of Trivandrum. Insect predators were found more efficient than spiders in managing the pests in rice ecosystem. Among the insect predators, *Cyrtorhynchus lividipennis* and *Micraspis discolor* showed better ability to search for plant hoppers.

SUMMARY

Screening trial was carried out with 22 varieties/ cultures of cowpea against important pests. Five cultures were tolerant to pea aphid, stem fly and leaf roller. Cul-7 were found free from pod borer attack. Aphid and pod borers were lowest in the treatment with urea 2% + neem oil 2% at 7th and 20th day after sowing. Pod bugs incidence was minimum in Nimbecidine 0.2% treated plots.

Symptoms of necrosis disease of cowpea include necrosis of growing point of the plant leading to severe stunting, profuse growth of short axillary shoots giving bushy appearance. Severe infection led to the death of the plants. The virus was transmitted successfully through mechanical inoculation.

Acephate at 0.1% was effective in managing sap feeders, hadda beetle and gall flies of bittergourd. Combined application of *Bacillus thuringiensis* and *Beauveria bassiana* with acephate 0.05% was effective against sap feeders.

Econeem, Neemazal, Halt, Dipel, Dellin and Nuvan were the most effective insecticide in controlling the pests of amaranthus. Dipel (@ 0.7 ml/l) was effective against leaf webbers and Halt (@ 0.7g/l) was found to control weevil very effectively.

Cinnamomum zeylanicum and *Cymbopogon martini* had pronounced ovipositional deterrence at 0.5% level on *Spodoptera litura*. Aqueous extract of *Azadirachta indica* showed ovicidal action at 10% concentration.

A combination of soil and foliar application of *Trichoderma harzianum* and *Aspergillus niger* was effective for the control of anthracnose in the pepper nursery. They have a dual role as antagonists and as plant growth promoters.

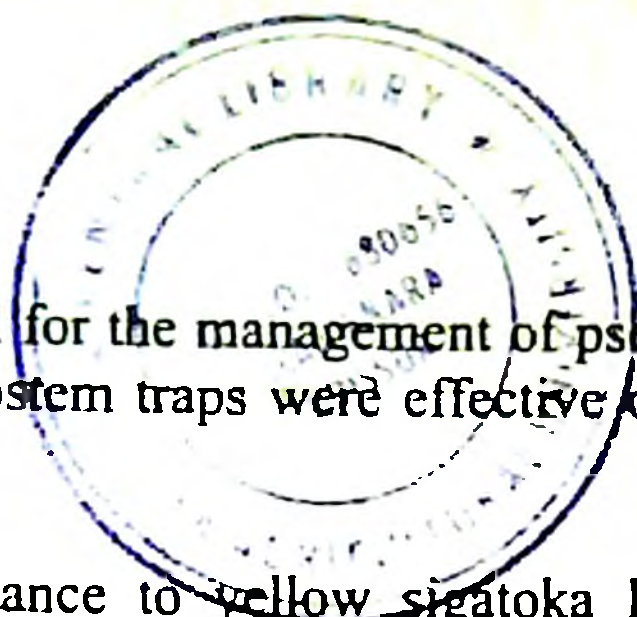
Forty days solarization, incorporation of *Trichoderma viride* and drenching of fytolan recorded cent per cent control of *Phytophthora* in pepper nursery. The treatment also reduced the foliar infection of rooted cuttings. Solarization reduced the weed population but increased the availability of nitrogen, phosphorus and potassium. It also increased the growth response of rooted pepper cuttings.

Cashew variety H-1600 was observed to be better as it was comparatively tolerant to both Tea Mosquito Bug TMB and *Colletotrichum gloeosporioides* complex. Quinalphos and carbaryl were effective in reducing the bug infestation. Combination sprays of carbendazin/copper oxychloride with quinalphos proved effective against the pest disease complex.

Odoiporus longicollis infestation in banana was absent in those plants, which received the minimum quantity of water though their yield was low. The plant, which received a slight moisture stress from 6th month onwards at least the outer sheaths escaped from the attack of the weevil without affecting yield adversely.

The morphological parameters associated with resistance against the pseudostem weevil *Odoiporus longicollis* were smaller width and breadth of the sheath coupled with more number of sheath. The anatomical feature associated with resistance was thick cuticle on epidermal cells with four to five layers of dense collenchymatous hypodermis imposing a physical barrier against oviposition. Higher content of phenol showed a positive correlation with resistance.

The study showed that the most susceptible variety Nendran, recorded upto 30% damage. Palayankodan, Rasthali and Chenkadali recorded 15-20% damage. Njalipoovan, Kadali, Dwarf Cavendish, Monthan and Robusta did not record any damage.



The most effective bait material for the management of pseudostem borer of banana was the cut pseudostem pieces. Pseudostem traps were effective only when the field population of the pest was medium to high.

The anatomical basis of resistance to yellow sigatoka leaf spot disease of banana was characterized by thickest cuticle and epidermis with intermediate sized epidermal cells on the adanial surface and denser epicuticular wax deposition on the abanial surface of leaves. The biochemical studies revealed that the resistant variety possessed higher quantity of total phenol, OD phenol, non-reducing and total sugars, protein and peroxidase activity and intermediate values for proline and polyphenol oxidase and lower quantity of reducing sugar.

The causal organism of rhizome rot disease of banana was identified as *Erwinia carotovora*. The variety Nendran was found highly susceptible to this disease. The *in-vitro* and pot culture experiment on the management of the disease revealed that fytolan (0.4%), streptocycline (300 ppm) or garlic extract (100 per cent) were effective in controlling the rot.

Banana bract mosaic virus was found to be a flexible and rod shaped one. All the cultivars tested were found susceptible to this virus.

The survey conducted in jack growing areas revealed that leaf caterpillar *Margaronia bivitalis*, fruit borer *Margaronia caesalis*, bark caterpillar *Indarbela tetraonis*, stem borer *Batocera rufomaculata*, spittle bug *Cosmocarta relata*, bark borer *Platypus indicus* and aphid *Greenidia artocarpis* as the pests. Whereas anthracnose, fruit rot and algal rust were found as the common diseases. The fruit rot was caused by *Rhizopus*.

Minimum pre-emergence rotting of ginger was recorded in treatments with the combination of three antagonists *Trichoderma viridae*, *Aspergillus flavus* and *Aspergillus niger* at 60 and 120 days after planting.

Studies on fruit flies revealed that *Bactrocera dorsalis* was infesting guava. *B. dorsalis* and *B. caryeae* infesting mango and *B. cucurbitae* infesting ivy gourd and banana. Fruit pulp with jaggery increased the trap catch. Boiled jaggery could increase the keeping quality of the bait. Protein hydrolysate 3.0 % along with malathion 0.2 % could be used as a bait spray.

When bhindi and brinjal were raised after the cultivation of sweet potato, the population of nematodes in soil was reduced and the yield of bhindi and brinjal increased to 20 and 22 per cent respectively.

Seed dressing with carbosulfan @ 3% w/w increased the yield of pulse crop ranging from 8-13 per cent. Seed dressing with carbosulfan (25 EC) @ 0.1% for less than four hours and nimbecidine @ 5% seed soaking for 4 hours were equally effective in increasing the yield of cowpea.

For the management of root-knot nematode and increasing the yield of banana, application of *Trichoderma viride* @ 2.5 g/plant at the time of planting and 45 days after planting was very effective.

Neem oil (3%) Achook (3%) neem gold (2%) were effective in controlling stem borer, gall midge and leaf folder of rice.

List of experiments

i) KAU Projects

a) Concluded experiments

Sl No	Code No	Title of the experiment	Location
1	PP-02-00-01-2000/ VKA(4)/KAU/PG	Eco-friendly insecticides for the management of major pests of amaranthus	CoH, Vellanikkara
2	PP-02-00-13-98/ VKA(4)/KAU/PG	Bio pesticides for integrated pest management in bitter gourd	CoH, Vellanikkara
3	PP-03-00-19-95/ KYM (4) KAU	Management of bruchus beetle <i>Callosobruchus</i> spp. in cowpea under field and storage conditions	ORARS Kayamkulam
4	PP-03-00-21-98/ VKA(5)/KAU/PG	Management of pumpkin mosaic disease using selected medicinal plant extract	CoH, Vellanikkara
5	PP-03-01-01-2000/ VKA(4)/KAU/PG	Evaluation of potential botanical pesticides against tobacco cut worm <i>Spodoptera litura</i>	CoH, Vellanikkara
6	PP-03-01-03-2001/ ACV(4)/KAU/PG	Management of the American Serpentine leaf miner, <i>Liriomyza trifolii</i> (Burgess) Pietars on cowpea, <i>Vigna unguiculata</i> (L.) walp.	CoA, Vellayani
7	PP-03-01-05-2002/ ACV(4)/KAU/PG	Seasonal occurrence and ecofriendly management of pests of black pepper (<i>Piper nigrum</i> L.)	CoA, Vellayani
8	PP-04-00-18-97/ VKA(5)/KAU/PG	Bio-control of rhizome rot of ginger (<i>Zingiber officinale</i> Rose) using selected antagonists	CoH, Vellanikkara
9	PP-06-00-01-2001/ ACV(4)/KAU/PG	Evaluation of newer insecticides against major pests of cowpea <i>Vigna unguiculata</i> L. Walp and their effect on natural enemies.	CoA, Vellayani
10	PP-07-00-04-97/ VKA(4)/KAU/PG	Trapping of red palm weevil <i>Rhynchophorus ferrugineus</i> in coconut gardens	CoH, Vellanikkara
11	PP-08-00-01-2002/ ACV(4)/KAU/PG	Pathogenicity, yield loss assessment and management of root-knot nematode <i>Meloidogyne incognita</i> (Kofoid and White) Chitwood on chilli (<i>Capsicum annum</i> L)	CoA, Vellayani
12	PP-09-00-03-97/ VKA(5)/KAU/PG	Integrated management of <i>Phytophthora</i> rot in black pepper nursery	CoH, Vellanikkara
13	PP-12-00-02-98/ VKA(4)/KAU/PG	Resistance mechanism against the pseudostem weevil <i>Odoiporus longicollis</i> Olivier (Coleoptera: Curculionidae) in banana	CoH, Vellanikkara
14	PP-12-01-01-2000/ VKA(4)/KAU/PG	Management of banana pseudostem weevil <i>Odoiporus longicollis</i> Olivier with induced resistance and epideictic compounds	CoH, Vellanikkara
15	PP-12-01-04-2002/ VKA(4)/KAU/PG	Evaluation and management of pest complex in cashew grafts	CoH, Vellanikkara
16	PP-12-02-02-2000/ VKA(5)/KAU/PG	Anatomical and biochemical basis of resistance in banana to yellow sigatoka leaf spot disease	CoH, Vellanikkara
17	PP-12-02-05-2001/ VKA(5)/KAU/PG	Etiology and management of rhizome rot disease of banana	CoH, Vellanikkara

18	PP-19-00-05-98/ ACV(4)/ KAU/PG	Integrated pest management in grain and vegetable cowpea	CoA, Vellayani
19	PP-19-00-06-98/ ACV(4)/KAU/PG	Major predators in rice ecosystems and their potential in rice pest management	CoA, Vellayani

b) Experiments in progress

Sl. No.	Code No.	Title of the experiment	Location
1	PP-01-00-01-2004/ VKA(4)/KAU/PG	Biology and insecticide sensitivity of rice white backed plant hopper, <i>Sogatella furcifera</i> (Horvath) (Hemiptera: Delphacidae) in Kerala	CoH, Vellanikkara
2	PP-01-00-02-2004/ VKA(4)/KAU/PG	Bioecology and management of mulberry leaf roller <i>Diaphania pulverulentalis</i> Hampson (Pyralidae : Lepidoptera)	CoH, Vellanikkara
3	PP-02-00-02-2004/ ACV(4)/KAU/PG	Management of banana pseudostem weevil <i>Odoiporus longicollis</i> Oliv. using entomopathogenic fungi	CoA, Vellayani
4	PP-03-00-20-97/ MON (4)/KAU	Botanical pest control trial	RRS, Moncompu
5	PP-03-01-06-2002/ ACV(4)/KAU/PG	Extent of damage, bioecology and management of pests of stored pulses	CoA, Vellayani
6	PP-03-01-07-2002/ ACV(4)/KAU/PG	Pests of betelvine (<i>Piper betle</i> L.) and their management through bio-intensive approach	CoA, Vellayani
7	PP-03-01-08-2002/ VKA(4)/KAU/PG	Synergistic interactions of biocides and synthetic chemicals on tomato fruit borer <i>Helicoverpa armigera</i> (Habner)	CoH, Vellanikkara
8	PP-03-01-09-2003/ ACV(4)/KAU/PG	Management of insect pest complex in okra (<i>Abelmoschus esculentus</i> Linn.)	CoA, Vellayani
9	PP-03-02-06-2002/ ACV(4)/KAU/PG	Management of root knot nematode <i>Meloidogyne incognita</i> (Kofoid and White) Chitwood of okra with antagonistic and trap crops	CoA, Vellayani
10	PP-04-01-01-2003/ VKA(4)/NATP/PG	Evaluation and characterization of effective fungal pathogens associated with the coconut eriophyid mite (<i>Aceria guerreronis</i> K.)	CoH, Vellanikkara
11	PP-04-01-02-2004/ VKA(4)/KAU/PG	Biology and management of root mealy bug of banana cultivars	CoH, Vellanikkara
12	PP-04-02-04-2001/ AMB(5)/KAU	Evolving an antagonistic microbial formulation for integrated management of rhizome rot and bacterial wilt disease of ginger	RARS, Ambalavayal
13	PP-04-02-05-2002/ ACV(5)/KHDP/ PG	Disease management and growth improvement in chilli and tomato using <i>Trichoderma</i> and fluorescent pseudomonads	CoA, Vellayani
14	PP-04-02-06-2004/ ACV(5)/KAU/PG	Etiology and management of fungal diseases of vanilla (<i>Vanilla planifolia</i> Andrews)	CoA, Vellayani
15	PP-06-00-02-2001/ VKA(4)/KAU/PG	Bioefficacy of newer insecticides against leafhopper <i>Empoasca motti</i> Pruthi in bittergourd	CoH, Vellanikkara
16	PP-15-00-01-2001/ ACV(5)/KAU/PG	Purification and immunodetection of banana bract mosaic virus	CoA, Vellayani
17	PP-15-00-02-2003/ ACV(5)/KAU/PG	Characterization of a tospovirus causing necrosis disease of cowpea (<i>Vigna unguiculata</i> (L) Walp)	CoA, Vellayani
18	PP-15-00-03-2003/ PTB(5) KAU	Studies on viral diseases of cucurbitaceous vegetables	RARS, Pattambi

ii) Externally aided projects

a) Concluded experiments

Sl. No.	Code No.	Title of the experiment	Location
1	Aventhis Crop Science India	Bioefficacy evaluation of Hostathion 40 EC (Triazophos) against coconut mite <i>Aceria guerreronis</i> Keifer and residue determination	CoA, Vellayani
2	BARC	Application of Sterile Insect Technique (SIT) to control red palm weevil in coconut	CoA, Vellayani
3	PP-03-01-04-2001/ ACV(4)/BARC/ DAE/PG	Effect of plant products and sterile insect technique in the management of red palm weevil (<i>Rhynchophorus ferrugineus</i> Oliv.)	CoA, Vellayani
4	PP-03-03-02-2001/ ACV(5)/STED/PG	Management of bacterial blight of anthurium (<i>Anthurium andeanum</i> Hinden) using botanicals	CoA, Vellayani
5	PP-04-02-01/2000/ ACV(5)/STED	Utilization of pepper phylloplane mycoflora for the biocontrol of foliar diseases of pepper	CoA, Vellayani
6	PP-04-03-01-2000/ ACV(5)/DST/PG	Management of water hyacinth (<i>Eichhornia crassipes</i> (Mart.) Solms) using fungal pathogens.	CoA, Vellayani

b) Experiments in progress

Sl. No.	Code No.	Title of the experiment	Location
1	NATP	Development of an integrated pest management package for the eriophyid mite <i>Aceria guerreronis</i> (Keifer) of coconut in the southern states.	CoA, Vellayani
2	PP-03-01-02-2001 KNR(4)/ICAR	Evaluation of commercially available neem based insecticides for control of pseudostem borer of banana.	BRS, Kannara
3	PP-10-00-01-2001/ KNR(4)/ICAR	Management of pseudostem borer of banana using different bait traps	BRS, Kannara
4	PP-12-01-02-2001/ KNR(4)/ICAR	Biology and population dynamics of pseudostem borer of banana	BRS, Kannara
5	PP-12-01-03-2001/ KNR(4)/ICAR	Survey and incidence of insect pests of jack	BRS, Kannara
6	PP-12-02-04-2001/ KNR(5)/ICAR	Survey and incidence of diseases of jack	BRS, Kannara
7	ICAR	All India Network project on pesticide residues	CoA, Vellayani
8	AICRP	Nematode pests and their management	CoA, Vellayani
9	ICAR-UK	Integrated management of fruit flies in India	CoA, Vellayani

15. BIOTECHNOLOGY

Co-ordinator : Dr.K.Rajmohan

HIGHLIGHTS

- Protocols for the isolation of protoplasts from *Piper nigrum* and *P. colubrinum* were standardized.
- *In vitro* pollination in turmeric was done by suspending pollen grains in modified ME3 medium. Ovule development was observed in intra ovarian, placental and modified placental pollination techniques. Two hybrids from the *in vivo* crosses (VK 70 x VK 76) were germinated *in vitro* and six *in vitro* multiplied plantlets were successfully planted out in the field.
- In ginger, *in vitro* pollination was successful with pollens suspended in ME 3 medium, showing 90% development of ovules. Controlled selfing and crossing among autotetraploids and diploid cultivars using *in vitro* placental pollination were successful.
- RAPD profiles of 13 species of *Piper* were compared for genetic similarity. With the 20 primers used these species formed four clusters.
- Multiple shoots induction and rooting of the microcuttings were successfully carried out from the nodal segments of Malabar tamarind. Callus regeneration and somatic embryogenesis could be induced from the endosperm. Isozyme markers were developed (esterase) to identify the male and female sex forms at seedling stage.
- In neem, MS medium with combinations of BA + IAA or Kn + NAA was found ideal for shoot proliferation. Methanol:water (30:70) was the best solvent system for elution of azadiractin. The highest amount of azadiractin ($6.71 \mu\text{g g}^{-1}$) was produced in MS medium containing 1.0 mg l^{-1} IAA on the 30th day.
- Germination of cashew somatic embryoids could be induced, in a medium containing a combination of B 5 major salts and MS minor salts, supplemented with BA, PVP, and coconut water in the presence of light.
- In mango, somatic embryogenesis was initiated from the nucellus tissues in half strength MS medium supplemented with BA, glutamine, casein hydrolysate, sucrose, coconut water, and activated charcoal in darkness. The media for maturation and germination of the somatic embryoids were developed.
- Techniques could be standardized for the isolation and culture of the protoplasts of mango. Combination of cellulase (Onozuka R-10) and pectinase (Maccrozyme R-10) at a concentration of 1% and 0.5%, respectively produced the best result for protoplast isolation. In a medium ($1/2 \text{ MS} + \text{BAP } 3 \text{ mg l}^{-1} + \text{NAA } 1 \text{ mg l}^{-1}$) containing 90 g l^{-1} glucose as osmoticum, cell wall formation was initiated on the 4th day and microcalli formation after 4 weeks. The best result was obtained with a combination of sucrose 70 g l^{-1} , mannitol 10 g l^{-1} , and inositol 10 g l^{-1} .
- *In vitro* propagation of *Aegle marmelos* (Koovalam) via enhanced release of axillary buds was standardized. Compared to nodal segments, cotyledons responded better with respect to percentage of survival (100) and shoot proliferation (49 shoots per culture). MS medium containing BA 0.5 mg l^{-1} produced the highest rate of multiplication. A combination of BA 2.5 mg l^{-1} and IAA 1 mg l^{-1} produced maximum multiplication from nodal segments. Addition of GA3 3.0 mg l^{-1} produced lengthy shoots. Supplementation of adenine sulphate 20 mg l^{-1} improved shoot proliferation. Root formation was the best in basal MS medium and sand was ideal for *ex vitro* establishment.

- Somaclonal variants derived from tomato variety Sakthi were checked for resistance against tomato leaf curl virus (TLCV). Two variants were free from the disease and five plants showed only mild curling and puckering. Two variants were free from fruit cracking and another two yielded higher than the control plants.

SUMMARY

Two thousand seven hundred and fifty tissue culture pepper plants were hardened for on farm evaluation. One thousand nine hundred and fifty plants were distributed to 32 units. Both the tissue culture plants and conventional propagules were fortified with the biocontrol agent *Trichoderma* spp. The performance of tissue culture plants established earlier in farmer's field and KAU campuses were evaluated for their growth and yield. The growth, flowering, fruit set and yield of tissue culture plants were superior to the conventional propagules. RAPD profiling of 20 randomly selected tissue culture plant of Subhakara and Panchami, was done using 6 Operon primers each and the profiles indicated genetic uniformity among the micro-propagated plants.

Genomic DNA was isolated from 49 varieties of *Piper nigrum*. Twenty selected decamer primers were used to amplify the DNA for RAPD analysis. The 44 varieties of *Piper nigrum* were grouped into 11 groups, with the NE collection forming a group totally separate from all others. P1 and P3 which are hybrids of the same parents Uthiramkotta x Cheriyanakaniyakadan are seen grouped together. Similarly, Sreekara and Subhakara that are clonal selections from Karimunda are seen grouped together in the dendrogram. The other varieties are grouped into several clusters. P2 (OP progeny of Balankotta) and P4 (clonal selection from Kuthiravally) are grouped together, as also Ayimpriyan and P5 (OP progeny of Perumkodi).

Genomic DNA of 49 black pepper varieties were isolated and purified for AFLP. However the results showed slight concurrence with those obtained for RAPD markers. The NE collection 3089 was very distinct in both sets of analysis. Varieties Sreekara and Subhakara revealed close relationship in RAPD and AFLP analysis. The variety Uthiramkotta was found to cluster with Sager local in both the analysis. Nine *Piper* species were subjected to RAPD analysis with 20 selected primers and AFLP analysis with 12 primer pairs. A total of 148 markers were detected from the RAPD profile and 1005 markers were observed with primer pairs studied in AFLP assay for the 9 species studied. The dendrograms generated for RAPD and AFLP analysis showed a clear cluster formation excluding the species *P. arborium* and *P. colubrinum*, which showed high degree of dissimilarity among themselves as well as within the species studied. They are known to be two exotic species, morphologically very distinct from the other *Piper* species. The genetic diversity observed in the present study between these two species agreed with their existing morphological classification.

In the case of AFLP analysis of teak plants a total of 467 markers were observed with 10 primer combinations among 20 plants of the population studied. The dendrogram generated from AFLP banding profile revealed that the genotypes were grouped into eight clusters. The intra population variability varied from 20 to 40%.

Somatic organogenesis could be induced in bael (*Aegle marmelos*). Embryogenic callus could be induced in MS basal medium supplemented with, 2,4-D 0.2mg l⁻¹, BA 0.1mg l⁻¹, coconut water 200ml l⁻¹, sucrose 40.0g l⁻¹ and agar 6.0g l⁻¹.

In vitro clonal propagation of two promising gladiolus (*Gladiolus grandiflora* L.) varieties, namely Peach Blossom and Tropic Seas could be standardized. BA 4mg l^{-1} + NAA 0.5mg l^{-1} resulted in the production of the highest number of shoots in both the cultivars. Sucrose 40g l^{-1} in the shoot proliferation medium was ideal. IBA 2mg l^{-1} and IAA 2mg l^{-1} induced earliest rooting in Peach Blossom and Tropic Seas, respectively. Sucrose 30g l^{-1} and 40g l^{-1} induced early rooting and the longest root in Peach Blossom and Tropic Seas especially. *In vitro* rooted plantlets planted out in sand : soil (2:1) recorded 100% survival rate in both the varieties after 15 days.

List of experiments

i) KAU Projects

a) Concluded experiments

Sl. No.	Code No.	Title of the experiment	Location
1	BT-01-01-52/99 ACV-15-KAU PG	Molecular evaluation of genomic stability of banana plants developed by <i>in vitro</i> clonal propagation	CoA, Vellayani
2	BT-01-01-54/99 VKA-20-KAU PG	Micropropagation of teak (<i>Tectona grandis</i> Linn.) through <i>in vitro</i> techniques	CoH, Vellanikkara
3	BT-01-01-55/99 VKA-15-KAU PG	Micropropagation and crop improvement of cordyline (<i>Cordyline terminalis</i>) (L.) Kunth.)	CoH, Vellanikkara
4	BT-01-01-56/99 VKA-15-KAU PG	<i>In vitro</i> multiplication and genetic improvement of tuberose (<i>Polianthes tuberosa</i> Linn.)	CoH, Vellanikkara
5	BT-02-02-06/99 VKA-16-KAU PG	Parasexual hybridisation of <i>Piper nigrum</i> L. and <i>Piper colubrinum</i> Link. through protoplast fusion	CoH, Vellanikkara
6	BT-02-02-06/99 VKA-16-KAU PG	Somatic embryogenesis in banana <i>Musa</i> (AAB) 'Nendran'	CoH, Vellanikkara
7	BT-02-02-07/99 VKA-16-KAU PG	Refinement of <i>in vivo</i> and <i>in vitro</i> pollination techniques in turmeric (<i>Curcuma domestica</i> Val.)	CoH, Vellanikkara
8	BT-04-01-02 / 98 VKA 16 KAU PG	<i>In vitro</i> callus induction in gurmar (<i>Gymnema sylvestre</i> R. Br.) for secondary metabolite synthesis	CoH, Vellanikkara
9	BT-04-01-03/99 VKA-16-KAU PG	Genetic transformation for hairy root induction in Adakodien (<i>Holostemma adakodien</i> K. Schum)	CoH, Vellanikkara
10	BT-05-03-02/99 VKA-16-KAU PG	Variability analysis in calli clones of black pepper (<i>Piper nigrum</i> L.)	CoH, Vellanikkara
11	BT-05-03-03/99 VKA-16-KAU PG	Evaluation of pathogenesis related proteins in relation to <i>Phytophthora</i> foot rot in black pepper (<i>Piper nigrum</i> L.)	CoH, Vellanikkara
12	BT/06-00-03-2001 VKA(14)KAU/PG	Screening of tomato somaclones for resistance to Tomato leaf curl virus (TLCV)	CoH, Vellanikkara
13	BT/06-00-01-2000 ACV(15)KAU/PG	<i>In vitro</i> clonal propagation of two promising gladiolus (<i>Gladiolus grandiflorus</i> L.) varieties	CoA, Vellayani
14	BT/07-00-02-2000 ACV(15)KAU/PG	Molecular characterisation of banana (<i>Musa</i> AAB Plantain subgroup) clones	CoA, Vellayani
15	BT/09-00-01-2000 VKA(16)KAU/PG	Micropropagation and evaluation of azadirachtin production in the plantlets of neem (<i>Azadiracchta indica</i> A. Juss)	CoH, Vellanikkara

b) Experiments in progress

Sl. No.	Code No.	Title of the experiment	Location
1.	BT/08-00-05-2002 VKA(16)KAU/PG	Induction of variation <i>in vitro</i> and field evaluation of somaclones in ginger (<i>Zingiber officinale</i> Rosc.)	CoH, Vellanikkara
2	BT-01-01-53/99 ACV-15-KAU PG	Standardisation of <i>in vitro</i> techniques for the rapid clonal propagation of bael (<i>Aegle marmelos</i> (L.) Corr.)	CoA, Vellayani
3	BT-02-02-05/98 VKA-9-KAU PG	<i>Agrobacterium</i> mediated genetic transformation in black pepper (<i>Piper nigrum</i> L.)	CoH, Vellanikkara
4	BT/01-00-02-2001 VKA(16)SPIC- KAU/PG	Genetic transformation of black pepper (<i>Piper nigrum</i> L.) for <i>Phytophthora</i> foot rot resistance / tolerance	CoH, Vellanikkara
5	BT/02-00-01-2000 VKA(16)KAU/PG	<i>Agrobacterium</i> mediated genetic transformation of ginger (<i>Zingiber officinale</i> Rosc.)	CoH, Vellanikkara
6	BT/03-00-01-2000 ACV(18)KAUPI-	Molecular basis of resistance in rice to sheath blight disease incited by <i>Rhizoctonia solani</i> Kuhn	CoA, Vellayani
7	BT/04-00-01-2000 VKA(18)KAU	Detection of phytoplasma in root (wilt) affected coconut palms by molecular techniques	CoH, Vellanikkara
8	BT/08-00-02-2001 VKA(16)KAU/ PG	Exploitation of induced variability for crop improvement in ginger (<i>Zingiber officinale</i> Rosc.)	CoH, Vellanikkara
9	BT/08-00-03-2002 VKA(10) DBT/PG	Morphological and molecular characterisation of variability in <i>in vitro</i> derived seed-lings of vanilla (<i>Vanilla planifolia</i> Andrews)	CoH, Vellanikkara
10	BT/08-00-04-2002 ACV(15)KAU/PG	<i>Agrobacterium</i> mediated genetic transformation in <i>Dendrobium</i>	CoA, Vellayani
11	BT/08-00-05-2002 VKA(16)KAU /PG	Induction of variation <i>in vitro</i> and field evaluation of somaclones in ginger (<i>Zingiber officinale</i> Rosc.)	CoH, Vellanikkara
12	BT/06-00-04-2001 VKA(15)KAU/PG	Studies on <i>in vitro</i> shoot tip culture of banana for the development of a cost effective small scale production system.	CoH, Vellanikkara
13	BT/06-00-05-2002 ACV(16)KAU/PG	<i>In vitro</i> somatic embryogenesis in bael [<i>Aegle marmelos</i> (L.) Corr.] varieties	CoA, Vellayani
14	BT/06-00-06-2002 ACV(16)KAU/PG	Rapid propagation and conservation of selected leguminous medicinal plants using <i>in vitro</i> techniques	CoA, Vellayani
15	BT/06-00-07-2003 ACV(9)DBT/PG	Micropropagation of <i>Dendrobium</i> hybrids	CoA, Vellayani
16	BT/07-00-01-2000 ACV(15)KAU/PG	Morpho anatomical and molecular characterisation of <i>Dendrobium</i> Sw. cultivars	CoA, Vellayani
17	BT/07-00-03-2000 VKA(5)KAU/PG	Molecular characterisation of <i>Ralstonia solanacearum</i> (Smith) Yabuuchi <i>et al.</i> causing bacterial wilt in solanaceous vegetables	CoH, Vellanikkara
18	BT/07-00-04-2000 VKA(16)KAU/PG	Molecular characterisation <i>Piper</i> spp. using RAPD techniques	CoH, Vellanikkara
19	BT/07-00-04-2001 VKA(9)KAU/PG	Morphological, biochemical and molecular markers for the genetic analysis in cashew (<i>Anacardium occidentale</i> L.)	CoH, Vellanikkara

20	BT/07-00-05-2001 VKA(16)KAU/PG	Isozyme variation in <i>Areca catechu</i> L. and allied species	CoH, Vellanikkara
21	BT/07-00-06-2001 VKA(9)KAU/PG	Biochemical and molecular characterisation of 'Njavara' types of rice (<i>Oryza sativa</i> L.)	CoH, Vellanikkara
22	BT/07-00-07-2001 ACV(15)KAU/PG	Random amplified polymorphic DNA (RAPD) analysis of banana (<i>Musa</i> spp.)	CoA, Vellayani
23	BT/07-00-08-2003 ACV(16)KAU/PG	Genetic variability analysis in Indian indigo (<i>Indigofera tinctoria</i> L.) using Random amplified polymorphic DNA (RAPD) technique	CoA, Vellayani
24	BT/07-00-09-2003 ACV(15)KAU/PG	Characterisation of traditional mango (<i>Mangifera indica</i> L.) varieties of southern Kerala	CoA, Vellayani
25	BT/09-00-01-2000 VKA(16)KAU/PG	Utilisation of <i>in vitro</i> cultures of chittamrithu (<i>Tinospora cordifolia</i> Miers.) for berberine	CoH, Vellanikkara
26	BT/10-00-01-2002 VKA(5)KAU/PG	Characterisation of <i>Ralstonia solanacearum</i> (Smith) Yabuuchi <i>et al.</i> , causing bacterial wilt in ginger using molecular marker	CoH, Vellanikkara
27	BT/02-00-04-2003 VKA(19)KAU	Standardisation of protocol for <i>in vitro</i> fertilization and seed germination in Zingibaraccuos crops – ginger, turmeric and kacholam	CoH, Vellanikkara
28	BT/01-00-01- 2003/VKA(15)KAU	Large scale production of banana plantlets through <i>in vitro</i> methods turmeric and kacholam	CoH, Vellanikkara
29	BT/02-00-03-2004 VKA(9)KAU/PG	<i>In vitro</i> mutagenesis in rice (<i>Oryza sativa</i> .L.)	CoH, Vellanikkara
30	BT/01-00-02-2004/ VKA(15) KAU	<i>In vitro</i> propagation in two commercial diploid bananas of Kerala	CoH, Vellanikkara
31	BT/02-00-01-2004 VKA(19)KAU/PG	Induction of genetic variability in ginger (<i>Zingiber officinale</i> Rosc.) through <i>in vitro</i> fertilization.	CoH, Vellanikkara
32	BT/02-00-02-2004 VKA(19)KAU/PG	Induction of variability in <i>Vanilla planifolia</i> Andeus through intra / interspecific hybridization and embryo Culture technique.	CoH, Vellanikkara
33	BT/05-00-01-2004/ VKA (19) KAU/ PG	Genetic transformation of chilli (<i>Capsicum annum</i> L.) with osmotin gene	CoH, Vellanikkara
34	BT/05-00-02-2004/ VKA(19) KAU/PG	Genetic transformation for hairy root induction and enhancement of secondary metabolites in Aswagandha (<i>Withania somnifera</i> (L.) Dunal)	CoH, Vellanikkara
35	BT/05-00-03-2004/ ACV(19) /KAU/PG	<i>Agrobacterium tumefaciens</i> mediated genetic transformation in Kudangal (<i>Centella asiatica</i> (L.) Urban)	CoA, Vellayani
36	BT/05-00-04-2004/ ACV (9)/KAU/PG	<i>In vitro</i> regeneration and <i>Agrobacterium</i> mediated transformation in tomato (<i>Lycopersicum esculentum</i> Mill) in relation to disease resistance against Groundnut bud necrosis virus	CoA, Vellayani
37	BT/05-00-05-2004/ ACV(16)/KAU/ PG	<i>Agrobacterium</i> mediated genetic transformation in Koduvell (<i>Plumbago</i> spp. (L))	CoA, Vellayani
38	BT/06-00-01-2004/ VKA(19)KAU/PG	Variability of chakkarakolli (<i>Gymnema sylvestre</i> R. Br.) using morphological, biochemical and molecular markers.	CoH, Vellanikkara
39	BT/01-00-03-2004/ ACV(16)/KAU/ PG	Rooting of microshoots and <i>ex vitro</i> establishment of plantlets of bael (<i>Aegle marmelos</i> (L.) Corr.)	CoA, Vellayani

40	BT/06/00-02-04/ ACV(9)/KAU/PG	<i>In vitro</i> multiplication and DNA fingerprinting of selected hybrids and their parents in <i>Anthurium andreanum</i> Linden.	CoA, Vellayani
41	BT/07-00-01-2004/ ACV(19)/KAU/PG	Differentiated expression of genes involved in anthocyanin pigmentation in Red banana and green red clones	CoA, Vellayani
42	BT/07-00-02-2004/ VKA(19)/KAU/PG	Molecular characterization of 3 hydroxy 3 methyl glutaryl-CoA-reductase(hmgr) gene from solanaceous plants	CoH, Vellanikkara
43	BT/07-00-03-2004/ VKA(19)/KAU/PG	Isolation and characterization of β - 1,3 glucanase gene in <i>Piper</i> spp.	CoH, Vellanikkara

ii) Externally aided projects

a) Concluded experiments

Sl. No.	Code No.	Title of the experiment	Location
1		Triploid production in watermelon and anona through <i>in vitro</i> endosperm culture	CoH, Vellanikkara
2		Tissue culture research in cashew	CoH, Vellanikkara
3		Micro-propagation and development of seedless Malabar tamarind through <i>in vitro</i> techniques	CoH, Vellanikkara
4		Micro-propagation of <i>Ailanthus triphysa</i> and <i>Pterocarpus marsupium</i>	CoH, Vellanikkara
5		<i>In vitro</i> propagation and improvement of orchids	CoA, Vellayani

b) Experiments in progress

Sl. No.	Code No.	Title of the experiment	Location
1		Network Project on improvement of selected spices through biotechnology tools	CoH, Vellanikkara
2		Onfarm evaluation of tissue culture black pepper	CoH, Vellanikkara
3		Induction of variation through tissue culture and evaluation of the variants for <i>Phytophthora</i> foot rot tolerance in black pepper (<i>Piper nigrum</i> L.)	CoH, Vellanikkara
4		Micropropagation of Bejasal (<i>Pterocarpus marsupium</i>)	CoH, Vellanikkara
5		Genetic transformation in bell pepper	CoH, Vellanikkara
6		Sustainable management of plant biodiversity	CoH, Vellanikkara
7		AFLP analysis and characterization of teak	CoH, Vellanikkara
8		Breeding for interspecific and intergeneric hybrids of orchids for commercial cultivation	CoA, Vellayani
9		Crop improvement in orchids <i>via in vitro</i> mutagenesis	CoA, Vellayani
10		Biotech Kerala Project	CoH, Vellanikkara
11		Characterisation of traditional mango varieties of southern Kerala	CoA, Vellayani
12		Molecular and physiological analysis of banana clones	CoA, Vellayani

16. POST HARVEST TECHNOLOGY

Co-ordinator : Dr. P. Jacob John

HIGHLIGHTS

- An instant sapota-milk shake powder was developed by spray drying the mix with a shelf life of 4 months under ambient conditions when packed with metalized polyester pouches.
- Two fungal organisms viz., *Aspergillus* sp and *Trichoderma harzianum* was found to produce enzyme pectinase in solid-state fermentation of fruit wastes.
- A technology to produce ripe robusta banana powder was standardized by spray drying ripe robusta pulp under suitable conditions.
- Breadfruit when wrapped individually with unventilated polymeric pouches gave a shelf life of 5 days under room temperature.
- Chopped, dried and powdered Adhatoda when packaged in rigid plastic containers retained vasicine, the principal alkaloid up to 5 months in ambient conditions. The technique developed could store bulk quantity in a limited space without chemical or microbial spoilage.

SUMMARY

Bottled sapota- milk beverage with 20⁰Brix, containing 40 per cent sapota and 20 per cent skim milk was the best composition preferred by the sensory panel. The beverage when pasteurized at 85⁰C for 30minutes recorded a shelf life of 4 months under refrigerated condition.

Maximum growth rate in cashew apple was between 35-55 days after nutset where as for nuts it was between 30-40 days after the fruit set.

Higher growth rate in coleus was observed between 135 to 150 days of transplanting the coleus. Soluble solids in coleus were found to increase up to 135 days.

Effect of post harvest treatments like precooling, anti fungal treatments and packaging on the shelf life of banana is progressing.

Various varieties of coconut were being evaluated for the suitability to use as tender nuts and the feasibility of using coconut husk for growing orchids, mushroom, etc., is going on.

Different product standardization to utilize mango ginger is in progress. Screening of varieties for product preparation is also going on.

The studies on physical and biochemical changes in cocoa beans during processing are progressing.

Storage studies on ripe banana, juice, powder, packaged with laminated pouches under ambient condition is progressing.

The technology for enzyme clarification of banana juice has been standardized. Ripe banana pulp after pasteurization is treated with commercial pectinase @5ml/kg. The juice was extracted after 4 hours at room temperature.

Extension of shelf life of fresh breadfruits were found possible by packaging the fruits in polyethylene bags of 250 gauge and also by individually wrapping the fruits with cling film. By these treatments, it was possible to keep fresh fruits without spoilage for 5 days at ambient temperature and 9 days under refrigeration. Breadfruit slices subjected to blanching in water at 90°C for 3 minutes, when packaged in aluminum foil pouches filled with N₂ gas could be stored without quality deterioration for 8 days at ambient and for four weeks under refrigeration. In case of storage under frozen condition, filling of CO₂ and N₂ in the pouches were found to be better treatments. Dehydrated breadfruit slices subjected to blanching in water with 0.3% citric acid and 1500ppm SO₂ for 5 minutes and then microwave oven drying could be kept without spoilage in polythene and polypropylene bags of 250 gauge for a period of 4 months.

Some value added products from elephant foot yam and taro were standardized and evaluated for its nutritional qualities and shelf life.

The ideal method for pectin extraction from fruit waste was standardized. Mangosteen rind pectin was identified as the purest source of pectin among the different wastes analysed. The passion fruit rind and lime peel pectin showed rapid setting nature. The major defects observed with different jellies viz., firm and syrup consisting, synerus, cloudiness and bitterness were removed either by changing the composition of extraction media or blending with the pectin extracts from other fruit wastes.

Evaluation of the efficiency of three strains of wine yeast in the preparation of cashew apple wine revealed that strain MTCC 180 was superior to other strains. Gelatin (1%) was found to be superior to other clarifying agents for cashew apple juice. The varietal evaluation of cashew apple wine making revealed that the varieties Madakkathra-1 and Dhana were superior to other varieties studied. Wine kept for a storage period of six months showed a general improvement in the quality and acceptability over fresh wine.

Sun drying of the whole plants of *Adhatoda* chopped into pieces was evolved as the best drying technique with respect to quality attributes like vasicine content and alcohol extract as well as water soluble extracts for *A. zeylanica* and *A. bedomie*. Sundried chopped pieces stored in 250 gauge polythene bags and powdered samples in steel containers had maximum retention of principal alkaloid vasicine after storage in room temperature for 5 months for both the species and the same samples also recorded the lowest microbial load whereas for hot water extract, glass bottle was more ideal than plastic bottles. Higher growth rate of tubers was recorded between 135 to 150 days after transplanting (DAT) stage. Total numbers of tubers, length, diameter, peel thickness and peel percentage were found to increase with maturity of tubers. The peel colour changed from yellowish brown and flesh colour changed from yellowish cream to whitish cream during maturation. Studies on storage revealed that sprouting and physiological loss in weight was lowest under zero energy cool chamber storage. The starch content of tubers decreased and sugar content increased in storage.

Isolation and pure culturing and initial screening of microorganisms for their efficiency for pectinase production on media containing pectin resulted in release of two fungi *Trichoderma harzianum* and *Aspergillus* sp. The fungus *Aspergillus foetidus* 115 exhibited maximum

growth and production of pectinase on all waste media in SSF. The activity of pectinase producing microorganisms were more when inoculated on grape waste. The conditions and nutrient media for pectinase production were also standardized.

Evaluation of banana varieties for post harvest attributes, physical, chemical and physiological changes during post harvest period, effect of post harvest treatments on extension of shelf life of banana and effect of packaging on shelf life of banana varieties is in progress.

Twenty five accessions of banana from BRS, Kannara were evaluated for post harvest attributes and eight varieties with better post harvest attributes were selected for studying the physical, chemical and physiological changes during post harvest period. Of the different post harvest treatments for extension of shelf life, pre cooling was found to be better. Among the different packaging treatment vacuum packing was effective for extension of shelf life of the different varieties.

Different varieties of coconut were evaluated for suitability to use as tender coconut. The dwarf varieties especially CDG was more acceptable as its water contained more sugar and T.S.S. The study also revealed the suitability of tender coconut husk to be used as medium for growing orchids, mushroom etc. The husk can also be turned to compost with high nutrient profile.

The technology for banana powder from robusta variety was standardized. The ripe pulp is mixed with additives, pasteurized, homogenized and dried using spray and drum drier.

The technology for enzyme clarification of banana juice has been standardized. Ripe banana pulp is pasteurized, cooled and commercial pectinase @5ml/kg is added. The juice is extracted after 4 hours at room temperature.

The ideal method of fermentation and dehydration for cocoa beans under Kerala conditions were standardized. The physical and biochemical changes in bean composition during processing were analyzed. Studies on secondary processing and product development is in progress.

Collection of jackfruit seeds and storing them in dried form is in progress.

List of experiments

1) KAU projects

a) Concluded experiments

Sl No.	Code No.	Title of the experiment	Location
1	PHT-02-00-01-2000/ VKA(10)/KAU/PG	Effect of harvest maturity on quality and shelf life of pumpkin (<i>Cucurbita moschata</i> Poir)	CoH, Vellanikkara
2	PHT-02-00-02-2000/ VKA(17)/KAU/PG	Shelf life of bread fruit (<i>Artocarpus altilis</i> (Park))	CoH, Vellanikkara
3	PHT-02-00-04-2001/ VKA(17)/KAU/PG	Post harvest studies in adhatoda. [<i>A. zeylanica</i> (Medic) and <i>A. Beddomei</i> (Clarke)]	CoH, Vellanikkara
4	PHT-02-00-06-2002/ VKA(17)/KAU/PG	Post harvest quality evaluation of okra (<i>Abelmoschus esculentus</i> (L) Moench]	CoH, Vellanikkara
5	PHT-02-00-05-2001/ VKA(10)/KAU/PG	Quantitative and qualitative changes in coleus (<i>Solenostemon rotundifolius</i>) Poir	CoH, Vellanikkara

6	PHT-03-00-01-2000/ ACV(17)/KAU/PG	Value addition and evaluation of nutritional quality in Elephant foot yam [<i>Amorph phallus paeonifolius</i> (Dennst)]	CoA, Vellayani
7	PHT-03-00-02-2000/ VKA(17)/KAU/PG	Value addition in sapota [<i>Manilkara achras</i> (Mill)]	CoH, Vellanikkara
8	PHT-03-00-03-2000/ VKA(17)/KAU/PG	Development of an integrated light processing (L.P) technology for tender coconut and tender coconut husk based products.	CoH, Vellanikkara
9	PHT-03-00-04-2000/ ACV(17)/KAU/PG	Value addition and evaluation of nutritional quality in Taro (<i>Colocaria esculenta</i> L. Schott)	CoA, Vellayani
10	PHT-03-00-05-2000/ VKA(17)/KAU/PG	Evaluation of fruit wastes as sources of pectin.	CoH, Vellanikkara
11	PHT-03-00-06-2000/ VKA(17)/KAU/PG	Standardization of techniques for cashew apple wine production and development of wine based products.	CoH, Vellanikkara
12	PHT-03-00-08-2002/ VKA(17)/KAU/PG	Fruit waste utilization for pectinase production in solid state fermentation (SSF)	CoH, Vellanikkara

b) Experiments in progress

Sl. No.	Code No.	Title of expernment	Location
1	PHT-01-00-02-2003/ VKA(17)/KAU	Development of an integrated light processing, packaging, storage, marketing and by product utilization system for tender coconuts.	CoH, Vellanikkara
2	PHT-01-00-01-2003/ VKA(17)/KAU	Post harvest handling and value addition of fruits and vegetables.	CoH, Vellanikkara
3	PHT-02-00-03-2000/ VKA(17)/KAU/PG	Evaluation of selected banana (<i>Musa Spp</i>) varieties grown in Kerala for post harvest attributes.	CoH, Vellanikkara
4	PHT-02-00-07-2002/ VKA(17)/KAU/PG	Development of juice based beverage and ripe fruit powder from banana (<i>Musa Spp</i>)	CoH, Vellanikkara
5	PHT-02-00-08-2003/ VKA(17)/KAU/PG	Standardization of minimal processing techniques for selected vegetables.	CoH, Vellanikkara
6	PHT-02-00-09-2003/ VKA(17)/KAU/PG	Fruit development, post harvest handling and product development studies in red banana. (<i>Musa AAA</i> group)	CoH, Vellanikkara
7	PHT-02-00-10-2003/ VKA(17)/KAU/PG	Dehydration and storage studies in fig (<i>Ficus carica</i> .L)	CoH, Vellanikkara
8	PHT-03-00-07-2001/ VKA(17)/KAU	Survey, collection and evaluation of mango ginger (<i>Curcuma ameda</i>) types for processing qualities.	CoH, Vellanikkara
9	PHT-03-00-09-2003/ VKA(17)/KAU/PG	Scope of banana and plantain pseudostem sheaths for fibre extraction and utilization.	CoH, Vellanikkara
10	PHT-03-00-10-2003/ VKA(17)/KAU	Evaluation of banana varieties for fig making.	CoH, Vellanikkara
11	PHT-03-00-11-2003/ VKA(17)/KAU/PG	Standardization technology for value addition of cocoa (<i>Theobroma Cacao</i> L.)	CoH, Vellanikkara
12	PHT-03-00-12-2004/ ACV(17)/KAU/PG	Value addition in banana (<i>Musa Spp</i>)	CoA, Vellayani
13	PHT-03-00-13-2004/ VKA(17)/KAU/PG	Physico chemical properties of jackfruit (<i>Artocarpus heterophyllus</i> Lam) seed flour and its prospects for use in cattle feed.	CoH, Vellanikkara

ii) Externally aided projects : Nil

17. TRANSFER OF TECHNOLOGY

Co-ordinator : Dr. R. Prakash

HIGHLIGHTS

- The Thozhil sena (Labour force) formed in Kunnathukal panchayath, in Thiruvananthapuram resulted in increased employment and income generation. Education, achievement motivation and attitude towards peoples plan had positive and significant relationship with the role of Thozhil sena.
- Majority of the farmer's officials and people's representatives were found to have favourable attitude and good perception about the gramasabhas. Lack of active group discussion was the most important perceived constraint regarding gramasabhas.
- Forecasting technical manpower needs on agriculture in Kerala revealed that most of the respondents were working in identified organisations whose functional areas are research and development.
- The research problem identification emerged as the most important dimension of quality management in agricultural research.
- Regarding dynamics of co-ordination for agricultural development in the context of democratic decentralisation in Kerala, maximum extent of co-ordination performance was at the district level followed by block panchayath and grama panchayat, lack of proper interaction among the agencies involved in agricultural development was rated as the most important problem.
- Majority of agricultural officers were having a moderate awareness and knowledge on land evaluation for sustainable agricultural development.
- Participatory socio-economic land evaluation revealed that crops viz. pineapple, mango, sapota and cocoa were not suitable for watershed area due to various socio-economic reasons.
- Awareness about organic farming practices showed significant and positive relationship with education, mass media exposure and environmental orientation.
- In Trivandrum, livestock, rubber and tapioca, in Kollam rubber, livestock, pepper, coconut and in Pathanamthitta rubber, coconut and livestock were the major components contributed towards annual home garden income.
- Social cost benefit analysis in vegetable production programmes in Kerala through participatory approach showed that Malappuram district had the maximum percentage of social costs and least social benefits while in Thrissur district it is vice versa.

SUMMARY

The study conducted in Kunnathukal panchayath of Thiruvananthapuram district and Thamarakkulam panchayath of Alappuzha district to analyse the structure, function and role of Thozhil sena and to study the employment and income generation revealed that education,

achievement motivation and attitude towards peoples plan had positive and significant relationship with the role of Thozhil sena. More employment days were generated in Kunathukal panchayath compared to Thamarakkulam panchayath.

Influence of farming culture folk arts and rituals on north malabar region of Kerala state revealed that most folk arts like 'Theyyam' and "Chimmamkali" have widely been originated from an ancient agrarian society which had a deep rooted stand in farming culture. The lyrics of their songs and the content of their rituals, the region of performance all show the strong bond with farming culture.

The study on viability of Self Help Groups (SHG) in vegetable and fruit promotion council Kerala revealed that 80% of SHG,s had a membership ranging from 16-29 and a democratic style of functioning. Technology adoption, annual income, innovativeness and risk orientation showed a positive significant relationship.

Analysis of farmer's participation in the participatory technology development (PTD) with regard to plant protection in vegetables revealed that the farmers had high level of cosmopolitaness, self-concept, risk bearing capacity and credit orientation. Farmers had good knowledge regarding PTD and its related aspects.

Forecasting technical manpower needs in agriculture in Kerala revealed that most of the respondents were working in identified organizations whose functional area is research and development. The most important factors influencing the forecasting were emerging technological development, impact of WTO agreements and government policies related to agriculture.

Development of spatial group suitability model through participatory and integrated land evaluation for sustainable agriculture indicated that majority of the agricultural officers were in the medium category with respect to their awareness and knowledge on land evaluation for sustainable agricultural development. Majority of the agricultural officers had favourable attitude towards land evaluation for crop suitability. Participatory socio-economic land evaluation revealed that crops namely pineapple, mango, sapota and cocoa were not suitable for the watershed area due to various socio economic reasons.

Regarding the study on quality management in agricultural research in Kerala Agricultural University, research problem identification emerged as the most important dimension of quality management in agricultural research followed by formulation of objectives, research methodology, literature review, data generation, data analysis results and implications. A majority of the scientists where in a high level of quality management in their research work. Scope for personal development and task identification were the important factors in quality management in agricultural research.

The study on micro credit and technology utilization in vegetable production by self help groups showed that group dynamics indicators were showing good group activity. Members of the group had trainings conducted based on their felt needs facilitated by field officers. Regarding market behaviour field centers were preferred to market the production.

List of experiments

i) KAU Projects

a) Concluded experiments

Sl. No.	Code No.	Title of the experiment	Location
1.	TOT-01-00-02-2000/ ACV(6)/KAU/PG	Role of labour force (thozhil sena) in agricultural development implemented through peoples plan in Kerala	CoA, Vellayani
2.	TOT-05-00-02-2000/ ACV(6)/KAU/PG	Performance and potential of gramasabhas in crop production in Athiyannoor block of Thiruvananthapuram district	CoA, Vellayani
3.	TOT-01-00-09-2002/ ACV(6)/KAU/PG	Forecasting technical manpower needs in agriculture in Kerala	Trivandrum
4.	TOT-05-00-03-2001/ ACV(6)KAU/PG	Micro credit and technology utilization in vegetable production by self help groups in Thiruvananthapuram district	Trivandrum
5.	TOT-08-00-02-2000/ VKA(6)/KAU/PG	An evaluation of leading farm magazines of Kerala	Thrissur
6.	TOT-02-00-03-2002/ ACV(6)/KAU/PG	Development of spatial crop suitability model through participatory and integrated land evaluation for sustainable agriculture.	CoA, Vellayani
7.	TOT-01-00-11-2002/ ACV(6)/KAU/PG	Promotion of terrace cultivation of vegetables by urban housewives – an action research	Trivandrum
8.	TOT-01-00-07-2000/ ACV(6)KAU/PG	Dynamics of co-ordination for agricultural development in the context of democratic decentralisation	Trivandrum
9.	TOT-05-00-04-2000/ ACV(6)/KAU/PG	Variability of self help groups in vegetable and fruit promotion council Keralam – A multidimensional analysis	Trivandrum
10.	TOT-01-00-13-2003/ ACV(6)/KAU/PG	Analysis of organic farming practices in vegetable cultivation in Thiruvananthapuram district.	Trivandrum
11.	TOT-02-00-01-2000/ VKA(6)/KAU/PG	Influence of farming culture on the folk arts and rituals on north malabar region of Kerala state	Thrissur
12.	TOT-01-00-12-2003/ ACV(6)/KAU/PG	Production system and typology utilization pattern in cassava cultivation in Thiruvananthapuram district	Trivandrum
13.	TOT-01-00-08-2002/ ACV(6)/KAU/PG	Technology assessment in the home garden systems of Kerala	Thrissur & Kasargod
14.	TOT-02-00-01-2000/ VKA(6)/KAU/PG	Influence of farming culture on the folk arts and rituals of north malabar regions of Kerala	Thrissur
15.	TOT-02-03-13-1999/ ACV(6)/KAU/PG	Social cost benefit analysis in vegetable production programme in Kerala through participatory approach.	Trivandrum

b) Experiments in progress

Sl. No.	Code No.	Title of the experiment	Location
1	TOT-03-00-06-01/ ACV(6)/KAU/PG	Sustainability of tribal development in Kerala – A methodological study	Trivandrum

2	TOT-02-00-06-2004/ ACV(6)/KAU/PG	Socio-technical system analysis of tribal and settler farmers in western ghat region of Wynad district in Kerala	Wynad
3	TOT-02-00-07-2004/ ACV(6)/KAU/PG	Women empowerment through group action in the Kudumbasree programme of Kerala – A multidimensional analysis	Trivandrum
4	TOT-03-00-07-2003/ ACV(6)/KAU/PG	Impact of rural agricultural work experience programme of agricultural graduates in Vellayani campus.	Trivandrum
5	TOT-09-00-02-2003/ ACV(6)/KAU/PG	A multidimensional analysis of apiculture in Kollam and Thiruvananthapuram districts	Trivandrum & Kollam
6	TOT-11-00-01-2003/ VKA(6)/KAU/PG	Effectiveness of agribusiness and agriclincs trainings in Kerala	Thrissur
7	TOT-01-00-06-2002/ VKA(6)/KAU/PG	Participatory action research for remunerative rice production.	Thrissur
8	TOT-01-00-19-2004/ VKA(7)/KAU/PG	Interaction effect under AMMI model	Thrissur
9	TOT-04-00-03-2004/ VKA(6)/KAU/PG	Non governmental sources of agricultural extension in Kerala	Thrissur
10	TOT-13-00-01-2004/ VKA(6)/KAU/PG	Agricultural expert system - A participatory assessment	Thrissur
11	TOT-04-00-02-2002/ ACV(6)/KAU/PG	Extension strategies for major farming systems in the context of the changing agricultural situation in Kerala	Trivandrum
12	TOT-04-00-02-2002/ VKA(6)/KAU/PG	Rubber produces society in Thrissur district – SAP analysis	Thrissur
13	TOT-02-00-04-2002/ VKA(6)/KAU/PG	Research and extension gaps in commercial vegetable farming in eastern Palghat	Thrissur.

ii) External aided projects

a) Concluded experiments : Nil

b) Experiments in progress

Sl. No.	Code No.	Title of the experiment	Location
1.	TOT-02-00-09-2004/ ACV(6)/KAU/KSCSTE	Promotion of organics in vegetable cultivation in Kerala	Trivandrum
2.	TOT-02-00-08-2004/ ACV(6)/KAU/ GOK	Socio technical system analysis of tribal and settler farmers in the western ghat region of the Wynad district of Kerala	Wynad
3.	TOT-11-00-02-2004/ ACV(6)/KAU/PG	Information management of agricultural research in Kerala	Trivandrum
4.		Enhancing productivity of black pepper in the homesteads of western ghat	Idukki

18. BENEFICIAL MICROORGANISMS

Co-ordinator: Dr. P. Sivaprasad

HIGH LIGHTS

- Developed highly efficient fluorescent pseudomonads from Kerala soils and the selected isolate P₁ effectively suppresses major crop disease incited by fungal sp. *Pythium*, *Phytophthora*, *Rhizoctonia*, *Fusarium* and bacterial sp. *Xanthomonas* and *Ralstonia*.
- Developed native *Trichoderma viride* and *T. longibrachiatum* for the effective management of fungal diseases such as foot rot of black pepper, azhukal disease of cardamom, rhizome rot of ginger, wilt disease of vegetables, fungal diseases of vanilla and betelvine.
- A simple technique for inoculum production and farmer level multiplication of *Trichoderma* in cowdung-neemcake food base has been developed.
- Dual inoculation with native mycorrhizal fungi viz., *Glomus monosporum*, *Trichoderma viride* and *T. longibrachiatum* is effective for the management of root disease of crop plants viz., foot rot of black pepper, azhukal diseases of cardamom, rhizome rot of ginger and wilt disease of vegetables.
- Highly effective *Bacillus* and actinomycetes were isolated from Kerala soil for the management of soil borne diseases.
- Use of microbial inoculant technology (AMF, *Azospirillum* and *Pseudomonas*) for the establishment and growth of tissue culture plantlets have been developed.
- Successfully commercialized and transferred mother cultures of *Trichoderma*, *Pseudomonas fluorescens*, AMF and *Azospirillum* and the production technology has been transferred to government institutions. (State biocontrol lab, Mannuthy, Biofertilizer lab, Parottukonam, RARS of KAU viz., Ambalavayal, Pattambi and Kumarakom and ten private entrepreneurs). All the production centres are running on profit.
- Consultancy service is being given to all the production centres.
- Isolate P₁ is also effective against coconut eriophyd mite and possibility of using honey bee as vector for delivering bacteria to the inflorescence has been established under laboratory and field conditions.
- The technique of pre-inoculation with AMF in vegetables and ornamental nursery for the management of soil borne disease was standardized.
- Paddy straw supplemented with neem cake gave maximum yield followed by rice bran, coconut oil cake and wheat bran in *Pleurotus* sp.
- Ten strains of *Calocybe indica*, four strains of *Pleurotus* and one strain of *Ganoderma* sp. were collected, brought into pure culture and domesticated.

SUMMARY

Four lignocellulolytic fungi were isolated from retted coir pith. *Pleurotus tuber-regium*, which was obtained from Thiruvananthapuram district has a biological efficiency of 46 percent. Maximum reduction in organic carbon, C : N ratio, cellulose and lignin and maximum increase in nitrogen content in retted coirpith was recorded with *Trichoderma harzianum*. Maximum yield of *P. florida* was obtained in retted coirpith while the maximum yield of *C. indica* was observed in non-retted coirpith.

Springtail, flies and beetles were the major pests infesting oyster mushrooms. Competitor moulds viz., *Trichoderma* spp., *Aspergillus* spp., and *Coprinus* spp. caused reduction in yield. Covering the holes of beds with cotton and making pin pricks were found effective. A single spray of dichlorvos at 0.01 per cent three days after spawning controlled pest infection. Spot application of carbendazim - 50 ppm or lime was effective for managing *Trichoderma*. Increasing pH of the soaking water from 6-8 h increased the yield of beds.

Pre inoculation of AMF in vegetable and ornamental nursery reduced the incidence of damping off. *Glomus fasciculatum* gave maximum suppression of damping off in chilli and tomato followed by *G. etunicatum*, *G. constrictum* and *G. mosseae*. In ornamentals like zinnia and marigold also *G. fasciculatum* gave maximum disease suppression.

Nitrogen fixers were isolated from vermicompost as well as from the earthworms. But the occurrence of phosphate solubilising microorganisms was observed only in vermicompost. Soil borne pathogens such as *Rhizoctonia solani*, *Pythium* and *Phytophthora* spp. were absent in earthworm and vermicompost.

Maximum reduction in organic carbon was observed in non-retted coir pith inoculated with *Pleurotus eous* and *Schizophyllum commune*. N₂ content was maximum when retted coirpith was inoculated with *P. eous* and *S. commune* for 45 days. Significantly lower levels of C : N ratio was observed in non-retted coirpith after 45 days incubation with *Pleurotus eous*, *P. sajorcaju* and *S. commune*. *P. eous*, *P. sajorcaju* and *S. commune* were identified to be ideal lignocellulolytic fungi capable of decomposing retted and non-retted coirpith.

AMF inoculation along with phosphorus application significantly improved root length and volume in cowpea. This was maximum when 15 kg P₂O₅/ha was applied.

Extensive survey was done in Kerala and large collection of isolates of *Agaricus* spp. were made. Two species were identified as *A. squmuliferus* and *A. bernadii*. Temperature of 21.9 to 30.2°C was found to be optimum for their growth.

In rice inoculation of *Azospirillum* (Strain No. 2) along with 100% N gave maximum grain yield of 3.2 t/ha and straw yield of 2.57 t/ha. On 30 and 60 DAT, the rhizosphere population of *Azospirillum* was also maximum in this treatment.

Native isolate of *Azospirillum* (S₂) along with application of 100% N gave maximum yield of 1.08 kg/plant in watermelon.

Development of native biofertilizer and biocontrol organisms and formulation technology are being undertaken. Mother culture and production technology of *Azospirillum* has been transferred to State bio-fertilizer center, Parottukonam and seven private entrepreneurs for commercial production and marketing in Kerala. Similarly biocontrol agents like *Trichoderma* and *P. fluorescents* have been transferred for commercial production to different RARS in KAU, State biocontrol lab, Mannuthy and certain private entrepreneurs. Consultancy service is being given to all the production centres.

Techniques have been standardized for the inoculation of AMF along with *Azospirillum* and fluorescent pseudomonads for survival, establishment, growth and disease tolerance of black pepper plantlets. The mycorrhizal technology for tissue culture use has been transferred to Biotechnology centre, Kazhakuttam and Agro Biotech, Kottayam

Under the project exploration of Western ghat microbial biodiversity for crop nutrition and health, extensive survey has been conducted in the Palghat tract of Western ghats and biofertilizer and biocontrol organisms were isolated. Two promising bacterial isolates (B₂₈, B₈₁) effective against fungal pathogens have been selected through *in vitro* and *in vivo* screening. A collection of *Azospirillum*, *Azotobacter*, P-solubilizers and antagonistic fungi and bacteria has been made.

Under the project development of consortium of microbial inoculants for disease management and N and P nutrition of Black pepper and Vanilla isolation of biofertilizer and biocontrol agents for black pepper and vanilla from Kerala soil has been initiated.

Biofertilizer and biocontrol organisms developed under various projects are being maintained. Recommended culture and production technology have been transferred to various production centres including private entrepreneurs. A series of training programmes on microbial inoculants have been conducted for the benefit of farmers and extension officers. Technology has been developed for carrierless formulation of biofertilizer and biocontrol organisms. Technical help is also being given to other production centres.

The All India Co-ordinated Mushroom Improvement Project (AICMIP) started during 2001 to develop strains and technologies of tropical mushrooms suited to the region conducted seven experiments. The results of the experiments are (1) Among the supplements tested, neem cake gave maximum yield followed by rice bran, coconut oil cake and wheat bran (2) Six strains of *Calocybe* were evaluated and strain CBE and C₁-7, Ci-5 and Tvm-2 gave best results which were found suitable for Kerala (3) Seven strains of *Volvariella* were evaluated and strain, 0E-210 and 0E-214 were found most adaptable to our state (4) As part of collection and domestication of wild fleshy fungi, ten strains of *Calocybe indica*, four strains of *Pleurotus* and one strain of *Ganoderma* sp. were collected, brought into pure culture and domesticated. All cultures were deposited in the National Culture Collection Centre, Solan for which accession numbers were obtained.

List of experiments

i) KAU Projects

- a) Concluded experiments : Nil
- b) Experiments in progress

Sl. No.	Code No.	Title of the experiment	Location
1	BMI-02-00-05-91/ ACV(5)/KAU	Incidence of damping off disease in vegetables and ornamental plants and VA mycorrhizal crop interaction.	CoA, Vellayani
2	BHI-02-00-16-98/ ACV (1)/KAU/PG	Phosphorus use efficiency and productivity as influenced by microbial inoculants in vegetable cowpea var. Sharika.	CoA, Vellayani
3	BMI-06-00-03-95/ PIL(5)/KAU	Comparative evaluation of <i>Azospirillum</i> cultures for rice production.	RARS, Pilicode
4	BMI-02-00-06-91/ ACV(5)/KAU	Growth and establishment of tissue culture plantlets as influenced by VA mycorrhiza	CoA, Vellayani
5	KAU Plan	Strengthening of research on biofertilizers and biocontrol agents (CAV plan project)	CoA, Vellayani

ii) Externally aided projects

a) Concluded experiments

Sl. No.	Code No.	Title of the experiment	Location
1	KSCSTE	Utilization of fungi for composting and mushroom production on coir pith	CoA, Vellayani
2	KSCSTE	Identification and management of pest and diseases of oyster mushrooms	CoA, Vellayani

b) Experiments in progress

Sl. No.	Code No.	Title of the experiment	Location
1	KSCSTE	Comparative efficiency of lignocellulolytic fungi for the bioconversion of coirpith.	CoA, Vellayani
2	WG Devt. Cell	Exploration of Western ghat microbial biodiversity for crop nutrition and health	CoA, Vellayani
3	KSCSTE	Development of consortium of microbial inoculants for disease management and N and P nutrition of Black pepper and Vanilla.	CoA, Vellayani
4	State Plan	Biotech Keralam - Biotechnological interventions and opportunities towards enhancing crop production in Kerala - Biofertilizer and Biocontrol component.	CoA, Vellayani
5	BMI-06-00-06-98/ACV(5)/STED	Microflora associated with earthworm and vermicompost and their role in the production and use of vermicompost.	CoA, Vellayani
6	BMI-03-00-98/ACV(5)/ICAR/PG	Monographic studies on <i>Agaricus</i> spp. of Kerala.	CoA, Vellayani
7	AICMIP	All India Co-ordinated Mushroom Improvement Project	CoA, Vellayani

19. PRODUCTIVE INSECTS

Co-ordinator : Dr. S. Devanesan

HIGHLIGHTS

- The stingless bee *Trigona iridipennis* could be domesticated and reared in artificial hives viz., wooden hive, earthen pot and bamboo bit. The bamboo hive having a volume of 1500cc was ideal showing maximum brood development, pollen storage, population build up and honey storage.
- Stingless bee was found as the most efficient insect pollinators available in the ecosystem for crops and wild plants
- The honey collected by the stingless bees has greater medicinal value as it collected nectar from most of the medicinal plants from which the other *Apis* sp. could not collect due to their bigger body size.
- The average life cycle of *T. iridipennis* was recorded as 44.5 days.
- The morphometric characters of the queen and worker of stingless bees were studied.
- The ant, *Solenopsis geminate*, a megachilid bee, a dipteran fly and a mite were recorded as the pests of *T. iridipennis* under Kerala conditions.
- Stingless bee honey is more acidic than that of *A. cerana* honey.
- The studies on TSBV disease in Indian bee colonies revealed that the incidence of the disease still existed with varied virulence.
- Twenty different plant species were identified as source of pollen / nectar during lean season to honeybees.

SUMMARY

The result of the experiment on selective breeding of *Apis cerana indica* for TSBV resistance indicated that the virulence of the pathogen is declining gradually year after year, exhibiting resistance to the virus disease by the Indian bees. The percentage of virulence of the disease recorded was 35.7 (2001-02), 33.4 (2002-03) and 16.8 (2003-04).

The major groups of insects, which visited the coconut inflorescence were the Hymenopterans. Among these, honeybees (*Apis* spp.), ants (*Camponotus* spp) and wasps were dominant. Among true honeybees, *A. cerana indica*, *A. mellifera*, *A. dorsata* and *A. florea* were observed and among the stingless bees, the common species *T. iridipennis* and another stingless bee (not identified) which was bigger than *T. iridipennis* were also observed.

The management strategies for the ectoparasitic mite, *Varroa* sp. infecting *Apis mellifera* was standardized. Among the three concentrations of Fenazaquin (0.05 %, 0.03 % and 0.01 %) tried for the management of this mite, Fenazaquin, 0.05 % was found to be most effective for better mite fall with better safety to bees. The mean number of mite fall was maximum in the treatment with fenazaquin 0.05% (816.7) followed by 0.03 % (504.9) and 0.01 % (389.1).

List of Experiments

- KAU Projects : Nil

ii) Externally aided projects :

a) Concluded experiments

Sl. No	Code No.	Title of the experiment	Location
1	PI-02-00-01-2001/ ACV(4)/KAU/PG	Management of stingless bee <i>Trigona iridipennis</i> smith. (Meliponinae : Apidae) in the homesteads of Kerala	CoA, Vellayani
2	ICAR	Bioecology, domestication and management of stingless bee <i>Trigona iridipennis</i> Smith in Kerala	CoA, Vellayani
3	AICRP	Survey to assess the present status of the TSBV disease in Kerala	CoA, Vellayani
4	AICRP	Identification of additional flora for the lean season management of honeybees in Kerala	CoA, Vellayani

b) Experiments in progress

Sl. No	Code No.	Title of the experiment	Location
1	AICRP	Selective breeding of <i>Apis cerana indica</i> for Thai Sacbrood resistance.	CoA, Vellayani
2	AICRP	Role of honeybees in the pollination of coconut <i>Cocos nucifera</i> and yield increase	CoA, Vellayani
3	AICRP	Management of <i>Varroa</i> mite in <i>Apis mellifera</i> bee colonies	CoA, Vellayani
4	PI-03-00-01-2004/ ACV(4)/KAU/PG	Insect fauna on coconut (<i>Cocos nucifera</i> L.) spadix and effect of pesticides on major pollinators	CoA, Vellayani

20. INTEGRATED FARMING SYSTEMS

Co-ordinator : Dr. S. Ravi

HIGHLIGHTS

- Inter cropping banana var. Njalipoovan with tuber crops in general increased the banana yield to the tune of 12 to 64%. Lesser yam was found to be the best companion crop of banana followed by elephant foot yam.
- For banana-tuber crop intercropping system, the fertilizer recommendation for tuber crops can be reduced to 50% (NPK 40: 30:50 kg ha⁻¹ for elephant foot yam and 40:30:40 for greater yam and lesser yam) along with the recommended nutrient for banana.
- The present recommended dose of NPK for cassava can be reduced upto 50% (25:25:25kg./ha.) if khondolite @ 1 ton ha⁻¹ and FYM @ 12.5 tons ha⁻¹ are applied along with chemical fertilizer. Full substitution of chemical fertilizers with khondolite is possible if khondolite is applied at a higher rate of 2 tons ha⁻¹.

SUMMARY

A homestead model developed at FSRS, Sadanandapuram included components such as crop, animal, poultry, apiary and azolla cum ornamental fish unit. Japanese quail was also introduced in homestead. The efficiency of RIR under homestead condition in bens is being tested.

The study under NATP on homestead farming could develop profitable homestead models for different agro-climatic zones of Kerala and Andaman Nicobar islands.

The effect of application of powdered rock material viz. khondolite collected from the nearest quarry was studied on the yield of cassava in the laterite soil of Kottarakara. The highest yield of 21.32 tons ha⁻¹ was recorded in the treatment where 75% of POP recommended dose of NPK (38:38:38 kg ha⁻¹) was applied in conjunction with khondolite @ 1 ton ha⁻¹ and farm yard manure 12.5 tons ha⁻¹. This was on par with the treatment where 50 % of the recommended dose of NPK (25:25:25 kg ha⁻¹) was applied along with khondolite 1 ton ha⁻¹ and FYM 12.5 ton ha⁻¹.

List of experiments

i) KAU Projects

a) Concluded experiments

Sl. No.	Code No.	Title of the experiment	Location
1	IFS/07-00-02-99/ Kottarakkara (3)/KAU	Nutrient management in banana – tuber crop cropping system in homesteads	FSRS, Sadanandapuram

b) Experiments in progress

Sl. No.	Code No.	Title of the experiment	Location
1	IFS/08-00-03-99/KTR (8)/(KAU)	Development of homesteads through scientific planning and interventions in technology and management. An action research and analysis	FSRS, Sadanandapuram
2	IFS/01-00-5/91KTR(18)/NARP	On-farm research on existing homesteads for optimizing farm business income	FSRS, Sadanandapuram
3		Efficacy of Haritha super on banana in comparison with farm yard manure and different dozes of chemical fertilizers	FSRS, Sadanandapuram
4	(IFS/01-00-07-95/KTR (5)KAU)	Occurrence and severity of plant disease in homesteads as influenced by component crops and density	FSRS, Sadanandapuram
5	(IFS/06-00-02-99/ Kottarakkara(3)/KAU	Nutrient management in banana (Musa) [AAB] Palayankodan under homestead situation in Kollam District	FSRS, Sadanandapuram
6	AMP/02-00-16-99/ Kottarakkara (10)/KAU	Collection, conservation, cataloguing and biochemical characterization of medicinal plants in homesteads of southern regions of Kerala	FSRS, Sadanandapuram
7		Effect of manurial practices and sequential intercropping on crop yields and soil physico-chemical properties.	FSRS, Sadanandapuram
8		Economics of production and marketing of orchids and anthurium in south Kerala	FSRS, Sadanandapuram
9		Digitization of database on socio-economics of Kerala	FSRS, Sadanandapuram
10		Impact of soil and water conservation measures on the growth and yield of banana cv. Nendran	FSRS, Sadanandapuram

ii) Externally aided projects

a) Concluded experiments

Sl. No.	Code No.	Title of the experiment	Location
1	STED	Management of soil related constraints for increasing the productivity of laterite soils of Kollam District.	FSRS, Sadanandapuram

b) Experiments in progress

Sl. No.	Code No.	Title of the experiment	Location
1	NATP	Analysis and development of homestead farms of Kerala – A farmer participatory approach	FSRS, Sadanandapuram

21. AGROMETEOROLOGY

Co-ordinator : Dr. GSLHV Prasada Rao

HIGHLIGHTS

- The intensity of UV-B radiation is high between 10.30 a.m. and 2.30 p.m. across the central part of Kerala. It may be harmful to biological activities.
- The frequency distribution of onset of monsoon over Kerala revealed that it falls between 25th May and 8th June in majority of the years and the mean onset of monsoon is on 1st June \pm 7 days
- The monsoon rainfall is likely to be below normal when the onset of monsoon is before 25th of May. No such trend is noticed when the monsoon is late, that is beyond 8th June.
- There was a decrease of 131.4 mm in monsoon rainfall over a period of 130 years indicating a decline of 6.8 per cent over the normal rainfall of 1933 mm. The monsoon rainfall trend was seen revolving around the normal or below since last sixty years.
- There existed a negative relationship between the water deficit from December to May and annual cardamom production.
- The production potential is much better towards south of Kerala and Tamil Nadu across the Western Ghats as the climatic risk is relatively less.
- A multiple linear regression equation was developed using the agroclimatic indices for predicting coconut production of the State of Kerala. The model explains fairly well.
- Weekly agroadvisory bulletins prepared based on the medium range weather forecasting are disseminated to the selected farmers. The same is published in the daily print media once in a week.

SUMMARY

A) Climatic resources characterization

a) Onset of monsoon

The earliest onset of monsoon over Kerala was on 11th May in 1918 while the belated monsoon on 18th June in 1972. The onset of monsoon in recent years was early only in 1990 (19th May) and 2001 (23rd May) and 2004 (18th May). All the three the years recorded below normal monsoon rainfall. It appears that the monsoon rainfall is likely to be deficit rather than excess if the monsoon is early while no such trend if the monsoon is late. It was also observed that there was no trend in monthly rainfall when the monsoon was late or early. There was no change in normal onset of monsoon (1st June \pm 7 days) over Kerala. However, inter-annual variation in onset of monsoon is noticed as expected.

b) Seasonal rainfall

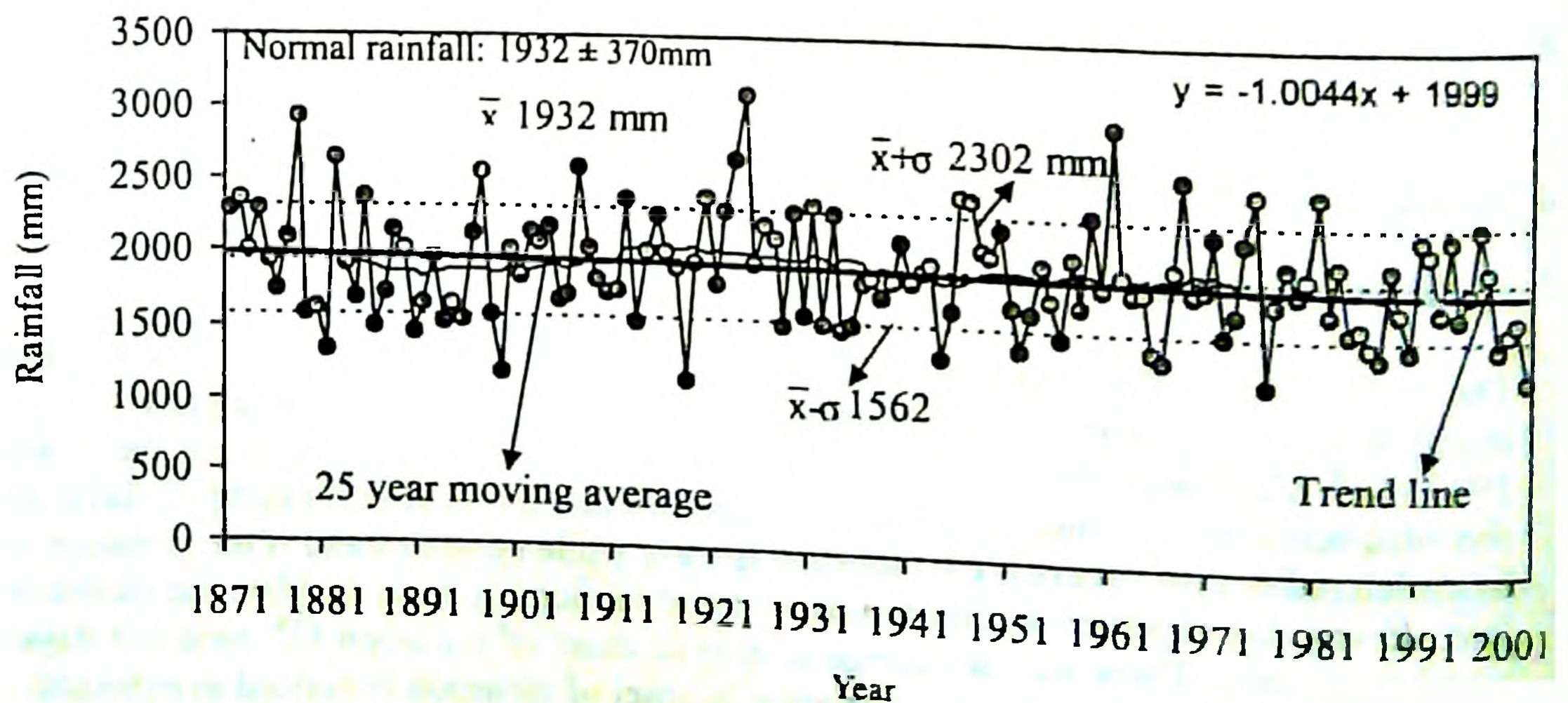
The seasonal rainfall of Kerala showed that 68 % of annual rainfall (2822 mm) was received during the monsoon, 16% in post-monsoon, 14 % in summer and 2 % in winter (Table 1). The seasonal rainfall during monsoon was dependable (CV -19.4%) while that of winter non-dependable (CV 72.4%). The analysis indicated that wetland paddy could be grown under rainfed conditions during virippu (kharif) while it can be grown in mundakan (winter) only under assured irrigation. Many of the plantation crops require irrigation from December to May, particularly in northern districts of Kerala where predominantly uni-modal rainfall situation is noticed.

Table 1. Season-wise normal rainfall (1871-2002) and its percentage contribution

Season	Normal rainfall (1871-2002)	Percentage contribution to annual	Standard Deviation	CV (%)
Monsoon (June -September)	1925	68	373	19.4
Post-monsoon (October-November)	441	16	140	31.6
Winter (December-February)	65	2	47	72.4
Summer (March-May)	391	14	160	41.0
Annual	2822	100	408	14.5

Overall, there was a decrease of 131.4 mm in monsoon rainfall, indicating a decline of 6.8 per cent over the normal rainfall of 1932 mm (Fig 1). The above trend was more evident in the rainiest months of June and July. In contrast, the monthly rainfall was in increasing trend in August and September. The monsoon rainfall trend was seen revolving around the normal since last 60 years. The decline in monsoon rainfall is insignificant towards north of Kerala when compared to south of Kerala.

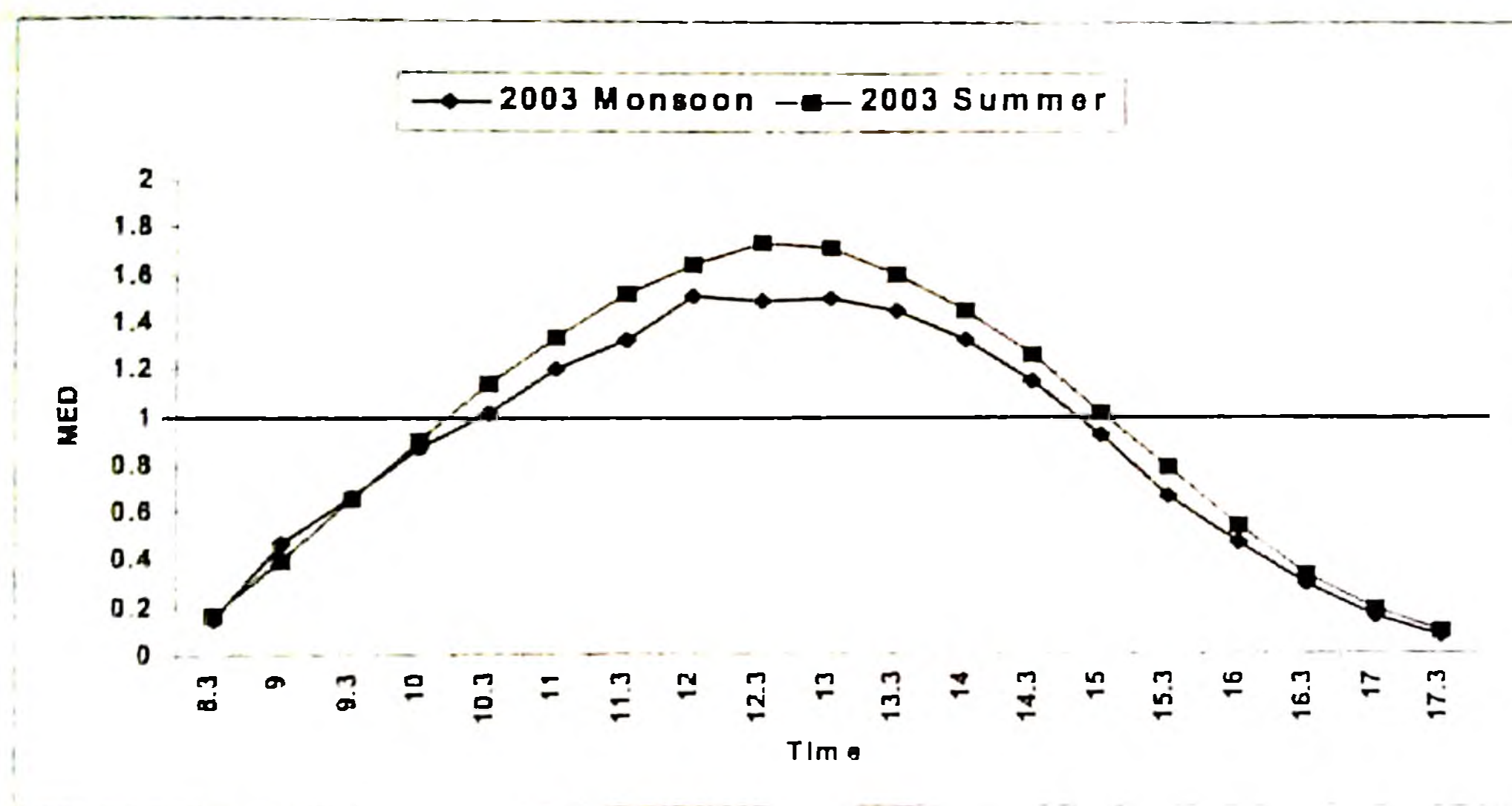
Fig 1. Southwest monsoon rainfall (mm) over Kerala from 1871 to 2002



c) UV B radiation

The UV Biometer was installed in the Department during June 2002. This is the first centre in India under AICRP on Agrometeorology to equip the UV - Biometer for monitoring the UV-B radiation. The intensity of UVB radiation from 280 to 320 nm was measured using the above device. The semi-diurnal variation of UVB radiation in MED (Minimum Erythema Dose) was being continuously monitored. The biological effectiveness of the UV irradiation is measured in MED/HR (Minimum Erythema Dose per Hour). The mean seasonal UV-B radiation never crossed the level of 2MED either during summer 2003 or during monsoon 2003, though there were instances of receiving > 2MED on individual days irrespective of seasons (Fig.2)

Fig. 2 Mean seasonal UVB Radiation (MED) at Vellanikkara during 2003



However, the daily analysis indicated that the intensity of UVB radiation was more (>2MED) on 15.5% of the days during March 2003 and drastically declined during April 2003 and it was nil in May though its intensity in the range of less than 2MED was similar to that of March and April (Table 2).

Table.2 Per centage occurrence of UV-B radiation during summer (March-May) 2003

Month	<1MED	1-2MED	>2MED
March	37.5	47.0	15.5
April	44.4	53.4	2.2
May	51.7	48.3	0

It was negligible on many days during southwest monsoon, varying between 12.5% (September) and 0.7% (July) of the occasions (Table 3). The intensity during September was as high as during March though September falls under the monsoon period.

Table 3. Percentage occurrence of UV-B radiation during Monsoon (June-September) 2003

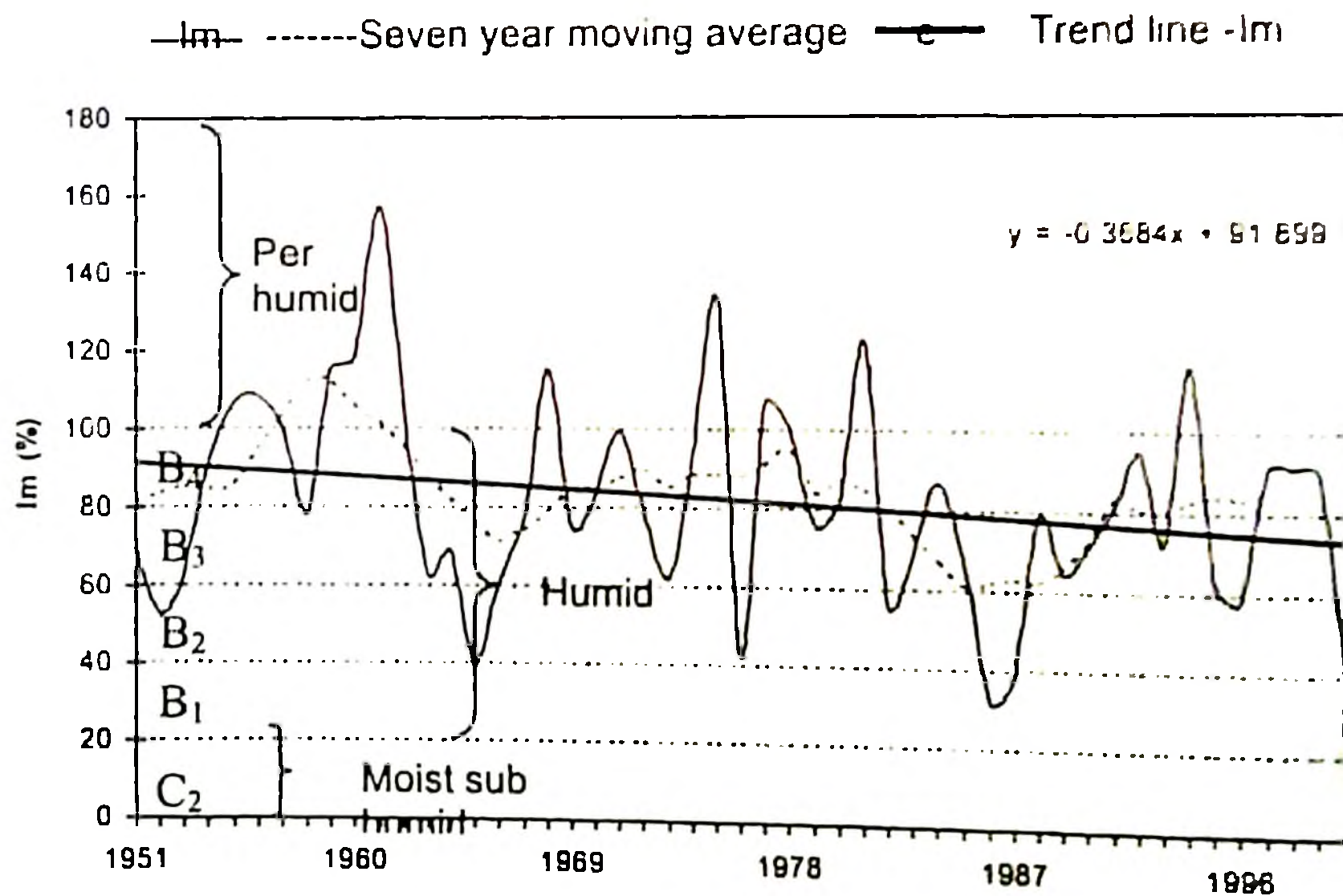
Month	<1MED	1-2MED	>2MED
June	62.1	35.3	2.6
July	59.9	39.4	0.7
August	53.2	41.1	5.7
September	37.0	50.5	12.5

It appears that the intensity of UVB (>2MED) radiation was more in the absence of rain as the case in September. A detailed analysis, which is in progress, will be reported later on temporal variations in UVB radiation.

d) Climatic variability

Kerala State falls under the climate type of "B₄ humid" based on annual climatic normal. The State had shifted from B₄ to A perhumid climate type in 36 years (Fig 3). The moisture index was also in decreasing trend (-18.4 %) from 1951 to 2000, indicating that the climate shifted from B₄ - humid to B₃, B₂ and B₁ - humid in recent decades though there was no such trend for the period as a whole. It revealed that the State of Kerala experienced from wet to dry within the B category of climate types in recent decades.

Fig 3. Yearly march of Moisture Index (Im) over Kerala during 1951 -2000



B) Yield forecasting models for coconut.

The monthly index of moisture adequacy (AE/PE x 100) and humidity index (WS/PE x 100) were worked out from 1945 to 2002. The humidity index during June to September and the index of moisture adequacy for remaining months were taken into account for predicting coconut production seven months ahead. The monthly agroclimatic indices (I_{ma} and I_h) were considered for 42 months, as the primodium initiation to coconut harvest takes about three-and-a-half years, for predicting coconut production of Kerala as a whole. A multiple linear regression equation was developed using the above agroclimatic indices for predicting coconut production and its productivity seven months ahead. The equations were developed using the data from 1949-50 to 1993-94. The model was used for predicting coconut production for the year 1994-95 to 2003-04 (Table 4). The maximum (-23.2%) deviation in

predicted coconut production was noticed during 1998-99, followed by 1999-2000 (15.2%). The abnormal low estimated coconut production in 2003-04 was due to erratic low rainfall distribution during monsoon and failure of northeast monsoon in recent years.

Table 4. Actual and predicted coconut production from 1994-95 to 2003-04

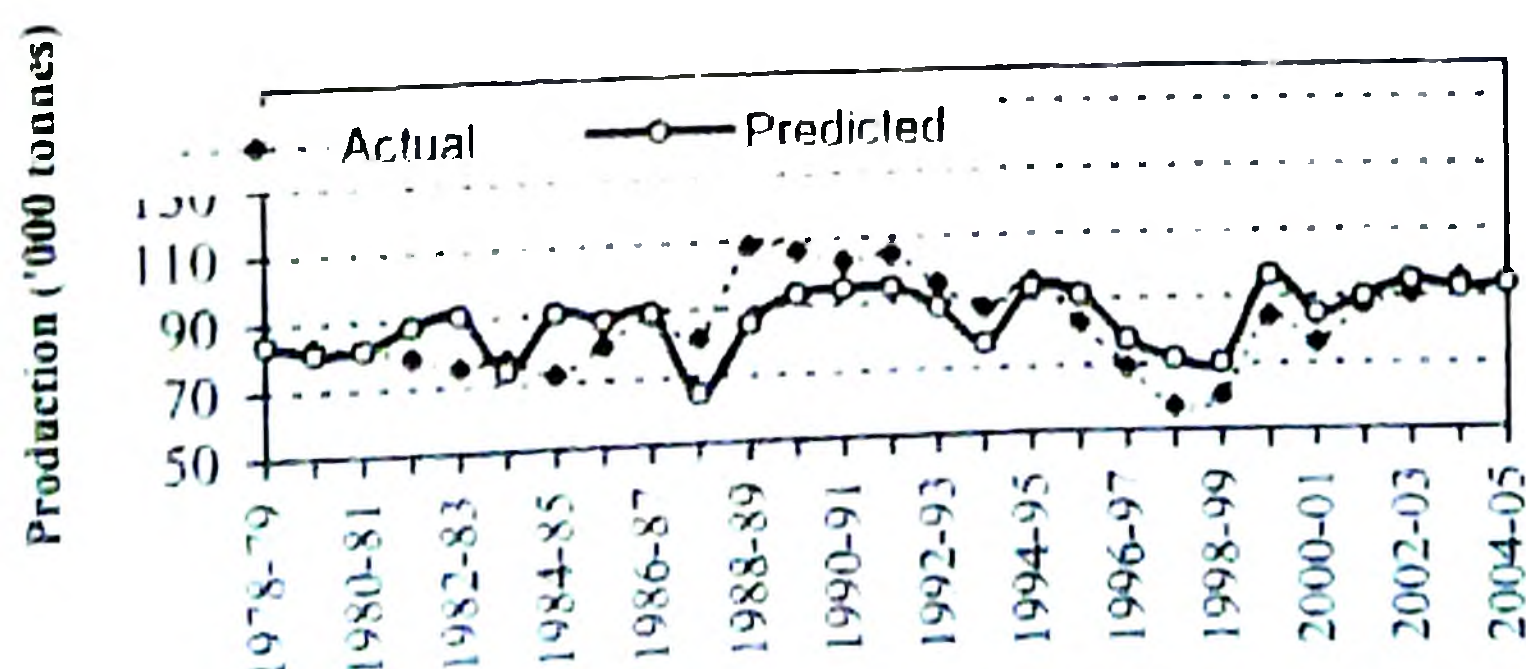
Year	Coconut production (million nuts)		
	Actual	Estimated	% deviation over actual
1994-95	5335	5109.8	-4.2
1995-96	5155	4943.6	-4.1
1996-97	5774	5444.2	-5.7
1997-98	5209	4651.2	-10.7
1998-99	5132	3942.1	-23.2
1999-00	5167	5963.9	15.2
2000-01	5496	4804.1	-12.6
2001-02	5744	5289.0	-7.9
2002-03	5338	4654.0	-12.8
2003-04		1595.0	

It indicated that the equation could be very well used for predicting the coconut production of Kerala seven months ahead. However, it needs revalidation as the estimated coconut production was always on lower side except during 1999-2000 and taking into account the abnormal weather phenomena that prevailed in recent years.

C) Yield forecasting model for cashew

Based on monthly rainfall from September to December, attempts were made to estimate cashew production across the Kerala State. A maximum difference between predicted and actual crop output was seen up to 22 per cent though both followed similar trend. It is more evident since 1986-1987 onwards (Fig 4). Of course, such deviation is expected as the equation is dependant on rainfall alone and not considering night temperature, which is one of the vital meteorological factors in deciding profuse flowering in cashew. The expected cashew production over Kerala State during 2003-2004 is similar to that of 2002-2003. However, it is understood that cashew production (late crop) appeared to be low during the current year across the districts of Kannur and Kasaragod due to prolonged dry spell/ drought.

Fig 4. Actual and estimated cashew production over Kerala from 1978-79 to 2003-04



D) Coconut phenology

A study was taken up to understand the seasonal influence of leaf and spadix production and their interval on different cultivars of coconut. The varieties selected for the study was Tiptur Tall, Kuttiyadi (WCT), Kasarakod (WCT) and Komadan (WCT).

All the four coconut cultivars behaved uniformly with respect to seasons in terms of functional leaves, spathe and female flower production. However, Tiptur tall was tolerant to weather aberration and superior in terms of its floral and yield characters. The study also indicated that low minimum temperature, optimum temperature range, wind speed, vapour pressure deficit, evaporation and sunshine hours resulted in maximum spathe duration during winter.

The average annual button shedding was high (73%) in 2003 when compared to 2002 (61%). Among the four test cultivars, highest button shedding was noticed in Tiptur Tall (77%) during summer 2003.

Table 5. Seasonal variation in button shedding in different cultivars of coconut

Cultivar	Summer	
	2002	2003
Tiptur tall	62	77
Kuttiyadi	55	73
Kasarakod	59	71
Komadan	69	72
Mean	61	73

E) Agroclimatic zones of cardamom

Studies on agroclimatic zonation of small cardamom revealed that the production potential of Zone I was relatively better (>200 kg / ha) when compared to that of Zone II and III across the Western Ghats, where the length of crop growing season was more than 300 days with annual Ima of more than 90 per cent. In addition, the annual temperature range was very low and optimum across the Zone I. The production potential of small cardamom was low (100-150 kg / ha) over Zone III (Karnataka), where the length of crop growing season was less than 250 days with annual Ima of 70-75 per cent. The annual temperature range was also high, which may be detrimental to cardamom production in the Zone III. The Zone II fall under intermediary category (150-200 kg / ha), where the length of crop growing season was more than 250 days with annual Ima varied between 80 and 85 per cent (Table 6).

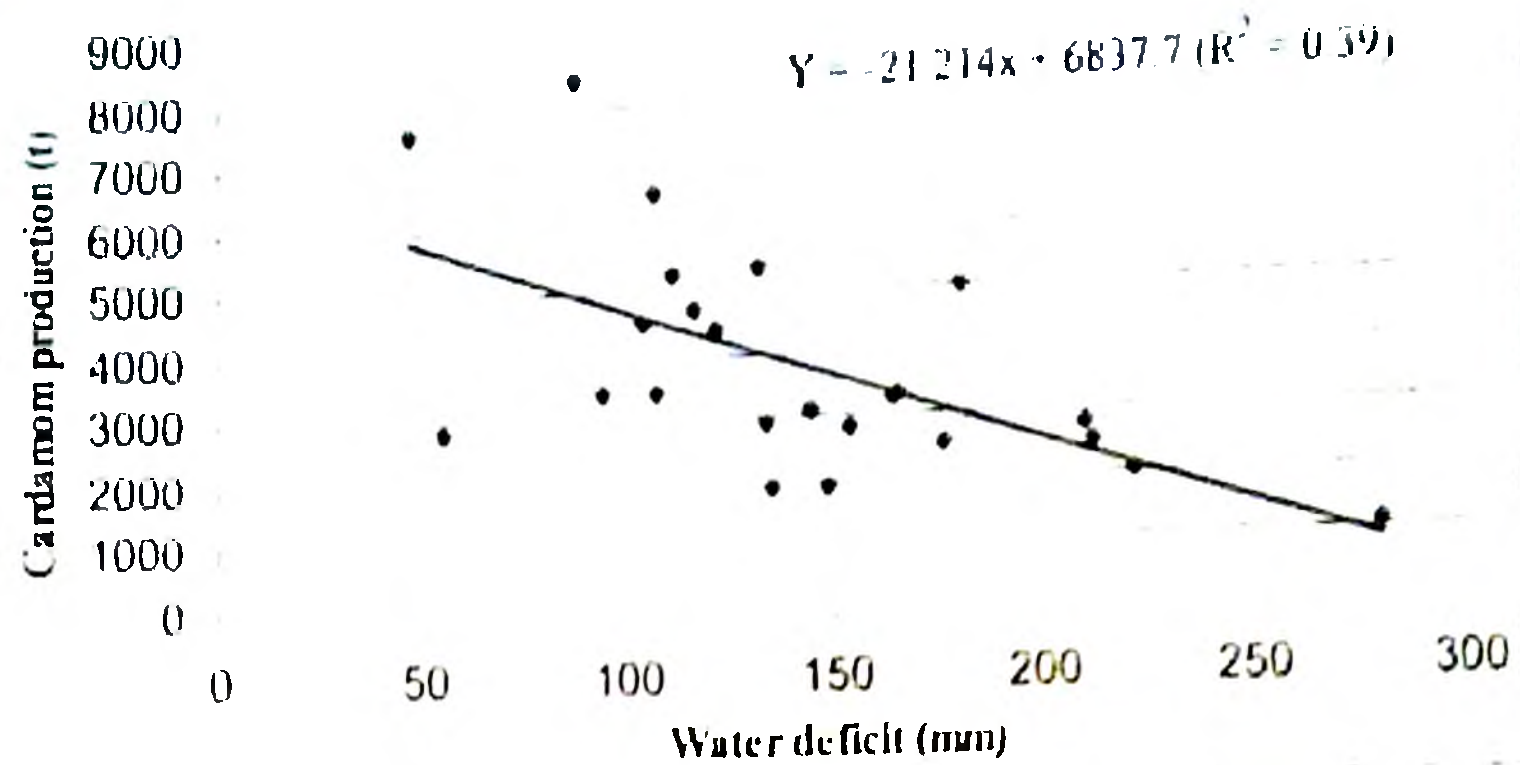
Table 6. Agroclimatic zones of small cardamom across the Western Ghats

Zone	Location	Soil type	Irra (%)		Length of crop growing season	Temperature range (°C)	Productivity (kg/ha ⁻¹)
			Annual	Summer			
I	Vandanmettu, Ayyapan Koil, Pampadumpara, Udu mbanchola, Santhanpara villages in Idukki district of Kerala (an ideal Cardamom Hill Reserve) and Sethur hills, Meghamalai, Agasthiamalai, Palani hills of Tamil Nadu.	Clay and fine loam	< 90	80 - 90	301 days	14.1	More than 200
II	Wayanad district of Kerala and Gudallur district of Tamil Nadu (Nilgiri Biosphere)	Fine loam	80-85	>70	265 days	15.6	150-200
III	Virajpet, Madikeri, Somwarpet, Saklespur and Mudigere taluks of Karnataka (Coorg, Chikmagalur and Hassen districts of Karnataka)	Red loam	70-75	50	230 days	19.0	100-150

a) Water deficit and cardamom production

There existed a strong relationship between the water deficit during summer and cardamom production. The cardamom production is high if the water deficit from December to May is less and vice-versa (Fig 5). As the period of water deficit during summer coincides with panicle emergence, its elongation and flowering affects the cardamom production adversely. In the case of cardamom production, more than 3000 tonnes is expected if the water deficit was less than 125 mm and at the same time the production varied between 2000 and 3000 tonnes if the water deficit was between 125-225 mm during summer months (December to May).

Fig 5. Water deficit during summer (Dec-May) and cardamom production over Kerala

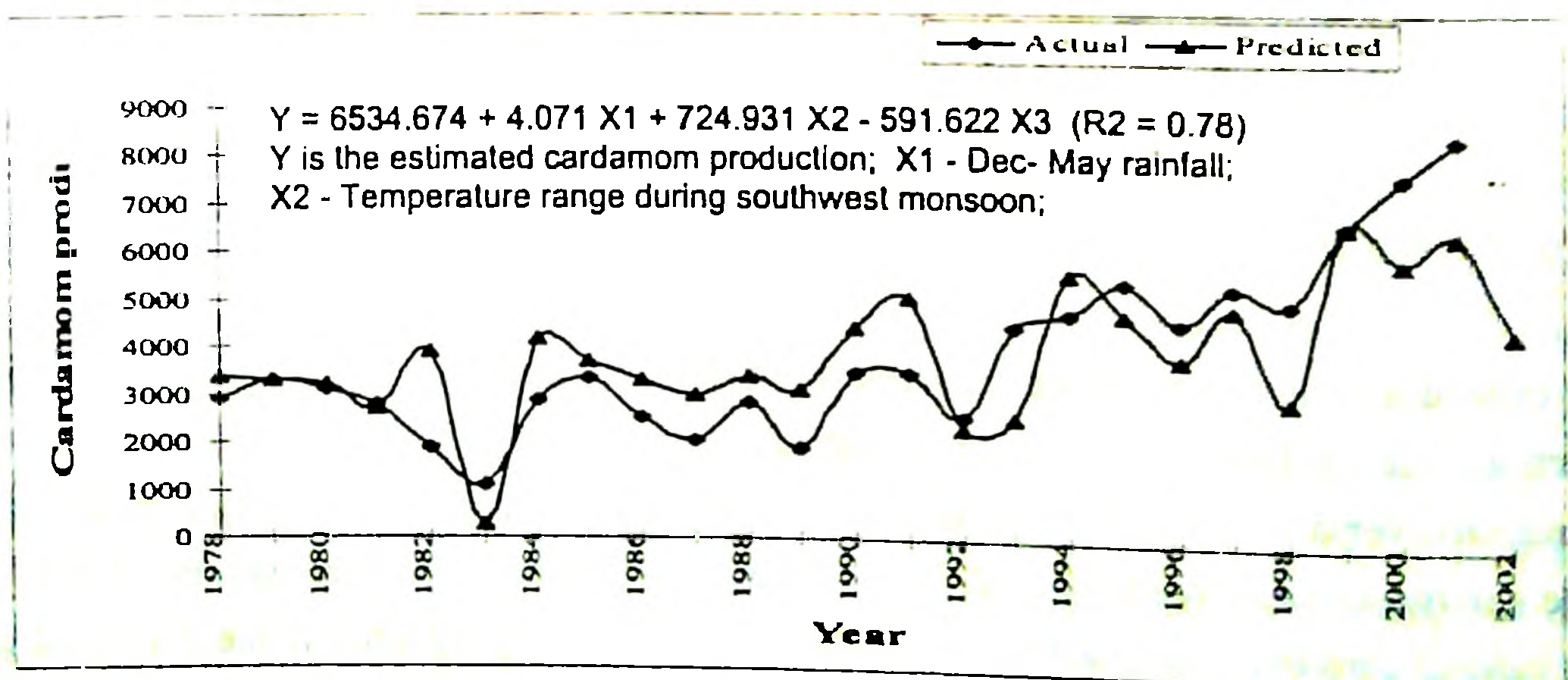


It was only around 1000 tonnes if the water deficit was more than 225 mm. The same trend was noticed in the case of cardamom productivity. For the same limits of water deficit during summer, the cardamom productivity was more than 100 kg ha^{-1} , 50 kg ha^{-1} and less than 25 kg ha^{-1} , respectively. Hence, it is better to irrigate the crop from the beginning of water deficit period (Dec/Jan) to onset of monsoon (May/June) to avoid stress period and yield loss in cardamom.

b) Crop-weather relationship in cardamom

From the crop weather relationship studies, it was understood that the rainfall from December to May, annual temperature range and temperature range during southwest monsoon could explain up to 78 per cent variability in cardamom production (Fig 6). It was also noticed that cardamom production was high whenever the annual water deficit was low and vice-versa.

Fig 6. Actual and predicted cardamom production over Kerala from 1978 to 2002



F) Monsooned Malabar Coffee

The project entitled "Influence of physical and biochemical factors on monsoon coffee" was started from 10-7-2003. It is a sponsored project by M/s Aspinwall and Co Limited,

Mangalore. The objectives of the study are to understand the scientific phenomena that impart special quality to Monsooned Malabar coffee. The Monsooned Malabar is suggested as an alternative to decaffeinated coffee which possess mellow flavour in the cup and is soft with full body.

The technical programme envisages to work out the correlation between the meteorological parameters and quality attributes of Monsooned Malabar and to study the physical and biochemical factors that contributes to quality.

Preliminary results revealed that physical and biochemical changes happened to coffee bean during processing to produce Monsooned Malabar. The volume of coffee beans was found to increase during monsooning. Among the different biochemical parameters analysed, the sugar content, poly phenol, acidity and amino acid content of the coffee beans were identified as crucial factors that govern quality.

G) Experimental agrometeorological advisory services

The project is funded by "National centre for medium range weather forecasting", Department of Science and Technology, New Delhi. This project is operational at College of Horticulture since 1992 and is the co-ordinating centre for the State of Kerala. Ambalavayal, Vellayani and Pilicode are the other zones where this project is ongoing. Preparation and dissemination of Weekly Agro-advisory Bulletins (AABs) for farmers, developmental agencies and planners is the mandate envisaged in the project based on weather forecasting, given by NCMRWF. The Agro advisory contains the Weather data of past week, weather forecast for the coming 3 days, stage and state of the crop and weather related advisories. These bulletins are delivered to 50 selected farmers by doorstep delivery. Bulletins are being published in Mathrubhoomi regularly on every Wednesday for mass coverage and also published regularly in websites viz., (www.kau.edu), (www.kauagmet.org) and (www.cropweatheroutlook.org), the official sites of Kerala Agricultural University, Department of Agricultural Meteorology and ICAR, respectively. Research results of different disciplines and results pertain to various crop models developed by the Department of Agricultural Meteorology are included in the advisories. 23rd March (World Meteorological Day) was being celebrated as "Farmers Interface Day". Last year, a farmer's interface on Drought Management Strategies was convened for the farming community of the region.

H) Economic Impact of Agro advisories on different crops

This project is operational in the department since 1-1-2004. The objective is to assess the economic benefits of the followers of the advisory service compared to the non-followers. Four Panchayaths selected for the study are Pananchery, Madakkatahara, Ollukkara and Puthur, of which farmers of Pananchery and Madakkathara are followers of AAS and that of Ollukkara and Puthur are non followers. The data collected from these farmers on crops viz., paddy and banana were sent to National Centre for Medium Range weather forecasting for further analysis.

List of experiments

i) KAU Projects : Nil

22. AGROFORESTRY AND SILVICULTURE

Co-ordinator : Dr. P.K. Ashokan

HIGHLIGHTS

- The leaf litter of *Strychnos*, tamarind, cashew, *Gliricidia*, mango and *Ailanthus* (Matty) showed allelopathic influence on other crops growing around them. The leaf and bark extracts of these trees had insecticidal value as it was effective in controlling root grub of coconut.
- Sandal seedlings grew best under 50% shade and inoculation with *Arbuscular Mycorrhizal Fungi* (AMF), *Glomus mosseae* improved the growth of seedlings. The plant water status was positively correlated with the water status of the host plant.
- In sandal, since the haustoria-connections are established only by 300 days after planting, the host plants need be planted only in the main field if the seedlings are transplanted at six to nine months stage. Fast growing pot host can however suppress the growth of sandal seedlings by competition for light, soil moisture and nutrients.
- Ginger grown in the inter spaces of *Ailanthus* plantation exhibited better growth as compared to sole crop.
- *Acacia auriculiformis* is a good support tree for black pepper.

SUMMARY

Allelopathic effects of *Ailanthus triphysa*, *Anacardium occidentale*, *Artocarpus heterophyllus*, *Strychnos nux-vomica*, *Tamarindus indica*, *Thespesia populnea* reduced the growth and yield of the test crops of cowpea, bitter gourd and brinjal to varying extent. The leaf extracts of cashew, tamarind, *gliricidia* caused severe mortality of root grub of coconut. Drenching with cashewnut shell liquid, *Ailanthus* and cashew leaf extracts resulted in maximum mortality. Bark extract of teak and *ailanthus* (matty) at 20 per cent concentration caused 50 per cent mortality of root grub of coconut. Root extracts of tamarind, *gliricidia* and teak at 20 per cent concentration resulted in significantly high mortality of root grubs when compared to the control. In general, the phenol, a potential phytotoxin, content was relatively higher in leaves. Cashew and *ailanthus* had very high leaf phenol content followed by mango and *casuarina*. Among the bark samples analysed, tamarind and *casuarina* had the highest phenol content. Among root samples, mango roots showed high phenol content.

In sandal, the seedlings of Marayoor provenance showed superior growth as compared to the Shimoga provenance. In natural stands of sandal, AMF association was not observed in Marayur, but in Wadakkanchery, 33% of the seedlings showed AMF association. The seedlings of Marayoor provenance also recorded lower pre-dawn water potential as compared to Shimoga provenance indicating its relative ability to tolerate water stress. The leaf diffusive resistance was relatively higher when the host was introduced at the time of planting sandal in Marayoor provenance, indicating that the host plants in the pots were causing water stress to sandal. Highest N content was observed in seedlings of Marayoor provenance when the host was introduced at the time of planting sandal. In both the provenances, P content was significantly high when the host was introduced at the time of planting sandal. When the hosts were introduced six months after planting sandal, K content showed an increasing trend

- n) Externally aided projects
 a) Concluded experiments : Nil
 b) Experiments in progress

Sl. No.	Code No.	Title of the experiments	Locations
1	ICAR, Govt. of India	AICRP on Agrometeorology	CoH, Vellanikkara
2	DST, Govt. of India	Agro-meteorological advisory services based on medium range weather forecasting	CoH, Vellanikkara,
3	M/s. Marico Industries, Mumbai	Climate and coconut	CoH, Vellanikkara
4	M/s. Aspinwall and Company, Mangalore	Influence of physical and biochemical factors on monsooned coffee	CoH, Vellanikkara
5	DST, Govt. of India	Economic impact assessment on agromet advosiry services	CoH, Vellanikkara

with the increase in the levels of water stress. The seedlings of Marayoor provenance where the hosts were introduced at the time of planting sandal had also higher Ca content.

A study for estimating zonation pattern and regeneration status of species along the ocean-land interior transects, along with litter dynamics (litterfall and litter decay) was carried out at Pudukkottai mangrove forest. Zonation pattern of species was revealed by carrying out phytosociological analysis along the land-ocean transect. Litterfall was quantified by dividing the study site into three zones along the ocean-land interface transect and monthly variations in litterfall between species in three zones was estimated for one year. Decay dynamics was studied by involving six predominant species of the forest trees namely, *Avicennia officinalis*, *Bruguiera cylindrica*, *Rhizophora mucronata*, *Sonneratia caseolaris*, *Acanthus ilicifolius* and *Excoecaria agallocha* and by estimating inter-zonal and monthly variations in mass loss and nutrient concentrations, for 12 months. The area could be divided into three zones (zone I: 0-300 m, zone II: 400-800 m, zone III: 900-1200 m from the sea) based on species distribution pattern. Species diversity along the zones decreased from zone I to zone II, whereas, phytosociological parameters of species increased, implying that both are conversely related. It was also observed that species like *R. mucronata* and *S. caseolaris* were restricted in zone I, whereas, *A. officinalis* and *B. cylindrica* were abundant towards the landward side, due to the tidal sorting of the species. Electrical conductivity and soil nutrient (N, K, Na) concentrations increased towards the landward side, whereas, pH decreased. Furthermore, soil P concentrations and *in situ* redox potential positively affected stand density. Regeneration was profuse in the zone II (700-800 m from the sea) and decreased towards the landward side and the seaward side. Leaf fall peaked during winter season (November-December), whereas, leaf production was initiated by rainfall. Litter decomposition followed an exponential pattern in *A. ilicifolius*, *A. officinalis*, *E. agallocha* and *S. caseolaris*, whereas, it followed a linear pattern in *B. cylindrica* and *R. mucronata*. The total litter fall in the mangrove forest in Pudukkottai was 10.3 to 13.6 t ha⁻¹ y⁻¹. *A. officinalis* accounted for 50-70 % of the total litter fall. The decay rates of the litter was more in the zone nearest to the sea (Zone I) and were inversely related with initial lignin and lignin: nitrogen ratio of the decomposing leaves. Approximately 92 to 112 kg⁻¹ ha⁻¹ of N, 5 to 7 kg⁻¹ ha⁻¹ of P and 54 to 69 kg⁻¹ ha⁻¹ of K are annually added to the soil through leaf litterfall. Out of which, on an average 52 to 84 kg⁻¹ ha⁻¹ of N, 4 to 5 kg⁻¹ ha⁻¹ of P and 43 to 55 kg⁻¹ ha⁻¹ of K is mineralized into the ecosystem through decomposition every year.

A total number of thirty accessions / provenances of teak were collected and planted in the field during September 2001. This included twenty six provenances supplied by IFGTB, Coimbatore.

To find out the best live standard for black pepper, seven tree species (*Grevillea robusta*, *Acacia auriculiformis*, *Ceiba pentandra*, *Artocarpus heterophyllus*, *Ailanthus triphysa*, *Macaranga peltata* and *Casuarina equisetifolia*) raised from seedlings, as well as from cuttings were tested. The experiment was started during June 1988. There was no significant difference in black pepper yield due to the influence of the support trees. Maximum black pepper yield was recorded when *Acacia auriculiformis* was used as the support tree.

Total annual litter production for different support trees of black pepper showed considerable variation. *Artocarpus heterophyllus* recorded the maximum litter fall (4.64 t/ha) followed by *Macaranga peltata* (4.55 t/ha), *Grevillea robusta* (3.02 t/ha) and *Casuarina equisetifolia* (2.92 t/ha). *Ailanthus triphysa* showed the lowest annual litter yield (2.21 t/ha). Peak litter fall was observed in December for all species except for casuarinas and acacia. Month of June characterized a second peak in litter fall.

A field trial was conducted since August, 2000 to identify superior *Acacia mangium* provenances from its natural range. The seeds were collected from selected provenances of *Acacia mangium* from Australian Tree Seed Centre, CSIRO, Australia. Locally collected mangium seeds were used as check. After 16, 22 and 28 months of field planting, maximum height was recorded by 'Upper Aramia' (Queens Land) and minimum by 'Claudie River' provenance. The height increment increased when mangium was planted at closer spacing (2 x 1 m) as compared to spacing up to 4 x 4 m.

Thinning studies in mangium showed that maximum annual girth increment was observed when half or 2/3 of the population was thinned. To evaluate the changes in under storey productivity due to thinning in mangium stands, shade loving ginger (*Zingiber officinale*. Roscoe) was planted during April 2003 as per KAU recommendations. Intercropping of ginger in mangium stands with moderate to high intensity thinning gave higher yield as compared to un-thinned stands.

List of experiments

i) KAU Projects

a) Concluded experiments

Sl. No.	Code No.	Title of the experiment	Location
1.	AFS-02-00-02-2000/ VKA (F) KAU/PG	Response of sandal (<i>Santalum album</i> Linn.) seedlings to shade and mycorrhizal association	CoF, Vellanikkara
2.	(AFS-02-00-07-2003/ VKA (F) KAU/PG)	Zonation, leaf phenology and litter dynamics of mangrove forests of Pudukkottai	CoF, Vellanikkara
3.	(AFS-02-00-06-2002/ VKA (F) KAU/PG)	Influence of soil moisture regimes and stage of host introduction on seedling growth of sandal provenances.	CoF, Vellanikkara

b) Experiments in progress

Sl. No.	Code No.	Title of the experiment	Location
1.	(AFS-04-02-09/95 VKA (20) KAU)	Provenance and species evaluation of certain selected acacias	CoF, Vellanikkara
2.	(AFS-02-00-07-2003/ VKA (F) KAU/PG)	Influence of host plants and soil moisture stress on water relations in sandal (<i>Santalum album</i> Linn.)	CoF, Vellanikkara
3.	(AFS-02-00-03-2000/ VKA (F) KAU/PG)	Evaluation of timber quality in certain selected tropical tree species	CoF, Vellanikkara

a) Concluded experiments

Sl. No.	Code No.	Title of the experiments	Location
1.	02-00-08-2003/ PKD (I)/STED)	Investigations on the allelopathic effects of certain multipurpose trees commonly planted in the homesteads of Kerala	CoA, Padannakad
2.	(AF-04-01-01/90 VKA-GOK DEPT)	Exploitation of indigenous multipurpose tree species in agro/social forestry systems	CoF, Vellanikkara

b) Experiments in progress

Sl. No.	Code No.	Title of the experiment	Location
1	(AF-03-00-01/2003/ TZK(F)/AICRP)	Provenances evaluation of teak (<i>Tectona grandis</i> Linn. f.)	LRS, Thiruvazhamkunnu
2	(AF-04-01-02/84/ TZK- ICAR COORD)	Collection and evaluation of promising species/cultures of fuel, fodder and small timber tree species	LRS, Thiruvazhamkunnu
3	(AF-05-00-02/88 TZK/ICAR COORD)	Utility of some fast growing trees as pepper standards. Part I stem cuttings grown trees	LRS, Thiruvazhamkunnu
4	(AF-05-00-03/88 TZK- ICAR COORD)	Utility of some fast growing trees as pepper standards. Part II seedling grown trees	LRS, Thiruvazhamkunnu
5		Provenance evaluation of mangium (<i>Acacia mangium</i> Willd.)	LRS, Thiruvazhamkunnu
6		Stand density manipulation and pruning strategies for <i>Acacia mangium</i> Part: 2 Effect of thinning and pruning in a five-year old <i>Acacia mangium</i> . Willd stand	LRS, Thiruvazhamkunnu

23. BIOCONTROL

Co-ordinator : Dr.S. Pathummal Beevi

HIGHLIGHTS

- The technique for the large scale production of the entomopathogenic fungus *Fusarium pallidorozeum* infecting the cowpea aphid was standardized. Rice bran is an ideal substrate for large scale production of this fungus.
- *Chrysoperla carnea*, a general predator of soft bodied insects was mass produced and distributed to 485 farmers.
- The techniques for mass multiplication of predatory mites viz., *Amblyseius longispinosus* and *Macrochelus merdarius* on prey mites such as *Tetranychus ludeni* and *Tyrophagous* sp. were developed.
- Seed treatment of bhindi with *Bacillus macerans* or *Paecilomyces lilacinus* @ 3% w/w (2.5kg/ha), nursery treatment of brinjal with *B. macerans* or *P.lilacinus* @ 25 g/m² along with drenching seven days after sowing @ 100 g/5 l/m², drenching in coleus @ 35 kg/ha. and seed material treatment of amorphophallus @ 3 g/kg. with either of the organisms were very effective for nematode management.
- Sixteen species of coccinellid predators were found associated with the pests of cowpea, coccinia, bittergourd, brinjal and bhindi..
- Six species of platygasterids (Platygasteridae: Hymenoptera) were identified as the parasitoids of the rice gall midge, *Orseolia oryzae* (Wood-Mason) of which five were new reports. Parasitism by platygasterids was high during the mundakan season as compared to virippu.
- The *Bacillus* strain BY-2 and the fluorescent pseudomonad, *Pseudomonas putida* 89B61 were effective for plant growth promotion as well as the suppression of *Phytophthora* disease in black pepper nursery.
- The fluorescent pseudomonad isolate Pf 16 could effectively control or suppress sheath rot disease in rice caused by *Sarocladium oryzae* (Sawada) Gams and Hawksworth and it enhanced plant growth also.
- A combination of *Alternaria eichhorniae* @10⁷ spores/ml and *F. pallidorozeum* @ 10¹¹ spores/ml caused 89.84 per cent intensity of infection on water hyacinth *Eichhornia crassipes*.
- The use of vermi compost and neem cake in the ratio of 5:1 was found to be an ideal carrier material for the mass production of myco inoculants such as *Trichoderma harzianum* and *Glomus fasciculatum*. The use of these biocontrol agents either alone or in combination resulted in significant control of foot rot of black pepper caused by *Phytophthora capsici*.
- The dual inoculation of AMF and *Azospirillum* was found to suppress the pathogen, *Pythium aphanidermatum*, causing damping off in chilli and tomato.
- Cent per cent control of water hyacinth at Akkulam lake, Thiruvananthapuram was achieved with 2 sprayings of 5% wettable powder formulation of *Fusarium pallidorozeum* and 5% CSNL without any toxic effect on other aquatic flora and fauna.

SUMMARY

The entomopathogenic fungus *Beauveria bassiana* was effective for the control of the leaf feeding pests of vegetables viz. *Sylepta derogata*, *Spodoptera litura* and *Pericallia ricini* with

LC₅₀ values of 5.75×10^8 , 6.99×10^8 and 2.72×10^5 spores/ml respectively. Rice bran and gingelly oil cake were found suitable for the mass multiplication of *B. bassiana*. *P. pallidoroseum* caused 50 per cent mortality of the aphids, *Aphis craccivora* and *Myzus persicae* at 3.86×10^6 and 0.72×10^6 spores/ml respectively.

Coccinella transversalis (Fab.), *Cheilomenes sexmaculata* (Fab.), *Brumoides suturalis* (Fab.) and *Jouravia soror* Weise were the persistent predators in the vegetable ecosystem. Higher feeding potential of *C. transversalis* (213.5 - 4.710 aphids) and *C. sexmaculata* (226.2 - 2.77 aphids), showed that they could effectively control *A. craccivora*. Higher fecundity of *C. transversalis* (421.8 - 4.983 eggs) accounted for the successful establishment of these predators in the field. Rainfall and temperature were having a negative correlation with aphid population. Coccinellid population did not show any significant relation with weather factors, except in cowpea.

Glomus sp. was found to be the most dominant AMF in the soils of high wilt (Vellanikkara, Thrissur District) and low wilt incidence areas (Ozhalapathy and Eruthiampathy, Palakkad district). The screening of AM fungal cultures against *R. solanacearum* under sterile conditions revealed that treatments with AMF combinations of *Glomus* sp. (OM) + *Glomus* sp. (VBT); *Glomus* sp. (OT) + *Glomus* sp. (ER) and *Glomus* sp. (OT) and *Glomus* sp. (VM) recorded least wilt incidence. The dry weight and root length were also higher for these combinations. Under field conditions, the native AMF combination of *Glomus* sp. (OT) + *Glomus* sp. (VM) delayed the disease incidence in the susceptible variety Pusa ruby up to 32 days after transplanting and up to 50 days in moderately resistant variety Mukhi.

Surveys conducted for the identification of indigenous biocontrol agents of coconut eriophyid mite resulted in the isolation and development of a specific fungal pathogen, *Hirsutella thompsonii*. This was identified as *H. thompsonii* Fisher var. *synnematos* Samson, McCoy and O'Donnel. The fungus could be isolated consistently from dead mites. A widespread occurrence of *H. thompsonii* has been confirmed as the major cause for the natural mortality of mites. Two species of predatory mites associated with the coconut mite were also identified. The field application of *Hirsutella* caused reduction in the live mite count up to 25 to 35 per cent and it was comparable with the application of wettable sulfur, dicofol and neem oil. However, there was no significant reduction in the external symptoms on nut surface caused by the mite.

Sabouraud's maltose agar + yeast medium was selected as the most suitable solid medium for the growth and sporulation of *H. thompsonii*. Broth culture of the same medium was found to be the best for maximum dry mycelial weight. The fungus preferred alkaline pH of 9.0, temperature of 30°C and humidity levels of 50-90%. Spraying with exotoxin and endotoxin, extracted from the broth culture of the fungus produced no significant difference in the percentage mortality of mite. The decreasing order of inhibition of fungal growth by insecticide/acaricide was dicofol, carbaryl, triazophos, wettable sulphur and endosulfan. Bordeaux mixture and copper oxyclochloride showed cent per cent inhibition of fungal growth. Among the botanicals, garlic with neem oil preparation was most inhibitory to the fungus *H. thompsonii* where as azadiractin showed least inhibition. For the mass production of fungus, wheat was identified as the most promising raw substrate for sporulation and germination percentage of spores.

List of experiments

i) KAU Projects

a) Concluded experiments

Sl. No.	Code No.	Title of the experiment	Location
1	BC/01-00-01-2000/ VKA(5)KAU/PG	Parasitism of <i>Hirsutella thompsonii</i> Fischer var. <i>synnematos</i> Samson, McCoy and O'Donnell on coconut eriophyid mite <i>Aceria guerreronis</i> (Keifer)	CoH, Vellanikkara
2	BC/01-00-03-2001/ ACV(4)KAU/PG	Effect of entomopathogenic fungi on sucking pests and leaf feeders of vegetables under in-vitro conditions	CoA, Vellayani
3	BC/03-00-02-2000/ VKA(4)KAU	Biological control of coconut eriophyid mite <i>Aceria guerreronis</i> (Keifer)	CoH, Vellanikkara
4	BC/03-00-05-2001/ VKA(4)KAU/PG	Biodiversity and bionomics of predatory coccinellids in vegetable crop.	CoH, Vellanikkara
5	BC/03-00-07-2001/ ACV(5)KAU/PG	Evaluation of fluorescent pseudomonads for the management of sheath rot of rice	CoA, Vellayani
6	BC/03-00-08-2002/ VKA(4)KAU/PG	Platygasterid parasitoids in rice and vegetables	CoH, Vellanikkara
7	BC/03-00-09-2002/ VKA(4)KAU/PG	Taxonomy of predatory coccinellid beetles (Coccinellidae, Coleoptera) in rice and vegetables	CoH, Vellanikkara
8	BC/03-00-10-2002/ ACV(5)KAU/PG	Management of <i>Phytophthora</i> disease of black pepper (<i>Piper nigrum</i> .L.Walp) using plant growth promoting microbial inoculants	CoA, Vellayani

b) Experiments in progress

Sl. No.	Code No.	Title of the experiment	Location
1	BC/02-00-02-2004/ VKA(4)KAU/PG	Management of root knot nematode in rice	CoH, Vellanikkara
2	BC/03-00-12-2002/ ACV(5)/STED	Development of AMF and Azospirillum inoculants for nursery disease management and growth enhancement in transplanted vegetables	CoA, Vellayani
3	BC/03-00-15-2003/ ACV(5)KAU/PG	Management of bacterial wilt of chilli caused by <i>Ralstonia solanacearum</i> (E.F. Smith) Yabuuchi using AMF and fluorescent pseudomonads.	CoA, Vellayani
4	BC/03-00-17-2004/ VKA(4)KAU/PG	Bionomics and suppressive potential of <i>Zygogramma bicolorata</i> Pallister (Chrysomelidae: Coleoptera) on <i>Parthenium hysterophorus</i> Linn.	CoH, Vellanikkara
5	BC/03-00-18-2004/ ACV(5)KAU/PG	Microbial antagonists and resistance inducers for the management of bacterial blight of anthurium (<i>Anthurium andreaeanum</i> .L.)	CoA, Vellayani

ii) Externally aided projects

a) Concluded experiments

Sl. No.	Code No.	Title of the experiment	Location
1	BC/03-00-01-2000/ ACV(4)/DBT	Bio control of aphids and mites infesting crops	CoA, Vellayani

2	BC/03-00-03-2001/ ACV(5)/STED/PG	Management of foot rot of Black pepper (<i>Piper nigrum L.</i>) with mycoinoculant enriched vermicompost	CoA, Vellayani
3	BC/03-00-04-2001/ VKA(5)/ICAR/PG	Bio control of bacterial wilt in tomato using arbuscular mycorrhizal fungi	CoH, Vellanikkara
4	BC/03-00-06-2001/ VKA(5)/ICAR/PG	Management of bacterial wilt of solanaceous vegetables using microbial antagonists	CoH, Vellanikkara
5	BC/03-00-11-2002/ ACV(5)/DST/PG	Bioherbicidal potential of fungal pathogens of water hyacinth (<i>Eichhornia crassipes (Mart.) Solms.</i>)	CoA, Vellayani
6	BC/03-00-13-2002/ ACV(5)/STED	Development of vermicompost based mycoinoculants for plant disease control.	CoA, Vellayani

b) Experiments in progress

Sl. No.	Code No.	Title of the experiment	Location
1	BC/02-00-01-2003/ ACV(4)/NATP/PG	Integrated management of root knot nematode (<i>Meloidogyne incognita (Kofoid & White)</i>) Chitwood in coleus. (<i>Solenostemon rotundifolius (Poir) Morton.</i>)	CoA, Vellayani
2	BC/03-00-14-2002/ ACV(5)/DST	Bio control of water hyacinth (<i>Eichhornia crassipes (Mart.) Solms.</i>) using mycoherbicides	CoA, Vellayani
3	BC/01-00-05-2004/ ACV (4)/NATP	Mass production and field evaluation of ecofriendly management of nematodes associated with vegetables (bhindi, brinjal, tomato, coleus and amorphophallus)	CoA, Vellayani

24. FOOD SCIENCE AND NUTRITION

Co-ordinator: Dr. P. Mary Ukkuru

HIGHLIGHTS

- Different baked, confectionery, preserved and extruded products with good nutritional, chemical, organoleptic and shelf life qualities were developed from sweet potato. This technology was transferred to 100 women from different self-help groups and small-scale entrepreneurs.
- Highly acceptable and value added diversified food products viz. beverages, bioprocessed products, simulated dairy milk products, protein enriched products, bakery and confectionary products were developed. Suitable packaging materials were also identified, for these products.
- Excellent preparations viz. pickle, squash, jam and preserves with shelf life of six months using under exploited fruits like bilimbi, roseapple and lovilovi were developed.
- Soya enriched nutrient supplements developed by KAU for lactating women resulted in appreciable improvement in the nutrition profile of the subjects and hence can be promoted as a supplement in nutrition intervention programmes.
- Food supplements standardized using spray dried spirulina (*Spirulina fusiformis*) was found to be effective in reversing the pre-cancerous symptoms of the oral cavity of selected fisher women.
- Red palm oil blended with sunflower oil based on P/S ratio (60:40) was found to be most ideal for baking and frying purpose.
- Vyttila-2 and cul: 2006 were found to be the best varieties with respect to physical and organoleptic characters respectively among the 10 pokkali rice varieties collected from RRS, Vyttila.
- Varieties of hyacinth bean (*Dolichos lab lab purpureus* (L) sweet) DL.40 and DL.50 were superior in nutritional quality, acceptability and yield.
- For cardiac patients a ready reckoner was formulated, which could help the patients to select and plan their daily diets. Diet counseling based on the diet chart, booklet and ready reckoner was found to be very effective in controlling the lipid profile of these patients.
- The serum β -carotene/retinol levels of omnivores was found to be better than that of lacto vegetarians though they had a higher dietary intake of vitamin A which could be attributed to greater absorption and utilization of vitamin A from animal sources.
- Consumption of antioxidant rich foods was inadequate in the diets of smokers. The serum lipid profile of the subjects was found to have a direct relationship with the Smoking Index.

- Food security was found to be better in the households of women agricultural labourers in the organized sector, mainly due to their better purchasing power. In the households of unorganized sector, food insecurity without hunger and with moderate hunger were prevalent.
- Moderate levels of malnutrition leading to mild anaemia, Vitamin A and energy deficiency was observed among pre school children of coastal areas and adolescents of urban and rural areas of Trivandrum and Thrissur district.
- Nutrition education carried out with specially designed IEC materials was found to be effective in improving the nutrition knowledge, attitude and practices of the selected population groups.

SUMMARY

Breadfruit flour and rice flour with garlic ginger flavour in the proportion of 2:2:1 was found to be highly acceptable for wafer making. Fresh breadfruit chips were more acceptable to consumers than blanched chips and were found to have a shelf life of up to one month in polyethylene covers (25 gauge).

Acceptable food products like Tuti fruiti, preserve jelly, candy, salads and samosa can be prepared from Indian gooseberry. Amla products were found to retain vitamin C content even after processing and storage unlike other processed products.

Cocoa mass could be successfully incorporated at five per cent level for products such as milk chocolates, burfi, biscuits, fudge and ice cream.

Banana by products viz. flower bud, pseudostem and peel of kannan, robusta and poovan variety were analysed for quality parameters; kannan flower bud was found to have the highest protein content. Robusta rhizome was found to be high in starch and peel had good fibre content. Calcium and iron content were found to be highest in flower buds of poovan and palayankodan respectively. Robusta flower bud was rich in phosphorous and contained good amount of vitamin C, while Na and K were high in kannan rhizome. Vattals from banana pseudostem and pickles from peels were appealing and had good keeping quality.

Different degree of chronic energy deficiency and upper body obesity were observed in elderly persons. Visual disturbances, toothlessness, difficulty in chewing, hearing problems, anaemia and different levels of hypertension were the other clinical manifestations seen in them. No significant difference was observed with respect to different nutritional parameters assessed among the institutionalized and non-institutionalized groups of elderly persons. The study recommends that proper care, feeling of security and conducive psychosocial environment should be given to the elderly, which in turn will influence their health status.

Nutritional quality of nine different green leaves viz. tamarind, ponnnaviram, mint, coriander, pisonia, pumkin, cowpea, colocasia, burmese coriander indicated that leaves of colocasia was high in moisture, fibre and potassium content while starch content was highest in coriander leaves. Pisonia and ponnnaviram were found to have high phosphorus and vitamin C content while calcium, iron and β -carotene recorded highest in burmese coriander. Cowpea leaves excel in protein content. Among anti nutritional factors oxalate content was more in pisonia, while nitrate level was more in mint leaves.

Study conducted among landless agricultural labourers residing in Kalliyoor Panchayat of Thiruvananthapuram to assess the extent of household food security revealed strong association between food security status and rural quality life index. Balanced dietary pattern was recorded with an excess consumption of fleshy foods, roots and tubers. Based on the food security index computed, none of the families could be designated as food secure. The level of food security enjoyed by the families was found to be associated with nutritional status of the family members and not influenced by the quality of life.

A study on the health and developmental history of the children revealed a comparatively higher prevalence of low birth weight, with higher incidence of illness. Children with top academic performance depicted better nutritional status. Learning disability of children was not merely genetical but also depended on demographic, social, health, dietary and developmental factors. Moreover, nutritional status, intelligence, overall development and learning disability were found to be inter-related.

Assessing the food habits of the adolescents revealed that rice and rice-based preparations were preferred for breakfast, lunch and dinner and fried foods for teatime. Egg, meat, chicken and fish were the most frequently used side dishes. Consumption of greens, milk and milk products, roots and tubers were less in the diet. Majority of the surveyed adolescent boys depicted grade-I and II malnutrition while among the girls only grade-I malnutrition was recorded. Clinical manifestations of deficiency symptoms were very low among the adolescent surveyed.

None of the adolescent girls studied had good endurance capacity, as more than 50 per cent had lower Hb level and low nutrient intake. In spite of their low nutritional status and nutrient intake, their habitual physical activities had a positive effect on their endurance capacity. Poor nutritional status was detected among the adolescents due to inadequate and irregular meal pattern and wrong dietary habits. Improper time distribution and heavy workload led to poor health profile and psychosocial adjustments among the adolescents studied.

The influence of television on the food purchase behaviour of urban homemakers revealed a positive and significant relationship with the purchase of various processed products such as diary products, biscuits, chocolates, chips and toffees. Urban homemakers spent more for convenience foods than rural families.

List of experiments

i) KAU Projects

a) Concluded experiments

Sl. No.	Code No.	Title of the experiment	Location
1	FSN-06-02-06-99/ ACV(11)/KAU/PG	Developing value added and diversified products from coconut (<i>Cocos nucifera</i> C)	CoA, Vellayani
2	FSN-02-03-03-99/ ACV(11)/KAU/PG	Learning disability in malnourished children	CoA, Vellayani
3	FSN-02-02-04-99/ ACV(11)/KAU/PG	Impact of New Brahmi (<i>Bucopa monnieri</i>) and Kodangal (<i>Centella asiatica</i>) as supplements on health status and mental abilities of pre-school children	CoA, Vellayam

4	FSN-02-07-99/ACV (11)/KAU/PG	Standardization of reversal diets for cardiac patients	CoA, Vellayani
5	FSN-08-00-22-99/ ACV(11)/KAU/PG	Attitude of urban and rural home makers towards convenience food	CoA, Vellayani
6	FSN-10-04-02-99/ ACV(11)/KAU/PG	Suitability of red palm oil and its blends for culinary purpose	CoA, Vellayani
7	FSN-12-00-01-99/ ACV(11)/KAU/PG	Effect of training on food safety measures to the anganwadi helpers of ICDS	CoA, Vellayani
8	FSN-01-00-02-2000/ VKA(11)/KAU/PG	Nutritional profile and endurance capacity of adolescent girls	CoH, Vellanikkara
9	FSN-01-00-02-2000/ VKA(11)/KAU/PG	Nutritional profile of elderly	CoH, Vellanikkara
10	FSN-02-00-01-2000/ VKA(11)/KAU/PG	Traditional food habits of different communities in Thrissur districts.	CoH, Vellanikkara
11	FSN-03-00-02-2000/ VKA(11)/KAU/PG	Standardization and acceptability of dairy products with cocoa mass	CoH, Vellanikkara
12	FSN-09-00-02-2000/ ACV(11)/KAU/PG	Dietary antioxidants and lipid profiles of smokers	CoA, Vellayani
13	FSN-09-00-03-2000/ ACV(11)/KAU/PG	Impact of spirulina (<i>Spirulina fusi formis</i>) food supplements or premenopausal conditions in women	CoA, Vellayani
14		Impact of soya enriched food supplement on the nutritional status of women beneficiaries of ICDS	CoA, Vellayani
15	FSN-11-00-01-2001/ ACV(11)/KAU/PG	Nutritional status and vitamin A profile of lacto vegetarians	CoA, Vellayani
16	FSN-04-00-05-2001/ VKA(11)/KAU/PG	Acceptability and nutritional evaluation of hyacinth bean genotypes (<i>Lab lab purpureus</i> (L.) sweet	CoH, Vellanikkara
17	FSN-04-00-04-2001/ VKA(11)/KAU/PG	Nutritional profile of selected greens	CoH, Vellanikkara
18	FSN-04-00-04-2001/ VKA(11)/KAU/PG	Utilization of selected under exploited fruits for product development	CoH, Vellanikkara
19	FSN-01-00-06-2002/ ACV(11)/KAU/PG	Extend of household food-security of selected families of landless agricultural labourers of Kalliyoor panchayat - A case study	CoA, Vellayani
20	FSN-02-00-03-2002/ ACV(11)/KAU/PG	Determinants of dietary profile of higher secondary school children of Thiruvananthapuram	CoA, Vellayani
21	FSN-05-00-01-2002/ ACV(11)/KAU/PG	Effectiveness of information education and communication (IEC) materials on health and nutrition practices of adolescent girls.	CoA, Vellayani
22	FSN-04-00-07-2002/ ACV(11)/KAU/PG	Influence of processing methods on the bio-availability B-carotene in selected foods	CoA, Vellayani
23	FSN-01-00-04-2002/ VKA(11)/KAU/PG	Household food security and nutritional status of women agricultural labourers	CoH, Vellanikkara
24	FSN-01-00-05-02/ VKA(11)/KAU/PG	Nutritional profile of pre-school children of Fishermen	CoH, Vellanikkara
25	FSN-03-00-05-2002/ VKA(11)/KAU/PG	Nutritional and organoleptic qualities of value added products from breadfruit (<i>Artocarpus attilis</i> (park) fos berg)	CoH, Vellanikkara
26	FSN-03-00-06-2002/ VKA(11)/KAU/PG	Evaluation of fruit quality in banana Nendran (<i>Musa</i> AAB.)	CoH, Vellanikkara

b) Experiments in progress

Sl. No.	Code No.	Title of the experiment	Location
1	FSN-03-00-07-2002/ VKA(11)/KAU/PG	Exploitation of jackfruit (<i>Artocarpus heterophyllus</i> – Lam) for product development and product utilization	CoA, Vellayani
2	FSN-05-00-07-2002/ ACV(11)/KAU/PG	Nutritional profile of middle aged women of BPL families with special reference to micronutrients	CoA, Vellayani
3	FSN-01-00-07-2003/ VKA(11)/KAU/PG	Nutritional profile of fisher women	CoH, Vellanikkara
4	FSN-04-00-09-2003/ VKA(11)/KAU/PG	Quality evaluation of selected vegetables under rain shelter and open field cultivation	CoH, Vellanikkara
5	FSN-04-00-10-2003/ VKA(11)/KAU/PG	Nutrient analysis and value addition of under utilized fish	CoH, Vellanikkara
6	FSN-05-00-03-2003/ ACV(11)/KAU/PG	Assessment of nutritional cognition of selected rural youth and the nutrition related practices of their families	CoA, Vellayani
7	FSN-01-00-08-2004/ VKA(11)/KAU/PG	Nutritional profile and physical fitness of sports women	CoH, Vellanikkara
8	FSN-03-00-10-2004/ VKA(11)/KAU/PG	Standardisation and quality evaluation of protein enriched mango bars	CoH, Vellanikkara
9	FSN-04-00-12-2004/ VKA(11)/KAU/PG	Quality evaluation of fruit beverages	CoH, Vellanikkara
10	FSN-04-00-11-2004/ VKA(11)/KAU/PG	Quality evaluation of selected vegetables under rain shelter and open field cultivation	CoH, Vellanikkara
11	FSN-01-00-09-2004/ ACV(11)/KAU/PG	Nutritional status of job performance of Anganwadi workers	CoA, Vellayani
12	FSN-03-00-11-2004/ ACV(11)/KAU/PG	Developing multipurpose convenience mix from selected banana varieties	CoH, Vellanikkara
13	FSN-01-00-10-2004/ ACV(11)/KAU/PG	Nutritional status and stress determinants of women in rubber plantations	CoH, Vellanikkara
14	FSN-03-00-12-2004/ ACV(11)/KAU/PG	Developing rice based complementary food for infants	CoH, Vellanikkara
15	FSN-03-00-13-2004/ ACV(11)/KAU/PG	Developing value added rice based convenience foods	CoH, Vellanikkara
16	FSN-05-00-04-2004/ ACV(11)/KAU/PG	Contributing factors and problems associated with over weight among rural and urban school children	CoH, Vellanikkara

ii) Externally aided projects

a) Concluded experiments

Sl. No.	Code No.	Title of the experiment	Location
1	FSN-03-00-01-2000/ ACV(11)/ICAR/PG	Developing blended preserved products based on sweet potato	CoA, Vellayani
2	FSN-03-00-03-2000/ ACV(11)/ICAR	Value additives for sweet potato by developing different food products	CoA, Vellayani

b) Experiments in progress

Sl. No.	Code No.	Title of the experiment	Location
1	FSN-03-00-08-2003/ ACV(11)/ DST/PG	Utilisation of minor tubers for development of baked products	CoA, Vellayani
2	FSN-03-00-09-2003/ ACV(11)/ DST/PG	Formulating extruded food based on dioscorea (<i>Dioscorea rotundata Poir</i>) and taro (<i>Colocasia esculenta (L.) Schott.</i>)	CoA, Vellayani
3	FSN-04-00-08-2003/ VKA(11)/ ICAR/PG	Quality evaluation of selected leafy vegetables consumed by tribes of Wayanad district	CoH, Vellanikkara
4		Technology for developing diversified food products based on minor tubers of Kerala	CoA, Vellayani
5		Impact of food supplementation and dietary counseling on the lipid profiles of population in Thiruvananthapuram	CoA, Vellayani
6		Viable technology for exploitation of jackfruit for product diversification and by product recovery	CoA, Vellayani
7		Viable technology for developing value added food products incorporating coconut	CoA, Vellayani
8		Nutrient and antinutrient composition of ethnic plant foods consumed by tribes of kerala	CoH, Vellanikkara

25. SEED TECHNOLOGY

Co-ordinator : Dr. K. Sudhakara

HIGHLIGHTS

- Seed production can be combined with two vegetable harvests in cucumber (*Cucumis sativus* L.), for getting maximum returns.
- In snakegourd (*Trichosanthes anguina* L.), the keys for varietal identification were developed based on the primary diagnostic characters like seed size index, 100 seed weight, seed coat colour, leaf lobes, leaf pubescence, tendril length, fruit skin colour, fruit girth, fruit length and fruit weight.
- In chilli, cultivation exclusively for seed purpose not only improved the economic benefits but also enhanced the seed quality parameters. Harvesting the fruit at red ripe stage along with seeds from bottom portion gave maximum viable seeds. Combining vegetable harvests along with seed production can also be practised since this favored the production of good quality seeds with comparable fruit and seed yield. Maximum yield and highest net return were obtained with 50 ppm NAA.
- After cryopreservation (both direct plunging and slow freezing techniques) the seeds and excised embryos of thambakam (*Hopea parviflora*) failed to regenerate. Synthetic seeds obtained from excised embryos and stored at 4°C retained higher germination percentage compared to those at 20 and 27°C after four weeks. The viability of synthetic seeds stored at 27°C declined rapidly and none of them retained their viability after 3 weeks of storage.
- In mango, Chandrakkaran was found to be the most adaptive variety and exhibited more tolerance to seed desiccation indicating that it has a broad genetic base.

SUMMARY

Among the 25 accessions of snakegourd collected from different parts of the country, it was found that Type TA 104 was the highest yielder (7.8 kg/plant) followed by TA 95 (7.34 kg/plant) and TA 102 (6.42 kg/plant).

In oriental pickling melon, maximum fruit size in terms of fresh weight and volume was observed at 24 days after anthesis and maximum dry weight of seeds/fruits and seed weight were observed at 27 days after anthesis.

Among the different methods of seed extraction and drying, good quality seeds with highest germination percentage and vigour index was obtained by using 2% HCl (30 minutes) in ashgourd, machine extraction without fermentation of the pulp in OP Melon and with machine extraction in the case of okra.

In the field experiment conducted during kharif 2000 at College of Horticulture, Thrissur, to formulate a low cost and easily adaptable technology that can successfully alleviate the early season moisture stress in semi-dry rice cv. *Jyothi*, it was observed that the survival of seedlings in treatments hardened with 0.05% imidacloprid (a systemic insecticide) solution

and 2% azospirillum slurry was more. Hardening the seeds with imidacloprid produced the highest yield of 5.3 t ha⁻¹, recording an yield increase of 2.1 t ha⁻¹ over the untreated control.

Seed deterioration in mango was found to have complex changes in the cellular constituents. Accumulation of these changes accelerated by desiccation lead to a loss in the vigor and viability of mango seeds. This was expressed by a decline in the seedling characters like height of seedling, seedling girth, leaf number and internodal length.

List of experiments

i) KAU projects

a) Concluded experiments

Sl. No.	Code No.	Title of the experiment	Location
1	ST-03-00-03-98/ VKA(20)/KAU/PG	Effect of osmopriming before accelerated ageing/storage on the germination characteristics of teak seeds.	CoH, Vellanikkara
2	ST-05-00-01-97/ VKA(14)/KAU/PG	Standardisation of seed processing techniques in chilli (<i>Capsicum annuum</i> L.)	CoH, Vellanikkara
3	ST-10-00-01-99/ VKA(20)/KAU/PG	Development of storage techniques for thambakam (<i>Hopea parviflora</i> Bedd.) seeds.	CoF, Vellanikkara
4	ST-01-00-01-98/ VKA(14)/KAU/PG	Fruit and seed development, seed processing and storage methods on seed quality of oriental pickling melon (<i>Cucumis melo</i> var. Conomon).	CoH, Vellanikkara
5	ST-01-00-01-2000/ ACV(1)/KAU/PG	Agrotechniques for seed production in vegetable cowpea (<i>Vigna unguiculata</i> subsp. <i>sesquipedalis</i> (L.) Verdcourt.) variety Sharika.	CoA, Vellayani
6	ST-01-00-02-2000/ ACV(1)/KAU/PG	Influence of growth regulator and vegetable picking on seed yield and quality in chilli (<i>Capsicum annuum</i> L.).	CoA, Vellayani
7	ST-01-00-03-2000/ VKA(2)/KAU/PG	Impact of seed deterioration on seedling vigour in mango (<i>Mangifera indica</i> L.).	CoH, Vellanikkara
8	ST-02-01-02-2000/ VKA(1)/KAU/PG	Effect of seed hardening on establishment, growth and productivity of semi-dry rice	CoH, Vellanikkara
9	ST-02-01-01-2000/ PTB(9)/KAU	Standardisation of seed priming techniques in rice.	RARS, Patambi

b) Experiments in progress

Sl. No.	Code No.	Title of the experiment	Location
1	ST-06-02-08/93/ VKA(14)/KAU	Standardisation of seed extraction and processing to improve storability and quality of seeds.	CoH, Vellanikkara
2	ST-02-01-03/2001/ VKA(14)/KAU	Effect of pre-sowing treatments in breaking the dormancy of cucurbitaceous seeds	CoH, Vellanikkara
3	ST-05-00-01-2002/ VKA(F)/KAU/PG	Effect of seed size on the germination and seedling performance of teak (<i>Tectona grandis</i> L. f.)	CoF, Vellanikkara

ii) Externally aided projects : Nil

26. FOREST MANAGEMENT AND WILDLIFE

Co-ordinator: Dr. K. Gopikumar

HIGHLIGHTS

- Potting media with wastes like garbage and coir dust were highly promising with respect to initial establishment and final survival of *Tectona grandis*, *Albizia falcataria*, *Terminalia paniculata*, *Acacia mangium*, *Dalbergia latifolia* and *Artocarpus heterophyllus*.
- The cost of a six month old tree seedling produced in standard medium containing equal parts of soil: sand: cowdung was worked out to be Rs.4.50 while in the medium containing garbage, this was only Rs.1.90.
- Soil faunal diversity was more in natural forests than in agroforestry system. Among the 25 different groups of organisms collected, the most dominant macrofaunal group showing diversity was coleoptera, followed by earthworms and hemipterans
- The role of soil faunal elements was highly significant in increasing the N concentration and decreasing K and Mg in the initial decomposition of litter
- In Parambikulam wildlife sanctuary 27 species of small mammals were under eight mammalian orders such as primates, carnivora, rodentia, insectivora, chiroptera, artiodactyla, pholidota and lagomorpha.

SUMMARY

Leaf litter studies revealed that decomposition of litter due to microbial activity was rapid in the initial stages. An increase in N was observed while both K and Mg showed a decrease in their concentration during the initial phase of decomposition.

No clear-cut trend was seen in chlorophyll production with regard to shade levels. It was higher when grown under 75% shade.

The natural forest formed the major vegetation type with relatively higher diversity of plant species compared to other types of forests. Both Simpsons diversity index and Shanon Weiner diversity index were worked out.

Fifteen species of bats were recorded from Peechi- Vazhani wildlife sanctuary. This accounted for 45.5 per cent of the bats of Kerala. This included three species of fruit bats and twelve species of insectivorous bats. *Cynopterus sphinx* (44.68%) was the most abundant species in Peechi-Vazhani area followed by *Rhinolophus rouxii* (27.66%).

In teak, sowing seeds at wider spacing resulted in larger seedlings suitable for production of stumps. Nutrients were not having profound influence on the growth of seedlings compared to spacing. Ring width, vessel size and fibre proportion were higher when seeds were sown in cow dung @0.4kgm⁻² and neem cake @0.2kgm⁻² at a spacing of 12cmx12cm and hence these can be taken as anatomical parameters for selecting teak seedlings for superior quality stumps.

Litter production studies indicated that *Acacia mangium* produced maximum litter (16.93T/ha/year) followed by *Acacia crassicarpa* and *Acacia aulococarpa*. Decomposition of litter was also faster in *Acacia mangium* compared to other two species.

The seedlings of the tree species when grown in standard potting medium containing soil, sand, cow dung and also in medium with 4 weeks decomposed garbage were very vigorous in terms of shoot and root growth attributes, physiological growth attributes like relative growth rate, leaf area, specific leaf area and weight, leaf area and leaf weight ratio and chlorophyll content. However, the nutrient concentration of the seedlings was found to be very low when grown in pure coir dust and fresh garbage. Chemical analysis of the media also revealed that all nutrients like N, P and K were very low in coir dust as compared to other potting media.

In *Terminalia tomentosa* and *Terminalia bellerica*, 50% shade in the nursery produced best results with regard to shoot and root parameters, biomass production and nutrient uptake while in *Terminalia arjuna*, 75% shade was found to be most ideal

List of experiments

- i) KAU projects
 - a) Concluded experiments

Sl. No	Code No.	Title of the experiment	Location
1	FMW-02-00-01-2000/ VKA(F)/KAU/PG	Effect of shade levels on the growth and vigor of <i>Terminalia</i> species in the nursery	CoF, Vellanikkara
2.	FMW-05-00-01-2000/ VKA(F)/KAU/PG	Diversity of small mammals of the Parambikulam wildlife sanctuary	CoF, Vellanikkara
3.	FMW-03-00-02-2000/ VKA(F)/KSFD/PG	Litter production and decomposition studies in selected species of acacia	CoF, Vellanikkara
4.	FMW-03-00-02-2001/ VKA(F)/KSDF/PG	Role of macro and micro fauna in litter decomposition and plant production in natural forest and agro-forestry systems.	CoF, Vellanikkara
5.	FMW/03-00-03-2001/ VKA(F)/KSFD/PG	Phytosociological and litter dynamics studies in selected Shola forest of Nilgiri hills	CoF, Vellanikkara

6.	FMW-02-00-03-2003/ VKA(F)/KAU/PG	Development of an anatomical key for the identification of currently used timbers of Kerala	CoF, Vellanikkara
7.	FMW-02-00-04-2003/ VKA(F)/ICAR/PG	Effect of municipal garbage on the growth and vigour of rosewood (<i>Dalbergia latifolia Roxb</i>) seedling in the nursery	CoF, Vellanikkara
8.	FMW-02-00-06-2004/ VKA(F)/KAU/PG	Wood property profile of rosewood (<i>Dalbergia latifolia Roxb</i>). Ceylon rosewood (<i>Albizia odorattissima</i> (Linn.f.) Benth.) and raintree (<i>Samanea saman</i> (jacq.) Merr.)	CoF, Vellanikkara
9.	FMW-03-00-04-2002/ VKA(F)/KAU/PG	Nutrient content and decomposition and leaf biomass of selected forest tree species	CoF, Vellanikkara
10.	FMW-05-00-02-2001/ VKA(F)/KSFD	Human utilization on the forests of Western ghats and its effect on bio-diversity	CoF, Vellanikkara
11.	FMW-05-00-03-2002/ VKA(F)/KAU/PG	Diversity of bats in Peechi Vazhani wildlife sanctuary, Western ghats, Kerala	CoF, Vellanikkara
12.	FMW-05-00-04-2002/ VKA(F)/KAU/PG	Behavioural ecology of selected deer species in captivity – a case study at Thrissur zoo.	CoF, Vellanikkara

ii) Externally aided projects

a) Concluded experiments

Sl. No.	Code No.	Title of the experiment	Location
1	ICAR	Solid waste as a component of potting media for seedlings of agroforestry tree species	CoF, Vellanikkara
2	Kerala State Forest Dept.	Role of macro and micro fauna in litter decomposition and plant production in natural forest and agroforestry system	CoF, Vellanikkara

27. ORGANIC FARMING

Co-ordinator : Dr. K. Ushakumari

HIGHLIGHTS

- Use of vermicompost either as a seed inoculant or as an organic source resulted in better biometric characters and yield of cowpea, banana and tapioca.
- A basal dose of 50t ha^{-1} (N equivalent basis) in combination with Azospirillum @ 1kg ha^{-1} was the best economic organic nutrient schedule for increasing the productivity and quality of amaranthus.
- A basal dose of 25 t ha^{-1} of FYM and application of poultry manure to supply the recommended dose of 75 kg N ha^{-1} was the best economic organic nutrient schedule for bittergourd.
- A basal dose of 25t ha^{-1} of FYM and application of poultry manure or glyricidia or vermicompost or neem cake to supply the recommended dose of 75 kg N ha^{-1} (on N equivalent basis) in combination with Azospirillum @ 1 kg ha^{-1} was the best economic organic nutrient schedule in chilli. Vermicompost applied treatments recorded highest keeping quality of fruits.
- Soil application of bio-fertilizers viz, azospirillum and VAM mixed with small quantity of cowdung recorded good yield of Cassava.
- Seed treatment with Rhizobium and soil application of phosphobacteria (20 / pit) along with 75% recommended dose of N, P_2O_5 and full K as per POP recorded highest yield in cowpea.
- Integrated plant nutrient studies with different organic manures and recommended dose of chemical fertilizers in bhindi revealed that 12.5t ha^{-1} of vermicompost along with 75% recommended dose of fertilizer gave maximum yield in the laterite soil of Velloor watershed in Kottayam District.
- Studies in Velloor water shed of Kottayam district revealed that snake gourd responded well to biofertilizers and application of 75% recommended dose of POP along with biofertilizers gave the maximum yield.

SUMMARY

Application of vermicompost in bhindi at nine locations in Venganoor revealed that both fruit yield and plant height were significantly enhanced by the application of vermicompost. If FYM is substituted with vermicompost the dose of NPK can be reduced to half the recommended dose without yield reduction.

Composting of aquatic weeds is possible using additives such as urea 20 g/kg, cowdung 1kg/10kg, Trichoderma 15g/kg. Drying of aquatic weeds for one week speed up composting process.

Vermicomposting can be done by using aquatic weeds and cowdung in the ratio 10:1 by weight. For composting of 1 ton of fresh material, 500 earthworms are required.

When large heaps of aquatic weeds are used for composting addition of urea @ 100g and Trichoderma 15g/50cm height having 1m heaps diameter enhanced composting process.

Use of coirpith compost as an organic source for rice in Onattukara region showed that application of coirpith compost @ 2.5t ha⁻¹ + full dose of fertilizers was equivalent to FYM 5t ha⁻¹ + full dose of fertilizers.

Application of composted dairy solid waste has significantly increased the yield of amaranthus and available N content of soil.

Nutrient value and microbial population of vermicompost increased substantially by enriching the biowaste with organic additives like neemcake and bonemeal during vermicomposting.

List of Experiments

i) KAU projects

- a) Concluded Experiments : Nil
- b) Experiments in progress

Sl. No.	Code No.	Title of the experiment	Location
1	OF/01-00-01-2002/ ACV(3)/KAU/PG	Utilization of dairy industry solid source in soil productivity.	CoA, Vellayani
2.	OF/05-00-01-2003/ KYM(3)/KAU	Evaluation of coir pith compost as an organic source for rice in Onattukara region.	RARS, Kayamkulam
3	OF/01-00-02-2003/ ACU(3)/KAU/PG	Vermicompost enriched with organic additives sustainable soil health	CoA, Vellayani

ii) Externally aided project

a) Concluded experiments

Sl. No.	Code No.	Title of the experiment	Location
1.	OF/01-00-02-2002/ ACV(3)/DST	Nutrient economy through vermicompost application in major upland crops of Kerala.	CoA, Vellayani.
2.		Organic farming for sustainable vegetable production	CoA, Vellayani
3.		Response of snake gourd to bio-fertilizers	RARS, Kumarakom
4.		Integrated nutrient management in bhindi using vermicompost	RARS, Kumarakom
5.		Response of vegetable cowpea (bush type) to biofertilizers	RARS, Kumarakom
6.		Response of vegetable cowpea (panthal type) to biofertilizers	RARS, Kumarakom

b) Experiments in progress:

Sl. No.	Code No.	Title of the experiment	Location
1.		Utilization of aquatic weeds for composting and vermicomposting	RARS, Kumarakom

28. GENDER STUDIES

Co-ordinator: Dr. P.S. Geethakutty

HIGHLIGHTS

- Women farm labourers of rice sector face problems of negative energy balance, low nutritional status, high prevalence of anaemia, deficient intake of food groups and nutritional deficiencies.
- Women farm labourers of rice section face high rate of wage discrimination and unemployment.
- Need of integrating gender perspectives in agricultural education was identified and a model for engendering agricultural education was developed.
- Farm operations which are female specific or female dominant in their manually operated situation are observed to become male dominant operations in their mechanized situations.
- Technologies developed for women performed farm operations need designs and technology promotion as suitable and appropriate to women.
- Women agri-business operators of farm sector need empowerment in entrepreneurial and technological skills. Lack of marketing support and technological know how are the major constraints of women agri-business operators.
- Labour opportunity, daily income, wage rate, health and nutritional status, food security, skill acquisition, leisure time availability, drudgery reduction, access to institution and support services, and social participation are potential indicators of gender impact of agricultural technologies, programmes and institutions in the farming systems.

SUMMARY

1. Study among women farm labourers engaged in rice cultivation revealed that they face high rate of wage discrimination, poor nutritional status and negative energy balance. Majority of them are women labourers and are affected by anaemia. It was observed that the level of intake of food groups among these women is very low, especially raw vegetables. Symptoms of nutritional deficiencies like diffused pigmentation in face, angular stomatitis, oedema in tongue, skeletal deformities, goitre, xerosis in skin, pale conjunctiva, koilonychia and dental carries were also noticed among majority of farm women labourers of rice tracts. The study had also indicated that the women labourers use major portion of their income for the purchasal of food item, especially cereals. Very low level of saving habit was noticed among the women labourers of rice tracts.
2. Study of women entrepreneurs in agri business in the Central Kerala has revealed that there is low level of entrepreneurial success among women (21%). A scale for the measurement of success of farm women entrepreneurship has been developed with the following dimensions-profitability, social recognition, consumer satisfaction, produce brand recognition, recognition, employees satisfaction, quality of produces/services, capacity utilization and diversification. Only one fifth of the agri-business operators are with high level of success in Central Kerala. Majority of the women entrepreneurs are observed to possess only medium level of planned management, leadership, economic motivation, human relations, networking ability, risk bearing behaviour, decision making

ability and achievement motivation. Women agri-business operators face constraints of lack of marketing support, shortage of capital, marketing competition and, lack of technical knowledge.

3. The FAO supported study on building gender integrated agricultural curriculum has revealed the need of introducing a course on Human Centered Agricultural Development in all under graduate programmes of agriculture and the relevance of engendering curricular and co-curricular activities in agricultural universities. Need of capacity building among scientists for gender responsive agricultural education also was identified. A model approach for engendering agricultural education was also developed as part of the study.

List of experiments

i) KAU Projects

a) Concluded experiments

Sl. No.	Code No.	Title of the experiment	Location
1.	GS/06-00-01-2000/ VKA(6)/KAU/PG	Women entrepreneurs in agri-business	CoH, Vellanikkara
2.	GS/07-00-01-2001/ VKA(11)/KAU/PG	Nutritional profile of women labour in rice cultivation	CoH, Vellanikkara

b) Experiments in progress

Sl. No.	Code No.	Title of the experiment	Location
1	GS/01-00-01-2002/ VKA(6)/KAU	Case studies on gender role analysis in the farming systems of the major agroclimatic zones of Kerala	CSGCA, Vellanikkara
2	GA/01-00-03-2003/ VKA(6)/KAU	Adoption of sustainability of mechanical paddy transplanter for the farm women labour in the paddy cultivation of Thrissur and Palakkad districts	CSGCA, Vellanikkara
3	GA/01-00-04-2004/ ACV(6)/KAU/PG	Agricultural labour in rice based farming systems. A gender based multi dimensional analysis	CoA, Vellayani
4	GS/02-00-01-2001/ VKA(6)/KAU	Land ownership and participation of the farm women in Thrissur district	CoH, Vellanikkara
5	GS/02-00-02-2001/ ACV(11)/KAU	Impact of dietary counseling on the nutritional status of farm women labourers	CoA, Vellayani

ii) Externally aided projects

a) Concluded experiments

Sl. No.	Code No.	Title of the experiment	Location
1		KAU-FAO project on building gender integrated agricultural curriculum	CSGCA, Vellanikkara

b) Experiments in progress

Sl. No.	Code No.	Title of the experiment	Location
1	GS/01-00-02-2003/ VKA(6)/KAU	Gender analysis of farming systems for sustainable technologies, development programmes and livelihood	CSGCA, Vellanikkara
2		NRCWA Networking project on approaches to engendering agricultural research and extension	CSGCA, Vellanikkara
3		DBT project on Women empowerment networking in Kerala through science and technology	CSGCA, Vellanikkara

29. AGRI-BUSINESS MANAGEMENT

Co-ordinator : Dr. M. Mohandas

HIGHLIGHTS

- High proportion of overdues in respect of short-term agricultural advances was a problem in DCBs. The unscientific repayment scheduling policy followed by the DCBs aggravated the problem.
- Inadequate staff for field supervision, loan appraisal and legal support, lack of management training and inadequate infrastructure were the major organizational factors which contributed to high over dues in Primary Co-operative Agricultural and Rural Development Banks in Kerala.
- The farmers were not completely aware about the various sources of inputs and their supply even though the distribution mechanism was so wide.
- The marketing strategies followed by various fertilizer companies were not farmer or soil oriented because the farmers neither followed any rationality in the purchase of fertilizers nor they did soil testing prior to fertilizer application.
- Since 1990, the share of institutional finance in the financing of agriculture is significantly falling. While the stipulated rate is 18% of the total advances, currently it is below 12% in Kerala
- There existed sizable production credit gap in Kerala because of the unscientific norms followed for fixing the scale of finance.

SUMMARY

A comparative study of non-performing assets (NPAs) in the three District Co-operative Banks of Kasaragod, Palakkad and Thrissur showed that the magnitude of NPAs was the highest in Trichur District Co-operative Bank (TDCB) and lowest in Kasaragod DCB. NPAs of short-term agricultural advances accounted for more than 90 per cent of the total NPAs in Palakkad DCB.

A comparative study of loan recovery management of four PCARDS in Ernakulam and Thrissur districts showed rising trends in over dues with exception of Irinjalakuda PCARDB, which had achieved commendable success in recovery. While non-agricultural loans accounted for the biggest category in advances, it also contributed to the biggest share in over dues. Mismatch between time of payment and income generation, lack of adequate income generation, diversion of loans, expectation of loan waiver policy, defective loaning policies and default on the part of loanees resulted in mounting over due problem. Effective member education programmes, timely legal action towards defaulters and restoring autonomy to co-operatives could improve the situation. There is also a need for coercive action against willful defaulters and incentives to those who make prompt repayments. An effective loan appraisal and loan-monitoring cell managed by professionally trained is also to be established in each bank. Besides the banks must put into effect the SARAFESI (Securitisation and Reconstruction of Financial Assets and Enforcement of Security Interest) Act, 2002.

In an appraisal of the Agricultural input supply system in Kerala, it was found that there is an extensive arrangement for the distribution of agricultural inputs, which included private agencies, co-operatives, government departments and parasatials. The more frequently

demanding inputs were chemical fertilizers and credit. However, inspite of the elaborate arrangement for credit delivery, the farmers did not get the required volume of credit in right time. Further, the quantity of credit received was insufficient due to unscientific norms used for deciding, the scale of finance. Many technological developments and recent advances related to agricultural sector did not reach the grass root level farmers. This trend suggested that lab-to-land programmes are to be strengthened further. Among the various agencies, farmers had definite preference towards co-operatives mainly because of price advantage. Eventhough the farmers "prefer co-operatives" they made effective purchases from the private traders because of the availability of multiple brands and other infrastructural advantages attached. Eventhough, the agricultural input supply mechanism in Kerala state at present is sufficient it is to be reoriented, redirected and revamped to meet the recent challenges of globalization and reforms.

In the study on "Capital formation for Agriculture – Role of institutional finance in Kerala" it was found that among the various types of credit like short term, medium term and long term, the respective shares were 50%, 30% and 20%. A low share of long-term capital restricted the infrastructure development in agriculture, more broadly capital formation in agriculture. A low share of long-term capital was due to the less attention given by the commercial banks to the agricultural sector as a direct consequence of the reforms in the banking sector. Low priority given to the agricultural sector by the Government in recent years aggravated the situation. As part of the study, it was also observed that the co-operatives are not playing their listed role effectively. There was good amount of overlapping and duplication between various agencies as far as credit disbursement was concerned. India being a rural economy, it is high time to refocus the institutional finance in favour of agriculture and allied sectors.

The study on the buyer behaviour of the rice farmers towards selected agricultural inputs in Thrissur District emphasized the need for increasing the awareness of the farmers about HYV seeds and agro-chemicals.

List of experiments

i) KAU Projects

a) Concluded experiments

Sl. No.	Code No.	Title of the experiment	Location
1	AM/02-00-01/ VKA(C&B) KAU/ PG (2000-15-01)	Non-performing assets of district co-operative banks in Kerala with special reference to agricultural advances	CCB&M, Vellanikkara
2	AM-02-00-02-2001/ VKA(C&A)KAU/PG	Buyer behaviour of the rice farmers towards selected agricultural inputs in Thrissur dist.	CCB&M, Vellanikkara
3	AM-02-00-05-2002/ VKA(C&B)KAU/PG	Loan recovery management in primary co-operative agricultural and rural development banks in Kerala (Agri-business management)	CCB&M, Vellanikkara

b) Experiments in progress

Sl. No.	Code No.	Title of the experiment	Location
1	AM-02-00-02-2001/ VKA(C&B)KAU/PG	SWOT analysis of agro-chemical distribution system in Thrissur district	CCB&M, Vellanikkara

2	AM/02-00-03-2002/ VKA(C&B)KAU/PG	Agricultural financing through Kisan credit scheme in Thrissur district	CCB&M, Vellanikkara
3	AM/02-00-04-2002/ VKA(C&B)KAU/PG	Financing of fruit and vegetable processing industry in Thrissur district	CCB&M, Vellanikkara
4	AM/02-00-06-2004/ VKA(CBM)KAU/PG	Integrated credit in agriculture – role of farmer's service societies in Thrissur dist.	CCB&M, Vellanikkara
5	AM/04-00-04-2004/ VKA(C&B)KAU/PG	Marketing of commercial flowers in Kerala-A study in Palakkad and Thrissur district.	CCB&M, Vellanikkara
6	AM/04-00-05-2004/ VKA(C&B)KAU/PG	Market potential of value added products of coconut	CCB&M, Vellanikkara
7	AM/04-00-06/2004/ VKA(CBM)KAU/PG	Response behaviour towards branded agro-processed products	CCB&M, Vellanikkara
8	AM/07-00-01-2003/ VKA(CBM)KAU/PG	Export performance of tea industry in South India in the context of economic liberalization	CCB&M, Vellanikkara

ii) Externally aided projects : Nil

30. AGRO-ECONOMIC STUDIES

Co-ordinator: Dr. E. K. Thomas

HIGHLIGHTS

- Majority of the IFFCO adopted co-operative societies and storage cum community centers were having input storage facilities but output storage facilities were not adequately established. Accumulation of over due, influence of money lenders in the rural areas and lack of training and management skills were to hamper the working of the center.
- The value of water based on cost of supplying the same, productivity and willingness to pay of users were estimated. This is helpful in framing the pricing policy for irrigation water in the state
- A module for successful functioning of the home scale agribusiness units was developed. Revitalized some of the sick units run by Self Help groups/Kudumbasree units through financial/technical/managerial empowerment.
- Total number of sales points in IFFCO southern zone is exhibiting a negative growth rate during 1990-2000. A significant positive correlation existed between gross irrigated area and nutrient consumption in Karnataka and Andhra Pradesh. High cost of IFFCO fertilizer as the major constraint in high and medium categories of farmers in Karnataka. In Tamil Nadu high cost of fertilizer was the most important constraint for high consumption group, while for medium and low consumption group, non-availability of IFFCO fertilizer and lack of awareness was the most important constraint.
- The average gross capital formation in farm households of Nemom development block in Thiruvananthapuram District was Rs. 34450 and net capital formation was Rs. 3290 of which major share was on land improvement. The income, expenditure, savings, value of assets, gross and net capital formation was found to increase with farm size. The most important constraint faced by the farmers was high wage rate followed by non-availability of labour and low product price.
- Average savings of all the farm households in Ollukkara development block in Thrissur District was 19.22 per cent of total income and the main asset of the people was land, house and household durables. The investment in the farm was low compared to the non-farm investment, which indicates the low degree of interest of the people towards agriculture.
- The cost of cultivation of potato, garlic, carrot and cabbage in Iddukki District was estimated to be Rs.35370, Rs.34, 640.01, Rs.30565 and Rs.26564 per hectare respectively, at the aggregate level. Out of seven marketing channels identified for cool season vegetables (Iddukki district) the most important channel producer-village merchant-commission agent-wholesaler-retailer-consumer was adopted by 86.5 per cent of the respondents. The most important problem faced by the cool season vegetable growers was low price for produce

- The analysis of the marketing system of vetiver in Thrissur District revealed that private traders carried out the entire marketing activity. The major marketing channels identified were producer → wholesaler → processor → consumer and producer → wholesaler → drug dealer → consumer
- The annual compound growth in the consumption of medicinal plants varies from 4.19 per cent in *Boerhaavia diffusa* to 9.31 per cent in *Aegle marmelos*. The study identified the most important plants demanded by the user industry.
- The results of the growth rate analysis using exponential function revealed that the area under cashew expanded by 2.22 per cent per annum. The most significant constraint faced by cashew growers was the incidence of pests and diseases which severely affected their production.
- Trade competitiveness of cardamom, ginger and turmeric based on nominal protection coefficient revealed a lowering of competitiveness as a result of globalisation. Area and production of pepper in Kerala exhibited significant positive growth of 2.4 and 3.51 per cent respectively showing an accelerating trend in growth whereas growth in productivity was insignificant
- An analysis of the composition pattern revealed that natural rubber is slowly replacing the synthetic rubber in the world as well as in the Indian market. Analysis of trade competitiveness showed that Indian natural rubber was not globally competitive.
- The cost of cultivation of Njavara (rice) was 14059 per hectare and the B:C ratio found to be 2.03
- Impact study of Command Area Development Authority (CADA) in Neyyar, Trivandrum showed that the financial cost of irrigation water was Rs.246/ha/year while the economic cost was Rs.1041/ha/year.

SUMMARY

A state wise analysis of the performance of IFFCO adopted co-operative societies and storage cum community centers were done. Majority of the societies and storage cum community centers were having input storage facilities. These are fully utilized only in the case of fertilizer storage. Output storage facilities were not adequately established in majority of the societies and storage cum community centers. The facilities were limited to few crops like paddy and oil seeds. Most of the adopted societies/community centers are not supplying all types of IFFCO fertilizers the reasons for which have to be examined. Accumulation of over due was the most important problem in all societies. Influence of money lenders in the rural areas and lack of training and management skills were to hamper the working of the center.

A study on the pricing of irrigation water in Kerala with special reference to environmental management was done. Irrigation investments in Kerala have been questioned mainly on account of its poor financial performance. The project could produce results as to the various uses to which irrigation water is put to (irrigation and non irrigation uses) and its

productivity. The value of water based on cost of supplying the same, productivity and willingness to pay of users were estimated.

The study on agribusiness opportunities in Kerala - constraint analysis to ensure sustainable efficiency identified the potential agribusiness ventures, which can be taken up by the entrepreneurs in the state. A module for successful functioning of the home scale units by women was also developed. The study could also revitalize some of the sick units run by Self Help groups/Kudumbasree units through financial/technical/managerial empowerment.

A study on the prospects of fertilizer marketing in IFFCO south zone showed that Karnataka and Tamil Nadu states showed a significant positive growth rate whereas all types of nutrients use exhibited negative growth in Kerala and Andra Pradesh for all the nutrients in Kharif and Rabi and both seasons together. Total fertilizer products have shown a positive growth in Kharif and Rabi and both seasons together in Andra Pradesh, Karnataka and Tamil Nadu. Total number of sales points in IFFCO southern zone is exhibiting a negative growth rate during 1990-2000. The results of constraint analysis showed high cost of IFFCO fertilizer as the major constraint in high and medium categories of farmers in Karnataka. In the low consumption category, non-availability of IFFCO fertilizer was the most important constraint.

The study on capital formation in farm households of Nemam block panchayat of Trivandrum district was done to assess the extent and nature of capital formation and to identify the constraints faced by farmers in capital formation. The result revealed that the average gross capital formation was Rs.34450/- and net capital formation was Rs.3290/- of which major share was on land improvement. The income, expenditure, savings, value of assets, gross and net capital formation was found to increase with farm size. The most important constraint faced by the farmers was high wage rate followed by non-availability of labour and low product price.

A study on investment pattern in rural households of Ollukkara block panchayath in Thrissur district was done to study the different sources of income, to examine the savings and expenditure pattern, to analyze the nature of investment and the constraints associated with investment in rural areas. The total income was highest among service sector people, which amounted to Rs.82320.00/- and was lowest among the labourers which was Rs.47568.00/-.

Economic analysis of production and marketing of cool season vegetables in Devikulam block of Idukki district showed that the total cost of cultivation of potato, garlic, carrot and cabbage Rs.35370, Rs.34,640, Rs.30565 and Rs.26564 per hectare respectively, at the aggregate level. Out of seven marketing channels identified in the study area, the most important channel producer-village merchant-commission agent-wholesaler-retailer-consumer, adopted by 86.5 per cent of the respondents. The index of marketing efficiency was the highest for carrot (1.53) followed by potato (1.49), garlic (0.77) and cabbage (0.73). The most important problem faced by the cool season vegetable growers was low price for produce. Pest and disease incidence was the next important constraint. This was followed by constraints like lack of marketing facilities, problem of wild animals and lack of transportation facilities.

A study on the production and marketing systems of Vetiver - a micro-level analysis in Thrissur district revealed that the average yield was 9841 kilogram per hectare. The breakeven analysis indicated that all the farmers were operating above the required breakeven

output level. The cost of production of one kilogram of vetiver root based on cost C_3 was Rs.11.57 respectively for the sample as a whole. The BCR was found to be 1.11 at cost C_3 for the sample as a whole. The analysis of the marketing system revealed that private traders carried out the entire marketing activity. The major marketing channels identified were producer → wholesaler → processor → consumer and producer → wholesaler → drug dealer → consumer. In Thrissur market, the gross producer's share was 72.22 per cent. The major production related constraints were high labour wages and non-availability of labour during peak season. The major marketing related constraints were low price and price risk due to inter year price fluctuation.

Analysis of market economy of medicinal plants in Kerala showed that the annual compound growth in the consumption of medicinal plants varies from 4.19 per cent in *Boerhaavia diffusa* to 9.31 per cent in *Aegle marmelos*. The price elasticity of demand of all the medicinal plants studied were positive, varying from 0.33 per cent in the case of *Boerhaavia diffusa* to 3.31 in the case of *Terminalia chibula*. Many of them were scarce. In the marketing scene, tribals – commission agent – trader/dealer – ayurvedic manufacturing units is found to be the main marketing channel through which major portion of the medicinal plants are marketed in the state (60-65%). The market for medicinal plant in the state is found to be oligopolistic in nature.

A study on the economic analysis of production and marketing of cashew nut in Kerala was done. The results of the growth rate analysis using exponential function revealed that during the whole period under study, the area under cashew expanded by 2.22 per cent per annum. The productivity showed a decline by 2.11 per cent per annum. At the aggregate level annual maintenance cost was estimated to Rs.7710/- per hectare. The major marketing channels as identified in the study were producer-village trader-primary wholesaler-secondary wholesaler-processor and producer-primary wholesaler-secondary wholesaler-processor.

The study on market behaviour of spice in Kerala worked out the trade competitiveness of pepper, cardamom, ginger and turmeric using nominal protection coefficient. The study showed that trade competitiveness of cardamom, ginger and turmeric was lowered due to globalization. The results of growth rate analysis using different functions revealed that during the entire period, both area and production of pepper in Kerala exhibited significant positive growth of 2.4 and 3.51 per cent respectively showing an accelerating trend in growth whereas growth in productivity was insignificant.

A study on production and trade competitive advantages of natural rubber in India was conducted. An analysis of the composition pattern revealed that natural rubber is slowly replacing the synthetic rubber in the world as well as in the Indian market. The nominal protection coefficients indicated that Indian natural rubber was not enjoying trade competitive advantage in the international market.

A study on economics of commercial production and utilization of medicinal rice, Njavara was taken up. The study was undertaken in Thrissur, Malappuram, Palakkad and Wayanad districts of Kerala. The study showed that cost of cultivation of Njavara was Rs.14059/- per hectare and the BC ratio found to be 2.03, thus highlighting the economic viability of the crop.

A study on the impact of command area development authority (CADA) with respect to Neyyar irrigation project revealed that while the beneficiary farmers devoted more cropped area under more water demanding crops, the non-beneficiaries gave less thrust on water demanding crops. The cropping intensity and gross area irrigated were more for beneficiaries compared to non-beneficiaries. Income from agriculture was higher for beneficiary farmers as compared to the non-beneficiary farmers. The financial analysis was carried out which indicated that the project was financially attractive with a BCR of 1.43, NPV Rs 43.12 lakhs, and a financial rate of return of 16 per cent, which was higher than the cost of capital (12%). The operational problems in on-farm irrigation were water scarcity in summer, improper maintenance of canals, lack of timely desiltation, unscientific channel construction and wastage of water and poor canal lining. The financial cost of irrigation water was Rs.246/ha/year while the economic cost was Rs.1041/ha/year.

Micro finance programmes are becoming a mainstream development intervention for poverty alleviation and empowerment of the poor. Micro finance programme operates on the principle of group based lending, commonly referred as self-help groups. The study was conducted in Nilampur block of Malappuram district by selecting 30 SHG's and 200 beneficiaries. The economic impact was visible in terms of savings habit, accessibility to credit contribution to household income and acquisition of household assets. The social impact is the increased involvement in household activities, improvement of status in community and home, increased self-confidence and ability to deal with future. The factors which influenced group effectiveness were group interaction, group autonomy, accountability and transparency.

List of experiments

i) KAU Projects

a) Concluded experiments

Sl. No.	Code No.	Title of the experiments	Location
1.		Economics of farming systems under selected agro-ecological zones-Thrissur dist.	Thrissur
2		Economic analysis of production and marketing of cashew nut in Kerala	Kerala
3		Capital formation in farm households of Nemom development block of Thiruvananthapuram district	Thiruvananthapuram
4		Income, savings and expenditure pattern of farm households in Ollukkara development block of Thrissur district	Thrissur
5		Economic analysis of production and marketing of cool season vegetables in Devikulam block of Idukki district	Idukki
6		Analysis of market economy of medicinal plants in Kerala	Kerala
7		Production and marketing systems of Vetiver: a micro-level analysis in Thrissur district	Thrissur

8		Impact of command area development authority (CADA): An economic analysis of Neyyar irrigation project	Neyyar
9		Market behaviour of spice in Kerala	Kerala
10		Production and trade competitive advantages of natural rubber in India	India
11		Economics of commercial production and utilization of medicinal rice, Njavara	Kerala
12	AES-03-00-03-2000	Impact of micro finance through self help groups in Malappuram district	Malappuram

b) Experiments in progress

Sl. No.	Code No.	Title of the experiment	Location
1		Economics of production and marketing of Vanilla	Kerala
2		Production and marketing of vegetables in Palakkad district	Palakkad
3		Price behaviour of coconut and coconut products in India	India
4		Integrated pest management in rice production : resource use efficiency and relative economics	Kuttanad
5		Economics of farming systems under selected agro-ecological zones – Palakkad dist.	Palakkad

ii) Externally aided projects

a) Concluded experiments

Sl. No.	Code No.	Title of the experiment	Location
1		Performance of IFFCO adopted co-operative societies and storage cum community centers – A state wise analysis	Kerala
2		Agribusiness opportunities in Kerala – constraint analysis to ensure sustainable efficiency	Kerala
3		Research priority assessment in Kerala Agricultural University	Kerala
4		Prospects of fertilizer marketing in IFFCO south zone	South zone
5		Pricing of irrigation water in Kerala with special reference to environmental management	Kerala

b) Experiments in progress

Sl. No.	Code No.	Title of the experiment	Location
1		Economic analysis of vegetable production in Kerala state	Kerala
2		Impact evaluation study of NWDPPRA scheme implemented during IX th five year plan	Kerala
3		Pesticide use in rice production and human health-A study in Kerala	Kerala
4		Economics of granular urea application in selected crops of IFFCO south zone.	South zone
5		Participatory evaluation of the preference for rice varieties in the buyer-seller markets in Palakkkad	Palakkkad



Part - II

**Faculty of Veterinary & Animal
Sciences**

1. ANIMAL DISEASES

Co-ordinator : Dr. K.V. Valsala

HIGHLIGHTS

- In upper alimentary tract obstructions, frequent vomiting and pain were the prominent clinical features.
- Propofol under atropine-xylazine pre-medication provided smooth induction of anaesthesia.
- Plaster of paris cast favoured the return of limb function and disappearance of symptoms of fracture earlier than modified Thomas Splint in fracture of tibia.
- Collagen sheets are cheap and easily available material over synthetic ones for cystoplasty in treating urinary bladder rupture in rabbits and goats.
- Surgical excision along with administration of suitable antibiotics was found as the appropriate line of treatment of intra-abdominal umbilical infection.
- In the treatment of aural haematoma partial thickness suturing technique was found to be more effective.
- Epidurography is found to be advantageous over venography in diagnosing the site and type of lesions in cases of posterior paralysis in dogs.
- Immobilization of the fractured limb with PVC splint facilitated the repeated attention of concurrent complications associated with fracture and application of the same material, thus resulting cost effectiveness of treatment.

SUMMARY

The study on clinical and serum biochemical evaluation in surgery for alimentary tract obstruction in dogs revealed that in upper alimentary tract obstruction, frequent vomiting with the vomits either frothy or white in colour with undigested food materials and pain were the prominent clinical features. High levels of total leucocyte count, BUN, serum creatinine and serum albumin were observed. In lower alimentary tract obstruction, constipation and occasional vomiting with the vomits either frothy or yellowish in color with partially digested food materials and pain were the prominent symptoms. High levels of neutrophil count, BUN, serum creatinine, serum albumin, ALT and AST were observed.

Propofol under atropine-xylazine pre-medication provided smooth induction of anaesthesia and was safe for maintenance of sufficient duration with incremental doses for surgery in both shy and compromised animals. The recovery from anaesthesia was rapid, smooth and uneventful regardless of the number of incremental boli given for maintenance of anaesthesia.

Plaster of Paris cast favoured the return of limb function and disappearance of symptoms of fracture earlier than modified Thomas splint in fracture of tibia. Both the techniques did not affect the Haemogram and serum biochemical parameters and the healing was comparable radiographically and clinically.

The glutaraldehyde cross – linked canine collagen sheets and the requirement as a graft material for cystoplasty in treating urinary bladder rupture of rabbits and dogs was studied. The collagen sheets are cheap and easily available material over the synthetic ones and it

ensured better utilization of the waste animal tissues and fish air bladder, which are rich in collagen.

The study on surgical management of omphalitis in calves revealed that all the calves affected with umbilical infection should be examined for intra-abdominal also. Abdominal palpation near the umbilicus is highly helpful for diagnosis wherein, the extension of infection can be easily palpated as an indurated cord, continuing either towards the liver or bladder. Retrograde contrast fistulography using iodine-containing solution was found useful in differentiating extra abdominal and intra-abdominal infected tract. Surgical excision along with administration of suitable antibiotics, were found as the appropriate line of treatment for intra-abdominal umbilical infection.

Clinical trials carried out in dogs revealed "Iohexol" as a safe contrast medium for both epidurography and ascending coccygeal venography. Epidurography is found to be advantageous over venography in diagnosing the site and type of lesions in cases of posterior paralysis in dogs.

Plaster of Paris cast and PVC splints used in immobilization of radius and ulnar fracture did not affect the haemogram and serum biochemical parameters and the healing of bone fragments in all the animals radiographically and clinically studied. Immobilization of the fractured limb with PVC splint facilitated the repeated attention of concurrent complications associated with fracture; fracture and application of the same material, thus resulting cost effectiveness of treatment.

The study on evaluation of partial thickness suturing techniques for the repair of aural haematoma in dogs revealed that in canine aural haematoma the accumulation of blood is sub-perichondreal and for the treatment the partial thickness suturing technique was found more advantageous than full thickness suturing technique because of non-puckering and thickening of pinna. The degree of post-operative drooping of pinna in erect eared breed was less compared to full thickness suturing technique.

The All India Net Work Programme on Haemorrhagic Septicaemia at Mannuthy one of the collaborating center became operational on 30-4-01. Procurement of equipment, glassware and chemicals for the first and second year were completed by March 2004. Analysis of epidemiological data on Pasteurellosis in the State during this study indicated that animals like cattle and goats and birds like poultry, duck and turkey were the usual victims of this infection.

Isolation of *P. multocida* was attempted from 475 samples originated from bovine, caprine, porcine, and other mammalian species. Of these, 279 were from apparently healthy animals and the rest (196) were from clinically ill/dead animals. No *P. multocida* organisms could be isolated from the apparently healthy animals, while eight isolates were obtained from the clinically ill animals.

In the case of birds attempts were made to isolate *P. multocida* from 245 samples originated from 1232 apparently healthy/ailing or dead ducks, fowl & turkey. None of the samples collected from apparently healthy birds yielded any *P. multocida*. Out of the ailing/dead birds, 34 isolates of *P. multocida* were obtained.

Characterization of the 34 isolates from animals/birds revealed that only two isolates were *pasturella* subspecies *septica* while all other isolates belonged to subspecies *multocida*.

Antibiogram patterns of all isolates were also carried out. Chloramphenicol, Gentamycin, Cloxacillin, Nitrofurantoin, Pefloxacin and Tetracycline were found to be the most sensitive drugs against *P. multocida*.

P. multocida species specific PCR (PM-PCR) was performed for all the above isolates and all of them had an amplified product of ~ 460 bp.

Restriction enzyme analysis with *Hpa* II yielded three profiles among the n5 duck isolates studied.

Plasmid profile analysis of these 25 isolates revealed two profiles.

PCR for detection of *P. multocida* Type B using HSB PCR was standardized and the bovine isolates gave an amplicon of ~ 590 bp.

Multiplex PCR showed two bands corresponding to 460 bp and 590 bp for the bovine isolates while the isolates from ducks gave a single band having a molecular size of approximately 460 bp.

REP PCR was carried out for strain differentiation of duck isolates of *P. multocida*. All the 25 duck isolates (DP I -25) of *P. multocida* had a single REP PCR profile.

List of experiments

i) KAU Projects

a) Concluded experiments

Sl. No.	Code No.	Title of the experiment	Location
1.	AD-94/00/00/99/ VC(16)/KAU/PG	Clinical and serum biochemical evaluation in surgery for alimentary tract obstruction in dogs	CoV&AS, Mannuthy
2.	AD-06/00/10/99/ VC(16)/KAU/PG	Clinical evaluation of xylazine-profol anaesthesia in dogs	CoV&AS, Mannuthy
3.	AD-96/00/00/99/ VC(16)/KAU/PG	Management of tibial fractures in dogs using plaster of Paris cast & modified Thomas splint	CoV&AS, Mannuthy
4.	AD-100/00/00/99/ VC(16)/KAU/PG	Processed canine and fish collagen sheets for cystoplasty in rabbits and dogs	CoV&AS, Mannuthy
5.	AD-126/00/00/2000/ VC(16)/KAU/PG	Surgical management of omphalitis in calves	CoV&AS, Mannuthy
6.	AD-108/00/00/99/ VC(16)/KAU/PG	Ascending coccygeal venography in evaluation of paraplegia in dogs	CoV&AS, Mannuthy
7.	AD-19/00/02/2000/ VC(16)/KAU/PG	Management of poly vinyl chloride splints for the treatment long bone fractures in dogs.	CoV&AS, Mannuthy
8.	AD-117/00/00/02/ VC(16)/KAU/PG	Evaluation of partial thickness suturing techniques for the repair of aural haematoma in dogs	CoV&AS, Mannuthy

b) Experiments in progress

Sl. No.	Code No.	Title of the experiment	Location
1.	AD-/119/00/00/02/ VC (16)/KAU/PG	Radiographic evaluation of otitis in dogs	CoV&AS, Mannuthy
2.	AD-06/00/11/02/ VC (16)/KAU/PG	Clinical evaluation of the comparative effect of Xylazine and Xylazine – Ketamine pre-medication in Thiopentone anaesthesia in dogs	CoV&AS, Mannuthy
3.	AD-137/00/00/02/ VC(16)/KAU/PG	Evaluation and management of urolithiasis in dogs	CoV&AS, Mannuthy
4.	AD-123/00/00/03/ VC(16)/KAU	Radiographic evaluation of pyometra and its surgical management in dogs	CoV&AS, Mannuthy
5.	AD-50/00/00/95/ VC(16)/KAU	Surgical Management of Disease of Eye in Canines and Bovines	CoV&AS, Mannuthy
6.		All India Network Programme on Haemorrhagic Septicaemia	CoV&AS, Mannuthy

ii) Externally aided projects : Nil

2. POULTRY AND DUCK

Co-ordinator : Dr. A. Jalaludheen

HIGHLIGHTS

- Phytase and citric acid when fed along with low available phosphorus (P) diet improved growth and feed efficiency of broiler chicken.

SUMMARY

Effect of citric acid and microbial phytase on phosphorus utilization and performance in broiler chicken was studied. Inclusion of 3.0 per cent of either citric acid or phytase (700U/kg feed) or its combination (1.5 per cent citric acid + 350U phytase/kg feed) in low available P diet (0.3 per cent) resulted in better utilization and growth performance in chicks.

The postnatal growth pattern of the preen gland in duck at different ages is being studied to evaluate the relationship, if any, between the morphological and histological parameters of the gland with the age and body weight of the bird.

List of experiments

i) KAU Projects

a) Concluded experiments

Sl. No.	Code No.	Title of the experiment	Location
1.	PD-33/00/00/02/ VC(9)/KAU/PG	Effect of citric acid and microbial phytase on phosphorus utilization and performance in broiler chicken	CoV&AS, Mannuthy

b) Experiments in progress

Sl. No.	Code No.	Title of the experiment	Location
1.	PD-37/00/00/02/ VC(9)/KAU/PG	Effect of dietary iron and supplemental phytase on growth performance and mineral availability in broiler chicken	CoV&AS, Mannuthy
2.		Effect of dietary cation-anion balance (DCAB) on growth and feed efficiency of broiler chicken	CoV&AS, Mannuthy
3.		Growth performance of broiler chicken fed fermented fish waste silage diets	CoV&AS, Mannuthy
4		Post hatch development of preen gland in duck (Anas platyrhynchos)	CoV&AS, Mannuthy

ii) Externally aided projects : Nil

3. ECONOMICS, STATISTICS AND EXTENSION

Co-ordinator : Dr. P.J. Rajkamal

HIGHLIGHTS

- Age and experience were found to be important in the acquisition of knowledge as well as adoption of scientific practices among the elephant keepers and owners of Thrissur and Palakkad Districts.
- Zoo and wild life was the most preferred general subject matter domain for training among the Veterinary Surgeons of Kerala for Continuing Veterinary Education.
- Information technology was the most preferred major subject matter domain for training by the Dairy Farm Instructors (DFIs) of the Dairy Development Department of Kerala.
- Among the eight major domains to identify the training needs of pig farmers of Thrissur district, diseases and prevention was the major subject matter as far as the knowledge and skill aspects were concerned.
- The only weak driving force among the veterinary surgeons of Thrissur district for extension activities under Panchyati raj was the lack of enough youth and women participants in the animal husbandry development projects.
- Significant positive correlations were observed between knowledge and skill attitude and job satisfaction; knowledge and job performance and skill and job performance of the pig farm workers in the organized pig farms of Kerala.

SUMMARY

In the study on the socio-economic profile of the elephant owners as well as the mahouts indicated that these categories were representing distinct socio-economic strata of society. While the owners were socio-economically better, the mahouts were not so and were illiterates. Majority of the elephant owners as well as the mahouts had only low medium or low knowledge of harness practices. For both owners as well as mahouts the knowledge of general management, which included scientific feeding practices, among other practices, was one low. Further majority of the first mahouts were either medium or low adopters of scientific management practices. Age and experience, in general, were found to be important in the acquisition of knowledge as well as adoption of scientific practices. Further knowledge of scientific management and its adoption were correlated. Among the owners, first and second mahout training need of second mahouts was relatively more than that of first mahouts and their training need was more than that of owners. Appropriate training programmes can motivate the owners and mahouts to look after their elephants better thereby assuring their welfare.

A study was made to identify the training needs of veterinary surgeons of Kerala for Continuing Veterinary Education (CVE). The training need was not seen dependent on any socio-personal characteristics of the respondents. Zoo and wild life was the most preferred general subject matter domain for training. The training programmes organized by the various organizations such as KAU, IMG, KLDB, IVRI and CVE programmes proposed by Veterinary Council of India were found to be relevant. An institutional mode of training was preferred for veterinary science, animal production, livestock products technology, zoo and wildlife and information technology. Distance learning was preferred for extension and professional management. Trainers from outside the parent organization were preferred while

organizing training programmes. The venue of training period were institutes within the state in the case of short term training and those outside the state in the case of long term training. The preferred periodicity of short-term training was a year or less, while that for long term training was more than a year. The preferred duration of a short term training leading to a certificate was 15 days and that leading to diploma was 90 days.

The study on identification of the training needs of the Dairy Farm Instructors (DFIs) of Dairy Development Department of Kerala revealed that information technology was the most preferred major subject matter domain for training followed by milk and milk products, dairy cattle production and management, dairy extension, professional management and fodder production and management. Amongst the socio-personal characteristics, the role perception and training need of most of the respondents were found medium where as the training exposure and role perception of the respondents had significant relation with the training need. For all the domain studied, the trainers preferred demonstrational method and institutional type of training by trainers from outside the parent organization but within the state, which lasts for 1 to 7 days in the case of short-term trainings and 15 days to 1 month in the case of long-term trainings. An equal percentage of theory and practical training sessions in the training institutes within Kerala were preferred for all the domains except milk and milk products technology and information technology which needed more practical sessions and training in selected premier institutes outside of Kerala.

Training of pig farmers of Thrissur district revealed that most of the pig farmers were marginal farmers, middle school educated and of medium income group who rear exotic breeds located in the homestead, feeding them with hotel and butchery wastes and depend on other farmers for information about pig farming. Among the eight major domains to identify the training needs of pig farmers, diseases and prevention was the major subject matter as far as the knowledge and skill aspects were concerned which was followed by housing, breeding, management, integrated farming, marketing and economics of pig farming etc. It was also recognized that they need training in minor farm operations like deworming, vaccination, scientific construction of cage, selection of animal for breeding, disposal of excreta and waste, marketing and loan for pig farming. Pig farmers preferred one day training at Veterinary College pig farm and training through print media and electronic media.

Force field analysis of the work environment of veterinary surgeons of Thrissur district for extension activities under Panchayati raj revealed that the only weak driving force was the lack of enough youth and women participants in the animal husbandry development projects. More strong inhibitory forces were delayed clearance of projects, delayed funding, delayed and defective beneficiary selection, lack of proper arrangement for training development staff, inability of Panchayat authorities in decision making and inadequate monitoring and evaluation. The results of the study indicated general dissatisfaction of the veterinary surgeons with the prevailing work environment to perform extension work.

Study on organizational behaviour of farm workers as antecedent to the performance of pigs in organized pig farms revealed significant positive correlations were observed between knowledge and skill; attitude and job satisfaction; knowledge and job performance and skill and job performance. Absenteeism had significant negative correlation between job performance. A significant negative correlation was found between attitude towards the job and stillbirth per litter. Farm worker's skill and knowledge had significant negative correlation with pre-weaning mortality, skill had positive correlation with conception rate and job satisfaction has significant negative correlation with weaning weight and weight gain of

piglets. Absenteeism had positive correlation with pre-weaning mortality and mortality of pigs.

Analysis of the data on the milk yield of cows in the field areas have shown that the average milk production of cows reared by the farmers is 1800 kg in a standard lactation period. But the daughters of the bulls of the scheme had produced 2300 kg milk in a lactation showing their production potentials is 500 kg more than their contemporaries born from other bulls in the field. It was observed that land holding size, educational status and occupation of the farmers did not influence the milk yield. Utilizing the data on the milk yield of cows in the field, prediction factors had been developed for estimating lactation milk yield based on a single day milk yield in any stages of lactation and this has got a lot of practical application in predicting lactation yield under field conditions.

Attappady block panchayath consists of 37 wards, 17 in Agali and 10 each in Sholayur and Pudur village panchayaths. Seven wards were randomly selected from each village and survey was conducted in these 21 wards for complete enumeration of the demographic distribution of the breed using the questionnaire provided by the National Bureau of Animal Genetic Resources. Totally 9207 households were surveyed out of which goats were maintained only in 134.40% of households (1234). General information about the households, management practices and animals maintained were collected from these 1234 households.

The overall total goat population in the Attappady block was estimated to be 23346, and among them only 9351 (40.1%) were Attappady black goats. As the name indicates the colour of these goats is pure black and their eyes are bronze colored. The average birth weights of male and female kids were 1.7 and 1.6 kg. Even though these goats were raised purely on grazing without giving and concentrate feed, their body weight performance was quite comparable to that of any meat breed in India. At about one year, males weighed 26 kg and females weighed 23 kg and the mature male and females about 18 months of age weigh around 35 and 30 kg, respectively. Body measurements of various age groups showed that height at rump was more than their height at withers. They kidded at the age of 13.5 months and thereafter at 8 months intervals. The average litter size was 1.04 for the first kidding but in subsequent parities the average litter sizes were 1.5. Average milk yield was found to be low (1780 ml per day) hardly sufficient for their kids. These black-colored goats are having all the potentials to be developed as an excellent meat breed. The uncontrolled natural breeding of the female goats either by the scrub or non-descript bucks leads to the dilution of the breed at a faster rate. Since the total number of Attappady black goats is less than 10,000 they come under the insecure category. Therefore every effort should be taken to conserve this valuable germplasm of the state.

List of experiments

i) KAU Projects

a) Concluded experiments

Sl. No.	Code No.	Title of the experiment	Location
1.	EE-16-00-00/99-VC(6)/KAU/PG	Profile of elephant keepers and owners of Thrissur and Palakkad districts	CoV&AS, Mannuthy

2.	EE-15-00-00/99-VC(6)/KAU/PG	Analysis of the training needs of veterinary surgeons of Kerala for continuing veterinary education	CoV&AS, Mannuthy
3.	EE-17-00-00/2000-VC(6)/KAU/PG	Identification of the training needs of the dairy farm instructors (DFIs) of dairy development department of Kerala	CoV&AS, Mannuthy
4.	EE-14-00-00/2000-VC(6)/KAU/PG	Training of pig farmers of Thrissur district	CoV&AS, Mannuthy
5.	EE-19-00-00/2001-VC(6)/KAU/PG	Work environment of veterinary surgeons of Thrissur district for extension activities under Panchayati raj	CoV&AS, Mannuthy
6.	EE-18-00-00/2001-VC(6)/KAU/PG	Organisational behaviour of farm workers as antecedent to the performance of pigs in organized pig farms	CoV&AS, Mannuthy

b) Experiments in progress

Sl. No.	Code No.	Title of the experiment	Location
1.	EE-20-00-00/2002-VC(6)/KAU/PG	Training needs of dairy women of Thrissur Taluk in dairy and poultry farming	CoV&AS, Mannuthy

ii) Externally aided projects : Nil

4. CATTLE AND BUFFALO

Co-ordinator : Dr. Kunjukutty

HIGHLIGHTS

- Energy supplementation at different levels did not improve growth rate or feed efficiency in crossbred heifers.
- A crude protein level of 17% with 25 % of protein as undegradable was sufficient for crossbred lactating cows producing 7 to 8 liters of milk per day.
- Mineral availability from grass based and straw based lactation rations was studied and found that only calcium need be supplied in diet. Phosphorus, Mg, Cu and Zn requirement can be met from the feed ingredients.
- Dried yeast culture did not improve growth of pre-ruminant calves.
- Feeding of complete feed to calves improved the feed conversion efficiency, growth rate and carcass characteristics.
- Bakers yeast and Potassium diformate when incorporated in the ration improved growth and feed efficiency of growing pigs.
- Dried cuttle fish waste silage can be used to replace dried fish in the diet of growing pigs.
- Prawn waste can used to supply 50% of the protein requirement of the grower and finisher rations for Large White Yorkshire pigs.
- Animal fat added at 15% over and above their standard ration during late gestation and lactation improved the performance of sows and the litter.

SUMMARY

In a study on the effect of energy supplementation on growth of heifers conducted in crossbred heifers it was observed that there was no significant effect on the growth rate or feed efficiency by supplementing energy at different levels in the diet.

Supplementation of dried yeast culture (Neutramix-MDY) to pre-ruminant calves had no statistically significant effect on animal performance.

Feeding of complete feed to calves improved the feed conversion efficiency, daily body weight gain, had better carcass characteristics like dressing percentage, meat yield and meat-bone ration and better and more economical.

In the case of crossbred dairy cattle of Kerala, having a peak daily production of 7-8 kg milk a dietary protein level of 17 per cent in the concentrate mixture (13 per cent in the ration) with 25 per cent of the protein as rumen undegradable protein is sufficient and economical.

A study on the assessment of dietary level of minerals for lactation in crossbred cows in Kerala under different feeding systems was done. NRC (1989) requirements of Ca, P, Mg, Cu, and Zn is applicable to crossbred lactating cattle of Kerala under both grass and straw based feeding system. It is also inferred that the requirement of P, Mg, Cu and Zn can be met from their content in the feed ingredients and Ca is the only element that needs to be supplemented under both the feeding systems.

Nutritive evaluation of prawn waste for growth in Large White Yorkshire pigs showed that prawn waste can be used economically to replace the protein of the grower and finisher rations for Large White Yorkshire pigs up to 50 per cent level.

Study on the influence of rendered fat in the diet of Large White Yorkshire sows on the litter performance showed that rendered animal fat, as an energy source for Large White Yorkshire sows, can be added extra at 15 per cent level of the standard ration during late gestation and

lactation to improve the performance of sows and the litter to have a better economics of gain.

Baker's yeast can be included at 0.5 per cent level in the diet for growing pigs for better growth and feed conversion efficiency and live yeast culture can be used as an alternative feed additive to antibiotics in swine production.

Potassium diformate can be economically incorporated at 1.5 per cent level in the diet of Large White Yorkshire pigs

Dried cuttle fish silage can be used economically as a substitute for unsalted dried fish in the ration for growing and finishing pigs without any adverse effects.

The field progeny-testing scheme, funded by the ICAR has been functioning in the Centre for Advanced studied in Animal Genetics and Breeding since 1992 with simultaneous objective of evaluating of highly pedigreed crossbred bulls based on the milk yield of their daughters under field conditions and increasing the milk yield of the cows reared by the farmers. This is a part of the coordinated research project of the Cattle Project Directorate of ICAR to study the effect of genotype-environment interaction on milk yield based on the information from different agro-ecological conditions of Kerala, Punjab and Maharashtra and to select the best breeding bulls on a national basis. So far five batches of bulls have been tested and evaluation reports of the first three sets of bulls have been sent to the ICAR. The sixth set of bulls is under testing in the field. Now the scheme is running with the co-operation of farmer's milk societies at Avannur, Chuvannamannu, Chempamkandam, Marottichal and Puzhakkal areas of Thrissur district.

Attappady Black goats are found exclusively in Attappady area of Palakkad district and popularly known as the goats of tribes in Attappady. But this class is still not recognized as a breed despite their unique characteristics for want of breed descriptors. Recently the Centre for Advanced Studies in Animal Genetics and Breeding completed a study on survey and characterization and evaluation of Attappady black goats as a part of network of National Bureau of Animal Genetic Resources, ICAR with the objective of developing breed descriptors for the Attappady goats. This study will help in strengthening the position of Kerala in the breed map of the country.

The developmental pattern of the brain in goat at different stages of prenatal life is being studied to establish a standard to compare the normal and abnormal development and to determine the relationship if any, between the cranial size and brain size.

The morphogenesis and histogenesis of spinal cord at different stages of prenatal life in goats is being studied to establish a standard growth pattern to be used while studying the teratological factors.

List of experiments

i) KAU Projects

a) Concluded experiments

Sl. No.	Code No	Title of the experiment	Location
1.	CB-39/00/00/99/ VC (9)/KAU/PG	Effect of energy supplementation on growth of heifers	CoV&AS, Mannuthy
2.		Evaluation of complete feed for meat production in calves	CoV&AS, Mannuthy
3.	CB-42/00/00/99/ VC (9)/KAU/PG	Effect of supplementation of dried yeast (Neutramix MDY) on growth performance of pre-ruminant calves	CoV&AS, Mannuthy

4	CB-28/00/00/99/ VC (3)/KAU/PG	Effect of level and degradability of dietary protein on lactation on early lactation in crossbred cows	CoV&AS, Mannuthy
5	CB-28-00-02-99/ VC (9)/ICAR/PG	Assessment of dietary level of minerals for lactation in crossbred cows in Kerala under different feeding systems	CBF, Thumburmuzhy
6	SE-10/00/00/93/ VC/ICAR	Influence of different levels of energy on growth performance of crossbred pigs	CoV&AS, Mannuthy
7	SE-24/00/01/99/ VC(9)NATP/PG	Nutritive evaluation of prawn waste for growth in Large White Yorkshire pigs	CoV&AS, Mannuthy
8	SE-24/00/05/2000/ VC(7)ICAR-NATP/PG	Influence of rendered fat in the diet of Large White Yorkshire sows on the litter performance	CoV&AS, Mannuthy
9		Effect of dried cuttlefish (<i>Sepia officinalis</i>) waste silage on the growth in crossbred (Large White Yorkshire X Desi) pigs	CoV&AS, Mannuthy
10	SE-24/00/07/02/VC(9) ICAR-NATP/PG	Effect of bakers yeast on growth and nutrient utilization in cross bred pigs	CoV&AS, Mannuthy
11	SE-24/00/08/02/VC(9) ICAR-NATP/PG	Effect of dietary potassium diformate on growth performance in Large White Yorkshire pigs	CoV&AS, Mannuthy
12	GR-19/00/00/99/ VC(9)/KAU-PG	Effect of Monensin supplementation on growth and bioavailability of minerals in kids	CoV&AS, Mannuthy
13		Effect of varying levels of dietary Magnesium on growth and mineral bioavailability in goats	CoV&AS, Mannuthy

b) Experiments in progress

Sl. No.	Code No.	Title of the experiment	Location
1	CB-46/00/00/02/ VC(9)/KAU/PG	Effect of replacing dried fish with lysine and methionine on the growth performance	CoV&AS, Mannuthy
2		Effect of varying levels of dietary calcium on the performance and mineral availability in dairy cattle	CoV&AS, Mannuthy
3		Effect of urea as a source of rumen degradable protein on the milk production of crossbred cows in early lactation	CoV&AS, Mannuthy
4		Utilization of urea in different stage of rumen development in the early weaned calves	CoV&AS, Mannuthy
5	GR-23/00/00/2000/ VC(1)/KAU/PG	Prenatal development of brain in goats (<i>Capra hircus</i>)	CoV&AS, Mannuthy
6	GR-24/00/00/2000/ VC(1)/KAU/PG	Prenatal development of spinal cord in goats (<i>Capra hircus</i>)	CoV&AS, Mannuthy

ii) Externally aided projects

- a) Concluded experiments : Nil
b) Experiments in progress

Sl. No.	Code No.	Title of the experiment	Location
1.	CB-28/00/00/94/ VC(9)/PG/AICRP	Improvement of feed resources and nutrient utilization in raising animal production	CoV&AS, Mannuthy
2.	NATP	Development of value added products and byproducts from low cost fish and processing waste from fish and shell fish	CoV&AS, Mannuthy



Part - III

Faculty of Fisheries

FISHERIES

Co-ordinator :

HIGHLIGHTS

- The highly priced freshwater ornamental fish, sucker cat fish, could be successfully bred in earthen suitable habitat conditions. A protocol for breeding of the pearl gourami was developed.
- Prawn head meal based diet produced the highest growth rate for the culture of the fishes *Labeo rohita* and *Cyprinus carpio*. Best percentage of growth and survival of fish was obtained by using test diet with 20% soya bean inclusion level containing 27% crude protein.
- Monoculture of the giant freshwater prawn *Macrobrachium rosenbergii* with single stocking and drain harvest yielded a production of 903 kg/ha/6 months with a retrieval rate of 60%.
- Biofilm produced by bamboo for culture of *Macrobrachium rosenbergii* gives appreciable growth enhancement and survival.
- Cage and pen fish culture in open waters like Vembanad lake is found to be commercially viable than pond fish culture. Small sized pens allow higher fish yield and lower production cost and easier management, although cost per unit area will be higher.
- A fish sanctuary (10 ha) in the Vembanad lake for the indigenous fish species was established to promote natural habitat, breeding and also for in situ conservation and to evolve technologies for fish ranching through artificial stocking of fast growing fish and giant fresh water prawns.
- In the ranching studies, tagged prawns were monitored through collections from capture fishery. The released prawns attained a maximum size of 350gm in the first year. Maximum distance travelled was 30 km.
- Study of pesticides on the juveniles of rohu *Labeo rohita* (Ham.) showed that chlorophenoxy herbicide was moderately toxic, organophosphate (malathion and methyl parathion) was toxic and endosulfan was very toxic. The insecticide-weedicide combinations were strictly additive toxic. The insecticide pairs (methyl parathion and malathion, malathion and endosulfan) showed more than additive toxicity, especially the malathion and endosulfan combination.
- A male reproductive pheromone, from testis/vas deferens of *Macrobrachium idella* (Hilgendorf) was seen to be essential for normal ovarian maturation of females and in the absence of this male pheromone ovarian maturation gets arrested at the state IV at which stage massive yolk deposition usually starts.
- Large number of animals were collected from Cochin backwaters as a part of the study on the benthic invertebrates. 32 species which include polychaetes, lamellibranchs, gastropods, scaphopods, amphipods, isopods and tanaidacean were identified.
- In Cochin region, infestation with bopyrid isopod, which causes damage to fishery, was observed only in 2 species of *Macrobrachium* namely *M. idella* and *M. scabriculum*.
- Captive breeding technology was developed for the ten prioritized species of indigenous ornamental fishes such as *Puntius flamentosus*, *P. melanampyx*, *P. melanostigma*, *Danio malabaricus*, *Garra mullya*, *Nemacheilus triangularis*, *Pristolepis marginata*, *Rasbora daniconius*, *Esomus danricus* and *Puntius sarana*

- The biodiversity of prawns of Kerala consists of 14 species of *Macrobrachium*, one species of *Palaemon*, two species of *Leptocarpis*, four species of *Caridina* and four species of *Macrobrachium*.
- The region around Panangad in Vembanad lake and tidal section of rivers, a partially mixed estuary during post monsoon season becomes well mixed type during pre-monsoon. Maximum primary production was seen during post monsoon. On comparing the fishery potential estimated from primary production with the available fishery data it appears that there is scope for increasing fish catch within sustainable limit. Copepods were the dominant group in the zooplankton and higher benthic production was seen during post monsoon season.
- From the processing wastes of squid and cuttlefish bioactive substances like anti-bacterial, anti-viral and anti-cancer substances have been determined.
- Solar tent and solar cabinet driers for drying fish without contamination and a technology for curing fish using irradiated salt for controlling spoilage were developed.
- Products such as prawn stick, prawn cutlet and value added paste products like fish cake, fish ball, burger, sausage, ham and fish paste were developed from low cost fresh water fishes.
- Silt laden turbidity of water directly and indirectly hinder the gonadal maturity of *Penaeus indicus* in coastal wetland grow outs.
- In monoculture, limited manuring and application of frugal quantity of eco-friendly feed containing 20-25% crude protein can substantially promote growth and production of *Liza parsia* @ 1.4 t/ha/yr which is a finding that would have such desirable impact on brackish water fish farming.
- In monoculture of *Chanos chanos*, application of eco-friendly feed at optimum dose and frugal quantity of manuring could enhance mean growth @ 348 g achieving an appreciable production of 1.8 ton/ha/yr.
- Developed an eco-friendly management technique to effectively maintain disease free brood stock specimens of *Penaeus indicus* in wetland grow-outs.
- Strategic application of formulated and compounded diets of nutritional efficiency is found to enhance the growth of *P. indicus* in experimental growouts.
- Biculture between *Lates calcarifer* and *Oreochromis mossambicus* (Tilapia) @ 5000/ha in 1:5 ratio in grow-outs, enabled to attain optimum growth in both species ensuring the production of 2 ton fish/ha/crop.

SUMMARY

Larval rearing diets are an important aspect in ornamental fish culture to obtain high survival rates. Weaning diets using single cell protein source was developed for the larvae of pearl gourami, blue gourami and angle fish which can replace live feed diet.

Low cost protein sources were used to formulate feeds for commercially important species of carps. Viz. *Cyprinus carpio* and *Labeo rohita*. Prawn head meal based diet favored high growth rate in *Cyprinus carpio* and *Labeo rohita* compared to silkworm pupa and squilla based diets. The growth rate of *Cyprinus carpio* was seen to be 3.02g/day and that of *L. rohita* was 2.5g/day with retrieval rates of 75-79%, when fed on prawn head meal based diet.

The Giant freshwater prawn *M. rosenbergii* was cultured in various systems to evaluate the growth, survival and production potential. Monoculture of the species with single stocking and drain harvest yielded a production of 903 kg/ha/6 months with a retrieval rate of 60%.

Nursery rearing of *M. rosenbergii* in small enclosures during the water scarcity period followed by transfer to large areas consequent to the onset of monsoon was found to be feasible in coastal areas where there is acute scarcity of freshwater in summer months.

Bamboo strip substrate based bio-film was found to give appreciable growth enhancement and survival for *M. rosenbergii*, when compared with the substrates like sugarcane bagasse, and paddy straw.

In Western ghats region seven species of fish were found to be endangered. These are *Horabagrus brachysoma*, *Labeo dussumieri*, *Clarias dussumieri*, *Gonoproktopterus curmuca*, *Etroplussuratensis*, *Channa micropeltes*, *Wallago attu*. Breeding protocols were developed for the five species. Viz. *Horabagrus brachysoma*, *Labeo dussumieri*, *Clarias dussumieri*, *Gonoproktopterus curmuca*, *Etroplussuratensis*. Also cryopreservation techniques of two species viz. *L. dussumieri* and *H. brachysoma* were accomplished. A river watch programme and awareness campaign named *Meenachil Fish Count – 2004* was conducted. Standardization of captive breeding and seed production protocols of *G. curmuca* was accomplished in low land conditions away from their natural habitat.

Cage and pen culture in open water was done and small cages were found to be more efficient. The accepted cage depth is generally 2-4m and the cage bottom should be always 50 cm above lake bottom.

Under pen culture, fish is contained in by a netting or fencing fixed on the lake floor, so that the bottom of the lake forms the pen bottom. The polyculture of Indian major carps viz. catla - rohu, mrigal and pearl spot was taken up in double walled rectangular pens of size 800 m² where as monoculture of pearl spots was undertaken in single walled circular pens. Yields was 7900 kg/ha for carps and 2011 kg/ha for pearl spot.

In ranching studies, recovery of tagged prawns was monitored and collections from the capture fishery 36 fish species were found frequent in the commercial catches. *Channa* sp was the most dominant (32.1%) component in the wet land catches.

Arrest of ovarian maturation in female *Macrobrachium idella* reared in isolation from males pointed towards the presence of a male pheromone, which is essential for the normal ovarian maturation. The presence of a male pheromone was confirmed in *M. idella*. It was also found that the testis and vas deferens were the tissue sources for this pheromone.

In the natural ecosystem, fishes are exposed to several biocides or contaminants at a given time. So a study was carried out to understand the individual (48 h. LC₅₀) and combined (additive index and magnification factors) toxicity of 4 common pesticides- malathion and methyl parathion (organophosphate insecticides) endosulfan (organochlorine insecticide) and 2,4-D (chlorophenoxy herbicide) under laboratory conditions. The test animals used were the juveniles of rohu, *Labeo rohita*. The additive index values and the magnification factors for the combined toxicity were calculated for the different toxicant pairs based on the method of Marking (1977). Individually 2,4-D is 'moderately toxic', malathion and methyl parathion are 'toxic' and endosulfan is 'very toxic'. The insecticide - weedicide combinations showed "strictly additive" toxicity. The sequential or even simultaneous application of these pesticides in the paddy fields and plantations increase many fold the potential for pollution of these chemicals if leached in the freshwater and coastal ecosystems of the state.

An identification manual for the common benthic invertebrates of Cochin backwaters will be very useful to the students, teachers and researchers. As part of a KAU research project, survey and collection of benthic invertebrates from Cochin backwaters were made. 32 species were identified which included polychaetes, lamellibranchs, gastropods, scaphopods, amphipods, isopods and tanaidacean.

Species specificity and biology of bopyrid isopod infestation of prawns of the genus *Macrobrachium* of Cochin region was studied. Out of the 5 species occurring in Cochin backwaters and middle reaches of periyar river only 2 namely *M. idella* and *M. scaberrimum* are found to be infested with bopyrid isopod *Palaegyge alcocki* which causes damage to the fishery. Peak period of infestation, intensity of infestation of biological studies such as length-weight relationship, fecundity and larval life cycle have also been studied.

As part of the All India NATP project on germplasm inventory evaluation and gene banking of freshwater fishes, 80 indigenous ornamental fishes were collected from the western ghats and acclimatized in the captive conditions. Captive breeding technology for prioritized species of ornamental fishes from the western ghats was developed. This include *Puntius filamentosus*, *P. melanampyx*, *P. melanostigma*, *Danio malabaricus*, *Garra mullya*, *Nemacheilus triangularis*, *Pristolepis marginata*, *Rashora daniconius*, *Esomus danricus*, and *Puntius sarana*. Popularisation of these technologies among ornamental fish traders and farmers is another objective.

The ICAR project on biodiversity survey of Palaemonid prawns of Kerala and studies on the biology of *Macrobrachium latimanus* (von Martens, 1868) was carried out. 14 species of *Macrobrachium*, one species of *Palaemon*, two species of *Leptocarpus* and four species of *Caridina* were collected. Out of this four species of *Macrobrachium* are new record. A new species was found to have ornamental value with potential for introduction into aquarium. A Biodiversity Museum was being established and have been collected about 40 species of prawns from different parts of India.

A multiplicative model was developed to establish relationship between various parameters, such as, biomass, stocking density, area, growth, time and survival. The model is suitable for single and multi-species situations. A method for finding out the confidence limits of the parameters used in the model has been developed. Modified indices for feed consumption assessment also are developed based on the available indices.

Monthly data on eco-biology and primary production were collected from selected stations from the region around Panangad in the Vembanad lake. In addition, 13-hour tidal cycle observations were made at 2 locations in different seasons. Tidal propagation from Kochi upto Thanneermukkam bund was studied during monsoon and fear weather seasons by collecting half hourly/one hourly water level data from eight locations. Hemeomic analysis was brought out the relative predominance of different tidal components during different season. It appears that Thanneermukkam bund creates resonance. During the final phase of the project, observations were carried out along the main arm of Vembanad lake, on the south of Kochi during pre-monsoon period, at seven different cross sectional transects for complete tidal cycle.

In the project 'production of bioactive substances from squid and cuttle fish waste' antiatherogenic activity of cuttlefish liver oil was demonstrated by rat feeding studies. A peptidoglycan, purified from cuttlefish ink by ion-exchange chromatography and gel filtration showed antitumour activity against DLA in BALB/c mice. Feeding a low dose of cuttlefish liver oil could stimulate immune function, inhibit inflammatory response and platelet aggregation in rats.

Under the project 'Consumer amenable technology upgradation for prevention of losses to dried, cured and smoked fish' solar tent and solar cabinet driers were developed for drying fish with minimum loss. Developed a technology for curing fish using irradiated salt to

control halophilic spoilage organisms and insects. Fabricated an ultra violet cabinet for storage of dried and smoked fish products to prevent losses due to fungi and molds.

Under the project "Development and value added products from the meat of the undersized freshwater prawns" value added products like prawn pickle was made using standard recipe available. Value addition was also done by developing products such as prawn stick, prawn outlet. Prawn pickle has a shelf life of six months under ambient temperature.

From low cost freshwater fishes such as mrigal, silver carp and tilapia paste products such as fish cake, ball, burger, sausage, ham and paste were developed. Storage studies showed that the quick frozen products could be stored for more than 4 months, slow-frozen for 2-3 months, chilled for two weeks and vacuum packed and chilled for 3 weeks and canned for over 6 months. Consistometer an instrument for viscosity measurement of paste and a penetrometer for texture determination of products were fabricated.

List of experiments

i) KAU Projects

a) Concluded experiments

Sl. No.	Code No	Title of the experiment	Location
1	F1-Aqua-1.61/99-PGD/KAU	Investigations on the breeding of sucker catfish (<i>Hypostomus plecostomus</i>), Koi carp (<i>Cyprinus Carpio</i>) and Pearl Gourami (<i>Trichosaster leeri</i>)	CoF, Panangad
2	F1-Aqua-1.62/99-PGD/KAU	Effect of dietary incorporation of single cell protein (SCP) on the growth and survival of Pearl Gourami (<i>Trichosaster leeri</i>) blue gourami (<i>Trichosaster trichogaster</i>), angel fish (<i>Pterophyllum scalare</i>)	CoF, Panangad
3	F1-Aqua-1.63/00-PGD/KAU	Utilisation of low cost protein source in the feed formulation of cyprinus carpio and <i>L. rohita</i> .	CoF, Panangad
4	03/01-00-02/ PGD (F.Biol)/KAU/PG	Individual & combined lethal toxicity & pesticide combinations on the juveniles of rohu <i>Labeo rohita</i> (Ham.)	CoF, Panangad
5	F2-FB-1-10/2001-PGD-KAU/PG	Role of a putative male pheromone in the ovarian maturation of the freshwater prawn <i>Macrobrachium idella</i> (Hilgendorf).	CoF, Panangad
6	FT/01-0-0-2000/PGD(P.Tech)/NATP	Development of value added products from the meat of the undersized freshwater prawns.	CoF, Panangad

b) Experiments in progress

Sl. No	Code No.	Title of the experiment	Location
1	F1-Aqua-1.73/99-PGDKAU	Development of farming technologies for the giant freshwater prawn <i>Macrobrachium rosenbergii</i>	CoF, Panangad
2	F1-Aqua-1.76/99 PGD KAU	Development of environmental feeds for carps and ornamental fishes.	CoF, Panangad
3	Plan Projects 262-25-2201.	Use of substrate based bio-film for enhanced production of carps and prawn.	CoF, Panangad
4	262-35-2280	Reproductive performance of <i>Macrobrachium rosenbergii</i> female in captivity.	CoF, Panangad

5	262-25-2235	Domestication and varietal development of ornamental fishes of current commercial importance.	CoF, Panangad
6	262-34-3381	<i>In vitro</i> studies on the effect of the active components of selected plants and aquatic algae in inhibiting bacterial and viral pathogens of fin fish/Shell fish.	CoF, Panangad
7	FB/02/-00-00-2003/PGD(FB)-/KAU/PG	Infestation of isopod parasites in prawns of the genus <i>Macrobrachium</i> Bate, 1868 (Palaemonidae) of Cochin region.	CoF, Panangad
8	F3-FH-104/99 PGD-KAU	Studies on the benthic invertebrates of the Cochin backwaters.	CoF, Panangad
9	F5-mgt-1.03/99 PGD-KAU	Developing mathematical models in aquaculture systems.	CoF, Panangad
10	F1-Aqua.1.73/ 2000 PVP-KAU	Formulation and use of eco-friendly feed in brackishwater fish farming.	FS, Puduveypu
11	F1-Aqua.1.74/ 2000 FPV-KAU	Farming prospects of carnivorous fishes.	FS, Puduveypu

ii) Externally aided projects

a) Concluded experiments

Sl. No.	Code No.	Title of the experiment	Location
1	F11 No.4(8)/96-ASRI. ICAR	Fish culture in cage and pen enclosures in Vembanad lake.	RARS, Kumarakom.
2		Fish ranching and open water fishery management in Vembanad lake.	RARS, Kumarakom.
3	RIC(05)/01-00-00-01/ PGD(Fhyd)/ICAR.	Studies on circulation and mixing and their influence on productivity of Panangad region of Vembanad lake.	CoF, Panangad
4	FT/01-00-00-00-2001/ PGD(P.Tech)/NATP	Production of bioactive substances from squid and cuttlefish processing waste.	CoF, Panangad
5		Consumer amenable technology upgradation for prevention of losses to dried, cured and smoked fish.	CoF, Panangad
6	FT/01-0-0-2000/ PGD(P.Tech)/NATP	Development of paste products from low cost fresh water fishes.	CoF, Panangad
7	F.NATP/AEP(A&H)/P SR/99	Shrimp and fish brood stock development and breeding under captive conditions.	CoF, Panangad

b) Experiments in progress

Sl. No.	Code No.	Title of the experiment	Location
1	F.No.27(28)/98 NATP/MM-III-18	Germ plasm inventory, evaluation and gene banking of freshwater fishes.	RARS, Kumarakom.
2	F.No.27(77)/03 NATP/ MM-III-68	Modernisation of instructional fish/Shrimp farm.	CoF, Panangad
3	FB/01/00-00-2000/ PGD (FB)NATP	Germ plasm Inventory, evaluation and gene banking of freshwater fishes – Developing technology for the captive breeding of indigenous ornamental fishes.	CoF, Panangad
4	FB/01-00-00-2002/ PGD (FB) ICAR	Biodiversity survey of Palaemonid prawns of Kerala and studies on the biology of <i>Macrobrachium latimanus</i> (von Martens, 1868)	CoF, Panangad



Part - IV

**Faculty of
Agricultural Engineering & Technology**

AGRICULTURAL ENGINEERING AND TECHNOLOGY

HIGHLIGHTS

A. Farm Power Machinery and Energy

- A self centering basin lister attachment to power tiller, tractor or bullocks was developed for making a basin of 2 m radius in 2 –3 minutes.
- Tractor operated ditcher cum bed former was developed to make a ditch of 86.7 cm width, 17.75 cm depth and two half beds each of width 34 cm on either side. The equipment can cover 2.5 ha per day at about Rs.2000/-.
- A light-weight, direct driven weeder (Micro tiller) with field capacity of 0.024 ha/hr was developed to clear weeds even where clods/stones exist. The working diameter of the cutting blades is 0.42 m.
- A large diameter pit digger was formulated to take a pit of size 80 cm deep and 100 cm diameter at the top in nearly 3 minutes.
- The rotary coconut-husking machine was redesigned and refined. The concept of continuous rotary husking was introduced in this machine for the first time. The machine gave 400-600 nuts/hr.
- The power operated coconut climber was redesigned and refined which reduce the cost of harvesting to half and also avoids falling from the tall trees.
- An integrated composite anthropometer is designed for quick and reliable collection of anthropometric data.
- A work load classification is brought out for the female workers of Kerala viz. operations requiring energy expenditure less than 6kJ/min are found to be light, 6 kJ/min-12 kJ/min moderate, 12 kJ/min -18 kJ/min heavy and above 18 kJ/min unduly heavy for the target group.
- Energy expended by the workers for performing some common agricultural tasks involves in the paddy production process were estimated. Weeding (15.7 kJ/min), transplanting (14.89 kJ/min) and harvesting (13.64 kJ/min) were found to be the tedious among the operations considered.
- Several trainings on the operation and maintenance of agricultural machinery, spanning from 10 to 30 days were given to female agricultural workers of the region. Women were trained on the operation and minor maintenance of agricultural machinery like tractor, power tiller, transplanter, bush cutter, sprayer, pump vertical conveyor reaper and thresher under this initiative.
- Nine female workers, trained under the project, could obtain license for driving tractors and the women trained under the project are forming co-operative groups. Two groups are already registered under the names "*Sthree Shakthi*" and "*Vanitha Shakthi*"
- Mitsubishi power tiller with air-cooled engine for mounting it with reaper assembly was delivered to Kerala Livestock Development Board and the machine was redesigned after incorporating the suggestions by KLDB. This fodder harvester was fabricated in the college workshop and it was delivered to Dhoni farm with a view to substitute the costly imported machines.
- A counter weight type climber was fabricated with a weight of 50 kg permanently installed on the top of the palm and a sliding mechanism with foot-rest connected each

other with a steel wire rope was fabricated. It took 15 seconds to go up and come down in 4.5 m palm and 3 minutes of preparation.

- A powered coconut climber was developed and it consisted of mainly four rubber wheels fixed on two shafts, which were mounted on a frame. The power source for the up and down movement of the equipment was a 1 HP A.c motor of 2800 rpm reduced to 44 rpm using gear-box. The machine worked well but its weight was very high (103kg).
- A nut splitting machine was developed which consists a pedestal, pivoted long handle, cutting knife and a platform. The knife was raised by lifting the handle, the kernal was placed on the platform and then the knife was lowered and forced to cut the kernal.
- The design, development and field evaluation of low cost transplanting mechanism for paddy by employing the crank and oscillating link mechanism with a seedling pusher attached with inertia force exerted by a sliding mass was completed. The total cost of transplanter can be reduced by 30%.
- The six types of paddy transplanters viz, Yanmar, Kukje, Asia, Tong Yang, and Yanji from Japan, Korea and China were evaluated in farmer's fields and comparative studies were done.
- The riding type paddy transplanters were popularized through trained youths. Studied the extent of use of paddy transplanters (12 nos.) in Palakkad district.
- Comparative evaluation of TNAU 0.75 m, KAMCO KR 120, Vardaan, Power tiller mounted 1.6 m and tractor mounted 2.2 m paddy reapers were done in farmer's fields.
- The evaluation of Korean mini tiller with tilling rotor, miracle rotor, ditching rotor, hammer rotor, plough and reaper was done.
- The study to find out mechanization gap was conducted for Kottayam, Idukki and Palakkad districts and suitable farm machinery were identified.
- Extensive front line demonstration of 13 different machinery were taken up at farmer's field.
- Due to scarcity of water, it was not possible to adopt transplanters in eastern parts of Palakkad. In this area, tractor mounted 9 row cup feed paddy seeders with a field capacity of 0.46 ha/hr, field efficiency of 72 per cent, plant population of 62 hills/sq.m and 2-3 seedlings/hill were introduced and evaluated in 37 ha..
- Use of Yanji transplanter resulted in saving of 80 per cent labour, 56 per cent cost, 40 per cent time, 30 per cent seed paddy and 20 per cent increased yield. After transplanting with Yanji transplanter the cono-weeders are found effective for weeding and invariably it is used by farmers.
- Mini tiller with tilling rotor having 62.5 cm width and up to 20 cm working depth with 14 rotory blades is found suitable for cutting and leveling dry fields and also for wet fields.
- The miracle rotor is found effective to loosen the top soil in the coconut/arecanut fields.

B. Soil and Water Engineering

- Coir geotextiles can be very effectively used for conserving soil and water in varying slopes and for slope land cultivation.
- Fertigation studies in Nendran showed that water use efficiency and yield were higher with 80 per cent of the recommended fertilizer dosage.

- Crop geometry experiments in banana (Nendran) revealed that water use efficiency and benefit cost ratio were maximum for the treatment with three suckers per pit at 4 m x 3 m spacing.
- Off-season cultivation of tomato inside rainshelter was a success and productivity of tomato was higher by about 3.5 times than outside in the same season.
- Plastic mulching significantly increased the growth and yield of vegetables like bhindi, brinjal, amaranthus etc.
- Full potential of N efficiency can be realized only in conjunction with drainage.
- The density of open drains is not adequate to get the desired sub soil leaching and the open drainage density cannot be increased due to consequent loss of cultivable area and maintenance problem.
- The performance of clay tile drains are better than PVC drains even though mean port opening area is more in PVC drains. This is due to the thin slot width of the PVC drains that are clogged due to iron sludge deposition.
- The crop growth parameters, the grain yield and 100-grain weight were significantly higher when subsurface drainage was provided.
- Drain spacing up to 30 m could significantly improve the productivity of the area and the overall increase in rice yield due to subsurface drainage is 1.36 t/ha.
- Subsurface drainage could remove the heterogeneity in the soil chemical properties, which is the root cause for patchy crop growth and uneven ripening of rice crop in the Karumady area.
- Subsurface drainage was very efficient in leaching iron, sulphate, chloride, sodium, potassium, calcium and magnesium and for controlling salinity.
- K18 culture was found to be the most suitable of the rice varieties tested in *Kari* soils under subsurface drainage yielding 3.16 t/ha with a fertilizer dose of 120:60:60 of N: P: K per ha and a seed rate of 100 Kg/ha.

SUMMARY

A) Farm Power Machinery and Energy

a) NATP on development and testing of farm machinery for plantation crops of Kerala

The following are the important outcome of the project:

A novel self centering attachment for making basins around trees was developed and tested in the field and cost was about Rs.12000/-. This reduces the labour cost substantially taking only two minutes/basin in normal soils. A ditcher cum bed former was designed and developed, this could make 86.7 cm wide ditches of about 18 cm depth and simultaneously form a pair of half beds on either side each of 34 cm width. The cost of operation is Rs.252/hr at a field capacity of 0.336 ha/hr.

A digging attachment for tractor was developed and field tested, this can make funnel shaped pits of 100cm diameter and 80cm deep in 3 minutes time and saves substantial human labour. A new concept of rotary husking of coconut was perfected and a powered climber for coconut trees was also refined and field tested under the project.

b) NATP on alleviating occupational stresses imposed on women agricultural workers of Kerala : An ergonomic approach.

An extensive anthropometric survey of female workers of the region was being undertaken as a part of this investigation. Twenty two body dimensions having direct bearing on farm machinery design were incorporated in the survey. Data from more than 300 female workers have already collected and the survey is being extended to other parts of the state. A model anthropometer was developed for the quick and reliable recording the body dimensions.

Energy cost of farm operations performed by female workers was estimated. A work load classification has been brought out exclusively for Kerala females. Weeding (15.7 kJ/min), transplanting (14.89 kJ/min) and harvesting (13.64 kJ/min) were found to be the tedious among the operations considered. For assessing the body discomfort of the female workers while performing agricultural operations, an Overall Rated Perceived Exertion technique (ORPE) was formulated for the study. The overall rated perceive exertion analysis was also carried out for these operations. Under this analysis it was evident that the major share of energy utilized for these operations can be attributed to its adverse postural demand. Hence devices modifying the body posture of female subjects while performing these operations should be introduced and popularized.

Bio-mechanical models are being developed to identify the forces and reactions experienced in different body links and joints of the female workers while performing the activities. A computer software based on this model has been developed. Tools and implements that can be used by the female workers of the region has been identified.

Being the energy intensive operations, planting, weeding, harvesting and threshing are to be mechanized by introducing implements and machinery suitable for women. Machinery available for these operations are evaluated in engineering as well as ergonomic perspectives and suitable modifications are identified. For example, the handle height of the vertical conveyor reaper has to be reduced by 12 cm for making it comfortable for the female workers. Similarly a conveyor mechanism is to be introduced to the existing power paddy thresher to reduce the drudgery in mechanized threshing.

Under an initiative to introduce improved implements and machinery among the female workers of the region, extensive trainings programmes on the operation and maintenance of agricultural machinery like tractors, power tillers, bush cutters, sprayers, pumps harvesters and threshers were conducted during the report period.

c) NATP – A study of the socio economic impact of combine harvesters

The study on socio- economic impact of combine harvesters for harvesting paddy in Kerala, Tamil Nadu and Andhra Pradesh was completed. Crop tiger, kukji, kubota and standard are the popular brands of combine harvesters in these area. Zones were selected according to the intensity of combine use on paddy crop. The entire regions of Kerala, Tamil Nadu and Andhra Pradesh were sub divided in to three zones viz., high intensity zones (>60%), medium intensity zone (30-60%), and low intensity zone (<30%). Accordingly in 13 districts, 39 villages were selected. Study was conducted from 330 farm based on small, medium and large operational holdings. The reasons for using and not using combine harvesters and responses from farmers, labourers, operators and dealers were studied. The average annual use of these combines varied from 495 hrs to 780 hrs. The average total cost of harvesting paddy is Rs. 4870/ ha while the manual harvesting is Rs.5610/ha. The shattering loss of paddy and harvesting period were reduced by the use of combine harvesters.

d) Revolving fund-Farm machinery production and popularisation.

The main objective of the project is to multiply the successful machines and sell them to the intending farmers/users. Against this we have modified the Mitsubishi Power tiller with air-cooled engine for mounting of the reaper assembly. The machine was delivered to Kerala Livestock Development Board. The machine was redesigned and fabricated after incorporating the suggestions by KLDB. This fodder harvester further re-designed and fabricated in college workshop. Now testing of the machine is under progress and it is working successfully.

e) CSS on A study of coconut oil as an I.C. engine lubricant

Viscosity of five types of oils viz. commercially available servo 2T oil, commercially available MAK 20-40 oil, coconut oil as obtained from market, amrut - coco based 2T oil, amrut - coco based 4T oil were studied using redwood viscometer at temperatures ranging from 30 °C to 200 °C.

It was observed that when temperature was increased from 40 °C to 80 °C, for Servo 2T oil the viscosity was reduced from 70 to 10 centipoises and for MAK20-40 oil was reduced from 170 to 20 centipoises. Similarly for coconut based 2T oil, 'Amrut' the viscosity was reduced from 45 to 10 centipoises and for coconut based 4T oil, the viscosity was reduced from 64 to 10 centipoises, for ordinary coconut oil, the viscosity was reduced from 36 to 10 centipoises.

The installation and testing of the equipment's (exhaust gas analyser, electronic balance, viscometer, engine test rig etc) are yet to be completed.

f) CSS on Refinement and popularization of coconut climber and harvesting pole

The main objective of the project is to reduce the weight of the coconut climber, which was already developed weighing about 105 kg. The other objective is to develop a light-weight harvesting pole suitable for harvesting coconut and arecanut. The newly developed climber with centrifugal clutch and winch, reduced the weight considerably.

g) Ad-hoc scheme on Development of equipment and technology for pre-processing of coconut

A power operated coconut husking machine with three swinging jaws, was developed initially. The machine was modified with six pivoted narrow hook like jaws. The coconut was fed in an inverted position and was pushed by a three pronged pusher by hydraulic force. It was again modified for more penetration of the cutting edge of these jaws to the husk for various moisture contents and hardness of husk. A pre-locking arrangement was provided for the jaws so that the jaws did not open out until the cutting edges went up to the shell surface.

A simple continuous feeding rotary husking machine was also developed. It was operated by a 3 hp electric motor. During operation the drum rotated continuously, the coconut was fed through the inlet of the concave. A beating mechanism was incorporated to remove the husk from the hooks on the rotating drum.

A powered coconut climber was developed with four rubber driving wheels. It was operated with two DC geared motors of 44 rpm. The wide variation in the diameter of the trunk and its

sudden bends caused problems in the upward movement of the overhanging anchor of the climber. So a pneumatically extendable long handle was developed for raising the anchor. It consisted of 4 MS pipes and could be operated by a foot pump.

A counter weight type climber was fabricated. It consisted of a permanent weight of about 50 kg permanently installed on the top of the palms and a sliding mechanism with footrest connected each other through a steel wire rope. It took 15 seconds to go up and come down 4.5 m palm and 3 minutes of operation.

A nut splitting machine with pedestal, pivoted long handle cutting knife and a platform was developed. This is to be modified to integrate with the husking machine to make it a continuous feeding type and to collect the coconut water hygienically.

h) ICAR Ad-hoc project on development and testing of a simple riding type paddy transplanter

The low cost riding type transplanter was developed by employing only a pair of crank and oscillating link mechanism for positive delivery of seedlings, instead of eight such mechanisms in the imported 8 row transplanters. In the present study, the seedling pusher is actuated *to and fro* with the inertia force exerted by a guided and sliding extra mass in motion. This extra mass is incorporated on the seedling pusher-rod that slides in and out in a bush fixed on the common member through a safety device. A model of the above detailed mechanism was developed initially using plastic / PVC material after studying the velocity and acceleration diagrams by polygon method for different crank angles of Yanji sakthi transplanter.

The velocity varies from 0.6 m/s to 2.9 m/s for the crank angle 360° and 60° respectively. The acceleration also varies from 21 m/s^2 to 79.4 m/s^2 for the crank angle 360° and 150° respectively. The first model was fabricated and the six sets of new transplanting mechanism was evaluated at stationary position. High speed digital camera was utilised to find out the path of seedlings and to determine the critical values of other components. Improved version was fabricated using MS pipe planting mechanism and the square pipe. The new finger assembly was tested in the field and worked with satisfactory results. It could transplant in the puddled field with very loose soil condition.

The newly developed finger assembly of the paddy transplanter is simple and it efficiently transplant seedlings in the field. Total cost of the transplanter can be reduced by 30 per cent and hence the cost of the total transplanting can also be reduced by newly developed finger assembly.

i) AICRP on farm implements and machinery

1. Paddy transplanters

Six paddy transplanters viz. two wheel walk behind petrol four row kukje transplanter, two wheel walk behind petrol four row asia transplanter, two wheel walk behind petrol four row tong-yong transplanter, single wheel riding type diesel eight row yanji transplanter, four wheel riding type petrol six row yanmar transplanter, four

wheel riding type petrol six row LG transplanter were evaluated in farmers fields covering 24 ha at Anakkara panchayath in Palakkad district.

The simple method of raising successful mat seedlings without the need of sieved dry soil and special plastic trays were demonstrated. The Chinese Yanji and Korean Kukje, and Asia transplanters are now used by farmers in Kerala under custom riding basis.

Yanji transplaters were demonstrated extensively in Kerala in an area of 42 ha Palakkad district. The Kukje transplanter was demonstrated an area of 34 ha in Thrissur and Ernakulam districts.

Yanmar tranplanter has a high speed of transplanting paddy seedlings in vertical position compared to other transplanter because of its super rotary transplanting mechanism. The LG transplanter is similar to Yanmar except it has pick and plant mechanism. Both the tranplanters are having several advanced facilities to achieve satisfied performance. The high cost of the unit, petrol fuel and complicated mechanisam are the drawbacks for immediate acceptance to the farmers.

It is observed that mat seedlings raised by using wet puddled soil on any type polyethene sheet of 75 sq. m. with 50 to 55 kg of paddy seeds are found suitable to all these transplanters. The age of the seedlings for transplanting is from 16 days to 22 days. Creating special man-power by giving training on nursery raising, operation and maintenance of rice transplanters to rural unemployed young girls and boys has made impact in mechanizing transplanting operation.

2. Paddy seeder for dry sowing

Due to scarcity of water, it was not possible to adopt transplanters in eastern parts of Palakkad. In these area, tractor mounted nine row cup feed paddy seeders were introduced and evaluated in 37 ha. A field capacity of 0.46 ha/hr, field efficiency of 72 per cent, plant population of 62 hills/sq.m and 2-3 seedlings/hill were observed. Blocking of seed tube with soil, non-uniform flow of paddy seeds, low seed hopper capacity, difficulty in cleaning seed hopper and availability of correct soil moisture are the difficulties.

3. Riding type self propelled rice transplanter

Detailed evaluations of self propelled rice transplanter in different districts were conducted in 27 ha. Additionally an area of 249 ha was covered by the transplanter in other locations. Detailed study on operation and problems of the 12 Yanji transplanters available at Palakkad district were conducted. Trainings were given to rural unemployed 28 girls and 4 boys at Puthussery and Anakkara panchayaths in Palakkad district; Tavanur panchayath in Malappuram district. The trained teams are supported to take up the complete responsibility of transplanting using transplanters.

Comparison of Yanji transplanter with manual transplanting (per ha)

Sl. No.	Item	Yanji transplanter	Manual transplanting
1	Nursery area, ha	0.01	0.1
2	Nursery land preparation (Rs.)	50	100
3	Polythene sheet (Rs.)	25	--
4	Paddy seeds (kg)	55	85
5	Paddy seeds (Rs.)	550	850
6	Nursery sowing (man days)	3	1
7	Irrigation and management (man days)	5	5
8	Pulling/tying seedlings (woman days)	--	30
9	Cutting/loading mats (man days)	2	--
10	Hire charge (Rs.)	500	--
11	Transplanting (woman days)	1	30
12	Planting (man days)	3	--
13	Field coverage (ha/h)	0.2	--
14	Labour (man)	13	6
15	Labour (woman)	1	60
16	Total labour charges (Rs.)	2020	5100
17	Total cost (Rs.)	3245	6050

Saving of 80 per cent labour, 56 per cent cost, 40 per cent time, 30 per cent seed paddy and 20 per cent increased yield are the advantages while lack of trained manpower and unavailability of irrigation water are the disadvantages. After transplanting with Yanji transplanter the cono-weeders are found effective for weeding and invariably it is used by farmers for removing weeds.

4. Vertical conveyor reaper

The TNAU 0.75meter reaper, KAMCO 1.2 m. reaper, Vardaan 1.2 m. reaper, KAMCO Power tiller 1.2 m reaper and tractor mounted 2.2 m reapers were field evaluated in different locations. The KAMCO 1.2 reaper was evaluated in 57 ha at farmers fields and research farms and additionally an area of 134 ha was covered under demonstrations. The 120 kg reaper has an actual field capacity of 0.16 ha/h, labour saving of 87 per cent, and cost saving of 65 per cent and a total cost of harvesting Rs.2800 /ha. The hire charge is Rs.100/hr .The performances of the escorts crop tiger, swaraj, kukje-3-row and 4-row and Kubota combine harvesters in Thrissur and Palakkad districts were also monitored.

5. Flow through paddy thresher

The commercially available flow through 8 hp rasp bar paddy thresher was evaluated. The thresher was operated to thresh crop from 38 ha. The thresher is found to thresh wet and green crops satisfactorily. The performance of threshing, blowing and sieving are found satisfactory.

B. Soil and Water Engineering

a) Use of coir geotextiles for regeneration of exposed rock patches

The experiment aimed for developing technologies for rehabilitation of the degraded upland soils and rejuvenation of the rock patches, using eco-friendly coir geotextiles and by products. An area of 800 sqm was selected for the experiment, vertical height was computed using theodolite and the contours marked at 1.5 m vertical intervals. The side of the experimental plot was stone pitched to avoid seeping in and out of water. H2M6 coir fibre was spread on the rock patch over which raw coir pitch and turf was placed. Cocologs were used to reduce run off velocity. Run off measuring device (Coshocoton wheel) was fixed at the lower side of the plot. Among the grasses, *Axonopus compressus* and *Heteropogon contortus* alone survived. Maximum intensity was found to be of *Axonopus compressus*. All other grasses and broad-leaved weeds dried up during summer, except *Mimosa pudica*. The intensity of *Mimosa pudica* was maximum in the cocologs. It was noticed that at the end of the first year all the grasses were well established in the rock patches and the next generation of sedges had started establishing over the patches. By the end of second year, 1/3rd of the rock patches were covered with sedges.

b) Use of coir geotextiles for soil and water conservation in varying slopes

The project stems from the view point of minimization of splash erosion impact and thereby reducing runoff using eco-friendly coir geo-textiles. The objectives of the study are evaluation of the effect of different types of coir geo-textiles for slope land stabilization and evaluation of the possibilities of slope land cultivation using coir geo-textiles. Coir geotextiles of varying mesh sizes were used as soil cover to prevent soils and water erosion in slope lands. The runoff as well as soil loss was assessed using multislot devices. The experiment using coir geotextiles of two mesh sizes was completed. Total soil loss (t.ha⁻¹) in the three treatments (GT+crop), control) in 20, 30, 40 & 50 per cent slopes were 14.34, 25.60, 52.5 and 108.12 respectively. In case of GT alone in 20, 30, 40 & 50 per cent slopes were 6.35, 11.44, 32.49 & 57.65 respectively. In case of control in 20, 30, 40 & 50 per cent slopes were 92.56, 210.16, 369.21 & 503.09 respectively.

c) Use of coir geotextiles as a soil mulch

Bhindi - All the growth parameters of plants were found significantly influenced by mulching throughout the growth period. The mulching with different types of coir geotextiles were found beneficial in increasing the growth of the plant. The presence of the weeds were nil in rubberized coir and plastic mulches throughout the crop season. The flowering period of the plant also has influenced by the mulching materials. The flowering has almost reduced to 1/3rd in the plots where mulching materials were used. Rubberized coir was on par with transparent polythene and black needled felt was on par with natural needled felt. Plants in transparent polythene recorded maximum number of fruits closely followed by plants in rubberized coir.

Pineapple - The results of the experiment revealed that all the growth parameters and yield of the crop had influenced by the mulching materials with different types of coir geotextiles and plastic mulch. There was a considerable increase in the yield while using the mulching materials.

d) Use of coir geotextiles for template planting

The experiment consists of laying coir geotextiles and planting intercrops in the coconut garden without disturbing the natural topography. Three crops, brinjal, cocoa & pepper are planted as inter-crop. Inter-cropping is successfully done in undulated coconut gardens without changing the natural slope of the terrain. Soil loss from the plots with cocoa and pepper as inter crop was within the permissible limit. The yield of brinjal was the same as that of level land. This method for inter cropping prevents soil loss in slope land while being eco-friendly and cost effective.

e) Use of coir geotextiles for river bank protection and assessing the biodegradability of different types of coir geotextiles

The major objective of the programme was to evaluate the performance of the coir geotextiles as a protective material against river bank erosion. This experiment was conducted at the river Manimala which is facing acute river bank erosion during monsoon months. The cocologs were used to prevent river bank erosion and to encourage siltation along the river bank. Spurs were constructed using cocologs at an interval of 20 meters. These spurs protrude into the river at an angle of 45°. Coconut logs were piled according to the pressure of the water current in the river. The cocologs were placed horizontally in between the coconut logs piled to the riverbed. The height of the spurs were maintained uniformly from the water level.

f) ICAR Ad hoc scheme on water resources management studies on lateritic hill slopes of Kerala

The study provided required information to set up guidelines for implementing water resources management strategies for lateritic hill slopes of tropical humid region. A hillslope was selected and surface runoff, water table fluctuation, evapotranspiration, soil moisture status and rainfall were monitored throughout the study period. The topography, soil profile details and soil characteristics were also determined. The tensiometers installed at two depths in the four locations provided the moisture tension in the soil during the study period. Instantaneous profile method was adopted for analysing the vertical saturated flow. In most days, moisture content was more at the deeper depth for all locations. Weekly water table fluctuations were observed. The results showed that water table rises considerably corresponding to the rain. The maximum was observed at the topmost well and falls down immediately after the rains indicating considerable drainage of stored ground water to the valleys. There was a gradual decline of water table was observed in the wells near to the topmost one because of inflow from upper regions. The recharge was occurred only in rainy season. The rate of recharge was higher in the lower area of the study site because the area gets replenishment from the river when the water level in the river rises. The rate of release from hill slope decreases with time due to reduction in hydraulic gradient. Infiltration studies showed that high rate of infiltration was observed in lateritic hill slopes.

g) Precision farming development centre, Tavanur

Evaluation of production efficiency and product quality were done for different crops under protected conditions. Crops were cultivated with and without plastic mulching. Drip irrigation experiments including fertigation were also undertaken. Trainings were conducted for farmers, Agrl. officers and unemployed youths on different aspects of plastics in agriculture.

Survey was conducted in various districts of Kerala regarding status of use of micro irrigation and greenhouses.

h) AICRP on Agricultural drainage, Karumadi

The NATP project entitled productivity augmentation through subsurface drainage and farming system interventions in acid saline coastal wetlands, Kerala was commissioned in July 2001 for evolving an eco-friendly farming model suitable to the acid-saline wetlands of Kerala. The main strategies in developing the model are (i) subsurface drainage intervention to contain acidity, salinity and the inherent toxic concentration of salts in the soil profile to improve rice productivity of the area from the present level of 1.5 t/ha (ii) integration of compatible farming enterprises like aquaculture to improve productivity and profitability by ensuring fuller utilization of the vast fertile waters that are otherwise kept unutilized for most part of the year (7-8 months) due to saline water intrusion during summer and flood hazards during monsoon. There were five treatments in the experiment and each treatment contains two seasons in a year. Integration of aquaculture with rice has been tried successfully in these types of soil. Subsurface drainage has been found to bring about perceptible improvement on soil conditions and productivity. Soil heterogeneity with regard to acidity and salinity could be alleviated after the introduction of subsurface drainage. Most of the toxic elements inherent to the soil could be leached to safer levels for cultivation. Integration of aquaculture has resulted augmenting total productivity and increased income to farmers. The new farming model is capable of reducing the cost of rice production by eliminating weed menace and cutting down the cost of ploughing. The organic status of the soil got improved and the fertilizer dose had been reduced to half. Most of the by-products of homestead farming could be effectively utilized in the farm itself and recycled in different forms. The project is participatory and multi-disciplinary. The experiments are laid out in farmers' fields with full time participation of the farmers. A group approach to farming is ensured for obtaining uniform farming practices.

i) Comparative studies on wetting front advance of soil moisture under surface and sub surface drip irrigation for different discharge rates

Drip emitters of 2,4,6 and 8 lph were tested for their wetting front advance when installed at the surface as well as at 30 cm below surface. Quantity of water applied was the same in all the treatments. Soil profiles across the point of application were opened 24 hours after irrigation and were traced out.

An inverse relationship was observed between discharge rate and area wetted. The lower the discharge rates, the wider was the area wetted and vice versa. The sub surface application resulted in increased soil moisture retention of 3-4% at the point of application, compared to that of surface application. The pattern of moisture distribution was almost the same under both the locations of drip emitters. Mathematical models were also developed relating the horizontal and vertical water front advance and the rates of discharge.

j) Design criteria of bubbler (KAU micro sprinkler) irrigation system.

The experiments were carried out for arriving at a design criterion of bubbler irrigation developed at the Agronomic Research Station, Chalakudy, for varying crop/discharge requirements.

Effective wetting radius: Variation of effective wetting radius of different combinations of diameter and length of bubbler heads were studied at different pressures and at different height of riser pipes. A general trend of decreasing the wetting radius with increase in length and diameter of unit was observed. Maximum wetting radius was obtained for the lightest unit ie. 8 mm, 5 cm long. The energy required to rotate the unit along with water will be considerably small and the applied pressure may be sufficient to provide fine uniform spray. In all cases, the wetting radius was found to be increasing with increase in height of riser pipe.

Application depth and distribution efficiency: The average application depth (Da), absolute maximum application (Dxa) and the effective maximum application depth (Dxe) were found to increase with increase in number of nozzles ie. increase in the area of nozzles. Better performance was observed in bubbler heads of 8 mm dia, 5 cm long; 12 mm dia, 8 cm long and 16 mm dia, 12 cm long units with 1 mm nozzle and large percentage of area were receiving the average application depth. The coefficient of variation was less than 100 for all units except 8 mm dia, 8 cm; 8 mm dia, 12 cm and 12 mm dia, 5 cm long units with 1 mm dia, one nozzle. Clogging was negligibly small in all the units, whereas clogging is a great problem in drip emitters.

The following table shows the characteristics of the best performed micro sprinkler heads during the study.

Diameter of MSH	8mm	12mm
Length of MSH	5cm	8cm
Nozzle size	1mm	1mm
Pressure required for working	0.3 to 1.5 kg/sqcm	0.3 to 1.5kg/sqcm
Discharge rate	30 – 35 lph	40 – 45 lph
Wetting diameter	210 – 250 cm	200 – 230cm
Height of riser pipe	30 – 90 cm	30 – 90 cm
Crops suitable	Leafy vegetables, ornamentals, lawns etc	Vegetables, banana, coconut, medicinal plants etc.

k) Comparative studies on continuous and surge flow furrow irrigation in tapioca

The objectives of the experiment were to compare the irrigation efficiencies of continuous and surge flow irrigation in tapioca and to evolve an optimum irrigation schedule for the crop. The treatments included three schedules of irrigation at 50mm, 75mm and 100mmCPE under surge and continuous flow method. The cycle time and cycle ratio was 6 minutes and 1/3 respectively for surge irrigation and number of surges were five.

The results revealed significant influence of treatments on tuber yield per plant. The surge irrigation treatments at 50 and 75mm CPE and continuous flow treatment at 50mm CPE were highly superior to the rest of the treatments. Among the surge irrigation treatments at 50mm and 75mm CPE, the level at 50mm was significantly superior. Both the methods of irrigation at 50mm CPE were on par in yield, with a saving of 14.28 per cent of water in surge method. The results showed inferiority of both the methods at 100mm CPE and continuous flow method at 75mm CPE. The effect of treatments on number of tubers showed superiority of

higher level of irrigation in both the methods, that is at 50mm CPE. The other parameters were non-significant due to the level and methods of irrigation.

Considering the yield and the total irrigation water applied, the irrigation water use efficiency was calculated. It was found highest for surge irrigation treatment at 75mm CPE. It was 44 per cent higher than that of continuous flow treatment at the same level of irrigation. A water saving of 11 per cent could be achieved by adopting the surge flow technique without sacrificing the yield.

List of experiments

i) KAU Projects

- a) Concluded experiments : Nil
- b) Experiments in progress

A. Farm Power Machinery and Energy : Nil

B. Soil and Water Engineering

Sl. No.	Code No.	Title of the experiment	Location
1		Performance evaluation of ground water recharging system of the farm	CoH, Vellanikkara
2		Plastic mulching experiment in bush pepper	KCAET, Tavanur
3		Crop geometry studies in red banana under drip irrigation system	KCAET, Tavanur
4		Fertigation experiment in coconut	KCAET, Tavanur
5		Development of precision farming technique for organically grown pineapple	KCAET, Tavanur
6		Effect of plant growth regulator on off-season capsicum inside rainshelter	KCAET, Tavanur
7		Development of best crop rotation for maximizing the cost effectiveness of a rain shelter	KCAET, Tavanur
8		Evaluation of amaranthus genotypes under polyhouse and open condition	KCAET, Tavanur
9		Increasing the productivity of salad cucumber under rainshelter with integrated nutrient management practices	KCAET, Tavanur

ii) Externally aided projects

- a) Concluded experiments

A. Farm Power Machinery and Energy

Sl. No.	Code No.	Title of the experiment	Location
1	FPME-01-06-03-00/TNR (3)/ICAR	Development and testing of farm machinery for plantation crops of Kerala	KCAET, Tavanur
2	TOT-01-00-05-02/TNR (3)/ICAR	A study of the socio-economic impact of combine harvesters	KCAET, Tavanur
3	FPME-01-06-05-02/TNR (3)/DAC	Study of formulating long term mechanization strategy for each agro climatic zone	KCAET, Tavanur

4	TOT-01-00-02-95 TNR(3)/ICAR	Front line demonstration of farm implements and machinery	KCAET, Tavanur
5	FPME-01-02-01/TNR (3)/ICAR	Development and testing of a simple riding type transplanter	KCAET, Tavanur

B. Soil and Water Engineering

Sl. No.	Code No.	Title of the experiment	Location
1	Coir Board	Use of coir geotextiles for regeneration of exposed rock patches	SCRS, Konni
2	Coir Board	Use of coir geotextiles for soil and water conservation in varying slopes	SCRS, Konni
3	Coir Board	Use of coir geotextiles as a soil mulch	SCRS, Konni
4	Coir Board	Use of coir geotextiles for template planting	SCRS, Konni
5	Coir Board	Use of coir geotextiles for river bank protection and assessing the biodegradability of different types of coir geotextiles	SCRS, Konni
6	ICAR	Water resources management studies on lateritic hill slopes of Kerala	KCAET, Tavanur
7	SWE-03-01-03-99/CLY(2)/ ICAR	Comparative studies on continuous and surge flow furrow irrigation in tapioca.	CoH, Vellanikkara
8	SWE-03-02-03-99/CLY(2) ICAR	Design criteria of bubbler (KAU micro sprinkler) irrigation system.	CoH, Vellanikkara
9	SWE-03-02-03-99/CLY(2) ICAR	Design criteria of bubbler (KAU micro sprinkler) irrigation system.	CoH, Vellanikkara
10	SWE-03-02-02-99/CLY(2)/ ICAR	Comparative studies on wetting front advance of soil moisture under surface and sub surface drip irrigation for different discharge rates	CoH, Vellanikkara
11	SWE-04-01-03-99/TNR (2)/ NCPA	Raising of orchids and anthurium in lowcost greenhouse	KCAET, Tavanur
12	SWE-04-01-04-00/TNR (2)/ NCPA	Rainshelter cultivation of vegetables (tomato)	KCAET, Tavanur
13	SWE-04-01-04-00/TNR(2)/ NCPA(IV)	Rainshelter cultivation of cutflowers (china aster)	KCAET, Tavanur
14	SWE-04-01-04-00/TNR (2)/ NCPA(V)	Poly house cultivation of gerbera	KCAET, Tavanur
15	SWE-04-05-01-96/TNR (2)/ NCPA	Crop geometry experiment in banana	KCAET, Tavanur
16	SWE-04-03-01-96/TNR (2)/ NCPA	Fertigation experiment in banana	KCAET, Tavanur
17	SWE-04-02-03-97/TNR (2)/ NCPA	Drip irrigation with plastic mulching in arecanut	KCAET, Tavanur
18	SWE-04-04-01-01/TNR (2)/ NCPA	Packaging studies for perishable vegetables	KCAET, Tavanur
19	SWE-04-01-04-02/TNR (2)/ NCPA (I)	Rainshelter cultivation of bhindi	KCAET, Tavanur
20	SWE-04-02-01-95/TNR (2)/ NCPA	Drip irrigation with mulching in banana	KCAET, Tavanur
21	SWE-04-02-04-97/TNR (2)/ NCPA (III)	Effect of plastic mulching in conventionally irrigated amaranthus	KCAET, Tavanur
22	SWE-04-02-04-97/TNR (2)/ NCPA (I)	Drip irrigation with plastic mulching in bhindi	KCAET, Tavanur

b) Experiments in progress

A. Farm Power Machinery and Energy

Sl No	Code No	Title of the experiment	Location
1		A study of coconut oil as an IC engine lubricant	KCAET, Tavanur
2		Refinement and popularization of coconut climber and harvesting pole	KCAET, Tavanur
3	TOT-01-00-04-01/ TNR (3) ICAR	Farm machinery production and popularisation	KCAET, Tavanur
4	TOT-01-00-03-97/ TNR (3) ICAR	Frontline demonstrations on major pulses	KCAET, Tavanur
5	TOT-01-00-06-02/ TNR (3) ICAR	Alleviating occupational stresses imposed on women agricultural workers of Kerala	KCAET, Tavanur
6		Development of the anthropometric database for agricultural workers of Kerala and its use in efficient and safe design of agricultural equipment	KCAET, Tavanur
7	ICAR	AICRP on Farm implements and machinery	KCAET, Tavanur

B. Soil and Water Engineering

Sl. No.	Code No.	Title of the experiment	Location
1	AICRP	Watershed studies in selected districts of Kerala with special emphasis on tribal settlements	Trivandrum, Kollam, Idukki, Pathanamthitta and Kottayam districts
2	AICRP	Hydraulics of sub-surface water emission devices for sustainable irrigation in chilly.	ARS, Chalakudy
3	AICRP	Optimization of plant and lateral geometry for economizing micro irrigation(drip)in bhindi	ARS, Chalakudy
4	AICRP	Insitu rain water harvesting through micro catchments and its effect on coconut yield.	CoH, Vellanikkara
5	AICRP	Hydro dynamics of porous pipe sub-surface irrigation in medium soils.	ARS, Chalakudy
6	AICRP	Optimization of field water requirements for efficient operation of wet seeder and cono-weeder for rice	ARS, Chalakudy
7	KAU PLAN	Performance evaluation of of ground water recharging system of the farm	ARS, Chalakudy

