annual report

1994 - '95

NRCC

NATIONAL RESEARCH CENTRE FOR CASHEW

(Indian Council of Agricultural Research)

PUTTUR 574 202, DAKSHINA KANNADA

KARNATAKA, INDIA

ANNUAL REPORT
1994-'95

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DIRECTOR'S INTRODUCTION

National Research Centre for Cashew was established in April 1986 at Puttur, Dakshina Kannada District, Karnataka. This Research Centre also serves as headquarters for the All India coordinated Research Project on Cashew, which has eight coordinating centres under respective State Agricultural Universities in eight different states.

LOCATION

The headquarters of National Research Centre for Cashew is located 5 Km away from Puttur town at Kemminje (12.45° N latitude and 75.42° E longitude) and is about 90M above MSL. It is contemplated to acquire a total area of 60.08 ha of land for laying out field experiments at Puttur, out of which 57 ha has already been acquired.

Besides the main campus at Puttur, an Experimental Station at Shantigodu, which is 13 Km away from the main campus also forms a part of this Research Centre. This Experimental Station was started as Cashew Seed farm under Central Plantation Crops Research Institute in the year 1978.

MANDATE

The National Research Centres are conceived with the idea of undertaking mission oriented research projects. The mandate of the National Research Centre for Cashew is as under:

* Evolving high yielding varieties of cashew and breeding varieties for resistance/tolerance to pest such as tea mosquito bug.

* Evolving varieties with high protein, lysine and other biochemical parameters.

* Standardization of agrotechniques for achieving higher production and productivity with sustainability in view.

* Transfer of technology to farmers and extension agencies on improved production techniques through training, demonstration and extension literature.

STAFF & BUDGET

While establishing National Research Centre for Cashew, Puttur, 62 posts (14 scientific; 9 technical; 6 administrative; 2 auxiliary and 31 supporting staff) were deployed from CPCRI. During VII Plan period, additional 14 posts

(1 scientific, 3 technical, 2 administrative, 1 auxiliary and 3 supporting staff) were sanctioned. During 1990-91, six more scientific posts were deployed from CPCRI. During the VIII Plan period an additional 21 posts (5 technical, 6 administrative, 1 auxiliary and 9 supporting staff were sanctioned bringing the total staff component to 100 due to redeployment of two posts of Principal Scientist and one Project-Coordinator's post to other institutes in Horticulture Division of ICAR. The sanctioned budget for the financial year 1994-95 was:

	Allocation (Rs. in lakhs)	Expenditure (Rs. in lakhs)
Non-Plan	37.00	36.97
Plan	86.00	84.84
Revolving Fund Scheme	8.84	9.94

RESEARCH PROGRAMMES

During the year, a total of 21 research projects covering Crop Improvement, Agrotechniques, Crop Protection, Quality Analysis and Post-harvest Technology and Transfer of Technology were undertaken. Besides these research projects a Revolving Fund Scheme for production of grafts is also in operation. Salient results of the research projects are as under:

Crop Improvement: Establishment of cashew gene bank is one of the priorities identified under Crop Improvement programme. With the addition of 20 more accessions during the year the total holding in the Cashew Gene Bank stands at 380. Characterization of the accessions planted during 1986 is in progress.

In the varietal improvement project priority is to improve the nut size of proven high yielding varieties identified/released earlier. VTH-7117-4, a Brazilian accession with bold nut, is being used in hybridization programme for improving the nut size by crossing with the high yielding varieties, namely BLA-139-1 and V-2. In the evaluation of hybrids, VTH-36 x VTH-30 gave the best yield (5.8kg) in the seventh year of planting. The performance of VRI 2 continued to be superior among the released varieties and this variety also responded to the summer irrigation of 200 liters/tree at fortnightly intervals with a 15 per cent increase in yield.

Efforts are under way to standardize the micropropagation for cashew. Among the 24 combinations of cytokinins (BAP, kinetin, 2 ip and zeatin) at two levels (0.5 and 1.0 mg/l each), multiple shoots were observed in four combinations. Microshoots obtained from the nodal cultures were rooted both by *in vitro* and *ex vitro* methods. Rooted plantlets were potted in 1:1:1 mixture of soilrite, sand and

coconut pith and kept for observation under laboratory conditions. Contamination in field collected shoored plants was minimised by spraying at least 3 or 4 times with bavistin and streptomycin sulphate or oxytetracycline to new flushes.

Agrotechniques: To increase the productivity of cashew micro irrigation coupled with graded doses of NPK is being tested on cashew grafts. Significant differences were observed in the yield between irrigated and unirrigated plants.

In the cropping system trials, tree species like casuarina, acacia and subabul were tried for the first five years and subsequently the tree species were removed and pineapple was planted. There is an appreciable increase in the yield of cashew after the removal of tree species in all the plots. However, cashew yield was highest in the plot where pineapple was cultivated from the beginning of the trial.

In the high density planting trial, maintaining 555 trees after the seventh year (1111 upto 7 years) was found to be beneficial. The highest cumulative yield of 4.9 tonnes from 4th to 12th year after planting was obtained in the plot where plant density of 625 plants was retained and later thinned to 312 plants.

In an on farm trial on pruning, the pruned trees continued to give higher yields than unpruned trees.

Crop Protection: In Crop Protection, priority is being given for the development of suitable prophylactic control measures for the cashew stem and root borers. Application of carbaryl WP (0.2%) along with soil application of granules of Sevidol G (75 g/tree) was found to be effective in saving the trees in the initial stage of attack. For the first time, fungal pathogen *Metarhizium anisopliae* was isolated from the field collected grubs. An effective egg collection technique was devised using cotton tape wrapped host twings to avoid damage to eggs during the egg collection. This technique will be useful in standardizing the mass rearing technique for undertaking the studies on pheromones.

Commercial neem based pesticides like Godrej Achook, Nimbecidine and Limanool exhibited oviposition deterrence upto seven days after application. Both Limanool and Nimbecidine at 1.0 per cent were found to be promising in controlling the population build up of tea mosquito bug under field conditions.

Quality Analysis and Post-harvest Technology: Biochemical changes during storage of nuts were monitored upto 770 days both at ambient and low temperature. Moisture content of the nuts decreased after four months of storage at ambient temperature when nuts at different moisture level were stored.

Transfer of Technology: This centre regularly conducts training programmes on vegetative propagation and also on cashew production technology. During the year, 49 officials participated in the training courses. A one day refresher course was also conducted for the senior level officials of Department of Agriculture and Cooperation, Ministry of Agriculture and Cooperation, Directorates of Agriculture/Horticulture, Coconut Development Board and Directorate of Cashewnut Development, Cochin. Institute also laid out 54 demonstration plots in collaboration with Directorate of Cashewnut Development, Cochin, under the Central Sector Scheme. The demonstration plots are being regularly monitored and necessary technical guidance is given to demonstration farmers. Centre also receives and gives training/technical advice to a number of farmers, students and officials from Agriculture/Horticulture departments. During the year 45 055 grafts of recommended varieties are distributed to the farmers as well as developmental agencies.

Library: The library of this Research Centre has 694 reference volumes and 390 back volumes of the journals. Forty three Indian and 13 international journals were subscribed. During the year, an amount of Rs. 1,55,220 has been spent towards strengthening the library facilities.

ABOUT THIS REPORT

This is the ninth Annual Report of the Centre and it comprises the results of 21 ongoing research projects organised in 5 chapters, namely Crop Improvement, Agrotechniques, Crop Protection, Quality Analysis and Post-Harvest Technology and Transfer of Technology. Report pertaining to the concluded research project and a summary of All India Coordinated Research Project on Cashew are also included. General information pertaining to the Centre is appended at the end of the report.

EVV Bhaskararao

Puttur - 575 202
Dated August, 1995

(EVV BHASKARA RAO)
ACT. DIRECTOR

REPORTS ON ONGOING PROJECTS

CROP IMPROVEMENT

Twenty accessions of cashew germplasm collected from West Bengal (13), Orissa (6) and Kerala (1) were planted (6 grafts per accession) in the National Cashew Gene Bank, bringing the number of accessions planted so far in the Gene Bank to 380. The leaf phenols content ranged from 0.32 to 1.53 mg/g fresh weight and leaf orthodihydroxy phenols ranged from 0.13 to 0.78mg/g fresh weight.

Among the hybrids evaluated (145 trees) from 33 cross combinations, hybrid VTH-56 x VTH-30 gave the highest yield (5.86Kg/tree) followed by VTH-12 x VTH-56 (4.69Kg/tree) in the fifth harvest.

High yielding varieties BLA-139-1 and V-2 were crossed with bold nut type VTH-711/4 for improving the nut size of released varieties. Among the trees planted in 1991 and 1992 under the ongoing programme on nut size improvement, the highest nut weight (11.5g) and also highest kernel weight (5.5g) were recorded in H-1200 (VRI-2 x VTH-711/4). The shelling percentage in this hybrid was 31.7 per cent.

WPM supplemented with 2mg/l of NAA was ideal for raising aseptic seedlings from immature seeds with 90 per cent germination. In nodal cultures, highest budding was obtained in medium supplemented with a combination of BAP (0.5-1.0mg/l) and zeatin (0.5-1. 0mg/l). In thidiazuron (0.05-2.0mg/l) supplemented medium, axillary shoot bud proliferation was obtained in 85.7 per cent of the cultures. Maximum rooting (75%) was obtained in medium supplemented with NAA and IBA. Better establishment of mature tree explants was observed when explants taken from grafted seedlings and forced shoots on sterile sucrose medium were used in culture.

Gen. I(176) : Collection, conservation, cataloguing and evaluation of cashew germplasm.

(KRM Swamy, MG Nayak, N Yadukumar and KV Nagaraja)

The objectives of the project are collection of both indigenous and exotic germplasm, conservation of the germplasm in the National Cashew Gene Bank and evaluation and cataloguing of the germplasm.

Germplasm collection and conservation

Twenty accessions of cashew germplasm collected from Kerala (1), Orissa (6) and West Bengal (13) were planted in the National Cashew Gene Bank during August 1994 (six soft wood grafts per accession) by adopting a closer spacing of 6m x 6m. A total of 320 clonal accessions have been planted so far in the Gene Bank.

Supply of elite germplasm for trial

Twenty soft wood grafts each of ten elite germplasm accessions, namely VTH-50/4 (NRC 130), VTH-40/1 (NRC 131), VTH-92/2 (NRC 136), VTH-105/2 (NRC 137), VTH-107/3 (NRC 138), VTH-155L (NRC 140), VTH-146/1 (NRC 190), VTH-146/4 (NRC 191), VTH-133/4 (NRC 192) and VTH-22/2 (NRC 193), were produced during September 1994 for supplying to Indira Gandhi Krishi Vishwa Vidyalaya (IGKVV), Jagadalpur, Madhya Pradesh.

Germplasm evaluation

1. Studies on physiological parameters and biochemical characterization of selected cashew accessions.

Observation on physiological parameters such as evapo transpiration (Eo), Stomatal conductance (gs), net photosynthesis (Pn), intercellular CO_2 concentration (Ci), water use efficiency (WUE), temperature of leaf cuticle (TC), were recorded on ten cashew accessions which were planted during 1988 in the cashew Gene Bank with the help of LCA-3 phorsynthesis system. These parameters were recorded on

Table-1: Physiological parameters and leaf phenols of selected cashew accessions.

Accession Number (NRC)	Transpiration (m mol H_2O m-2 s-1)	Stomatal conductance (mol m-2 s-1)	Net photosynthesis (μ mol CO_2 m-2 s-1	Intercellular CO_2 concen (ppm)	Water use efficacy (μ mol CO_2 / m mol H_2O sec.)	Cuticle temperature	Leaf phenols mg/g fr. wt.	Leaf OD phenols mg/g fr. wt.
118	12.0	0.5	12.8	250	1.1	27.0	0.33	0.78
119	11.5	0.4	10.2	240	0.9	28.8	0.38	0.13
120	11.0	0.3	9.8	249	0.9	27.0	0.71	0.31
121	11.2	0.4	8.1	242	0.7	25.8	0.50	0.15
122	11.8	0.6	8.9	245	0.7	28.2	0.63	0.25
123	13.2	0.6	9.8	248	0.7	29.2	1.53	0.40
124	15.2	0.5	8.8	243	0.6	28.1	0.50	0.98
125	13.8	0.5	8.9	245	0.6	29.2	0.56	0.21
126	14.1	0.6	11.2	248	0.8	29.8	0.43	0.22
127	13.9	0.6	12.9	244	0.9	29.8	0.95	0.61

Improvement of nut size in released varieties:

In order to improve the nut size in released varieties, crosses were made between the released varieties (M-44/3, BLA-139-1 and V-5) and bold nut types (VTH-711/4 Brazilian and VTH-40/1) since 1990 and over 500 hybrid plants have been planted during last four years since 1991. Details of the combinations planted are as follows.

M-44/3	x	VTH-40/1
M-44/3	x	VTH-711/4
BLA-139-1	x	VTH-40/1
BLA-139-1	x	VTH-711/4
V-5	x	VTH-40/1
V-5	x	VTH-711/4

During the year, released varieties BLA-139-1 and V-2 were crossed with VTH-711/4, a bold nut brazilian type. A total of 2644 flowers were pollinated in these two cross combinations. The initial nut set was 94.3 per cent and final recovery was about 14 per cent. A total of 385 hybrid seednuts were produced this year for planting during 1995-96.

Among the trees planted in 1991 and 1992 thirty seven hybrid trees had nut size more than 7g. Nut weight in nine out of 37 plants was more than 8g and the nut characteristics of these nine plants are given in Table 4. The highest nut weight (11.3g) and also highest kernel weight (3.5g) were recorded in H-1200 (VRI-2 x VTH-711/4). The increase in nut weight of H-1200 over its female parent VRI-2 was 125.2 per cent. The shelling percentage was also very high (31.7%). The other hybrid trees which had bolder nuts were H-1216 (10.1g), H-1300 (9.2g) H-1186 (9.1g) and H-1450 (9.1g). Hybrid H-1450 (BLA-139-1 x NRCC-Selection-8) had highest shelling percentage (33.1%) and the kernel weight was also high (3.1g). The increase in nut weight recorded in H-1218 over its female parent VRI-2 was 101.6 per cent.

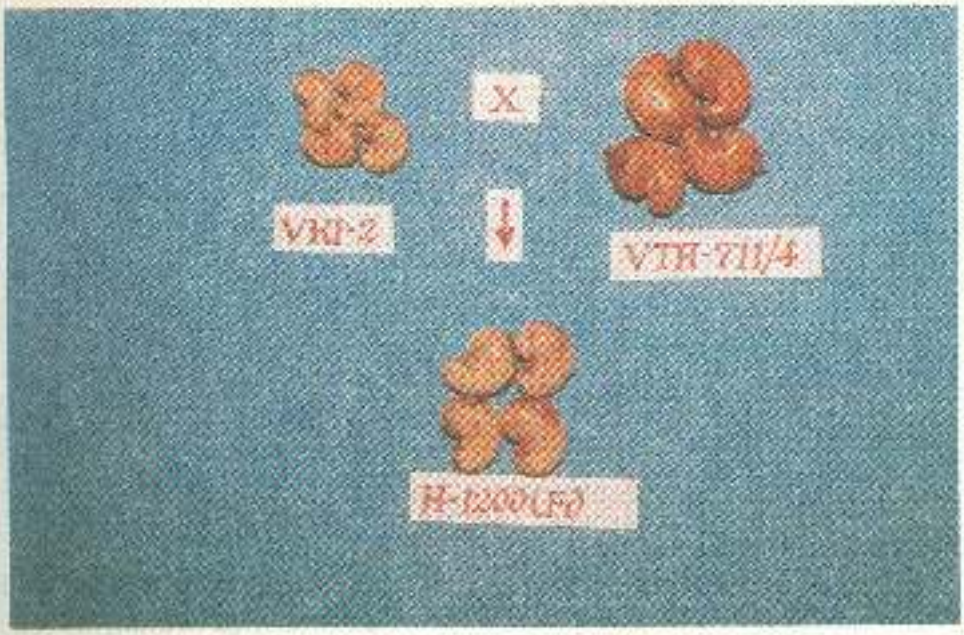
Evaluation of hybrids and selections of NRCC:

Hybrids (1987 planted)

Hybrid seedlings (145) from 33 cross combinations planted under closer spacing (6m x 6m) in 1987 at Kemminje were evaluated. The hybrid combination VTH-56 x VTH-30 gave the highest yield (5.86Kg/tree) followed by VTH-12 x VTH-36 (4.69 Kg/tree) while the control, M-44/3 had yield of 3.3 Kg/tree in the fifth harvest. In cumulative yield also VTH-36 x VTH-30 was the highest yielder (9.85 Kg/tree for five years).

Table 4: Nut characteristics of selected hybrid plants.

Tree No. H.No.	Parentage			Nut weight (g)	Kernel weight (g)	Shelling (%)	Nut weight of female parent (g)	Percentage increase of nut weight over female parent
H-1186	VRI-2	x	VTH-711/4	9.1	2.9	30.6	5.0	82.4
H-1191	VRI-2	x	VTH-711/4	9.0	2.6	25.7	5.0	80.2
H-1200	VRI-2	x	VTH-711/4	11.3	3.5	31.7	5.0	125.2
H-1215	BLA-139-1	x	VTH-711/4	8.7	2.4	27.6	6.0	44.8
H-1218	VRI-2	x	NRCC-Selection-2	10.1	2.6	29.0	5.0	101.6
H-1278	VRI-2	x	NRCC-Selection-2	8.8	2.6	29.1	5.0	75.2
H-1300	VRI-2	x	NRCC-Selection-2	9.2	2.7	30.0	5.0	85.4
H-1326	V-5	x	VTH-711/4	8.1	2.3	27.7	4.5	80.7
H-1450	BLA-139-1	x	NRCC-Selection-8	9.1	3.1	33.9	6.0	51.3



Hybridization for improvement of nut size in released varieties

Hybrids and Selections

Promising hybrids and selections are being evaluated in two replicated trials. Hybrids and selfed lines were identified based on the performance of individual trees for yield and yield component/nut characters at Vittal and Kemminje. The first set (planted in 1992-93) consisted of six hybrids, a selfed line, three selections and a control (VRI-2) while the second set (planted in 1994-95) consisted of five hybrids, two selfed lines, three selections and a control (VRI 3).

Evaluation of recommended varieties and elite lines

Recommended varieties of cashew are being evaluated in two replicated trials at Kemminje. The first set planted in 1986 has 12 varieties and the second set planted in 1991 has nine varieties. In the first set BLA-39-4 (1.56Kg/tree) and M 44/3 (1.48 Kg/tree) performed well in the sixth harvest as well as in cumulative yield (4.4 Kg/tree and 4.8 Kg respectively) while in the second set V-4, Ullal-2 and VRI-2 are promising. Among the 15 high yielding pre-release varieties planted in 1988 at Shanthigodu (CRD design), varieties VTH-592 (1.07 Kg/tree) and VTH-530/12 (1.02 Kg/tree) had better yield compared to other varieties in the third harvest. Trials on high shelling types, big apple types and comparison of grafts and seedlings planted in 1990 at Kemminje are in progress. A new trial on maximisation of yield with NRCC-Selection-1 and NRCC-Selection-2 cashew varieties has been laid out with yield target of not less than one tonne/ha/year by adoping all recommended package of practices.

Gen. III : Tissue culture studies in cashew for micropropagation and somaclonal variation

(Thimmappaiah and Shirly Raichal Samuel)

The project was initiated in 1989 with an objective of standardising micropropagation technique in cashew and to induce and exploit somaclonal variation for breeding purpose. During the year, the programme was confined only to the micropropagation of cashew. Nodal and shoot tip cultures were made both from seedlings and mature trees.

1. *In vitro* seed germination:

Three basal media namely MS, WPM and B_5 with NAA (2mg/l) and without NAA were tried to obtain aseptic seedlings from green nuts (3-6 week old). Woody plant medium with NAA (2mg/l) gave the highest germination (89.4%) followed by B_5. Seedlings, however, attained greater height (7.5cm) in B_5 medium supplemented with NAA (2mg/l) (Table-5).

Table 5: Effect of media on germination of embryos

Medium	Germination (%)	Mean height (cm)
MS + NAA (0)	48.1	4.4
MS + NAA (2 mg/l)	56.8	5.0
WPM + NAA (0)	58.8	4.8
WPM + NAA (2 mg/l)	89.4	5.4
B5 + NAA (0)	58.3	5.7
B5 + NAA (2 mg/l)	76.3	7.5

2. Nodal culture (seedling origin):

Nodal cuttings of young cashew seedlings were cultured on MS supplemented with BA, kinetin, 2ip (0.5-8.0mg/l) and adenine sulphate (10-160 mg/l). The budding varied from 77 to 94.4 per cent and emergence of leafy shoots from 56 to 75 per cent. The budding was highest in medium supplemented with 2ip. Multiple shoot induction was negligible

Multiple shoot induction from nodal culture

under various treatments. Combination of cytobinins, at two levels (0.5 and 1.0 mg/1) was tried. Highest budding (100%) was observed in medium supplemented with a combination of 2ip (0.5-1.0mg/1) and zeatin (0.5-1.0mg/1). In thidiazuron (0.05-2.0mg/1) supplemented medium axillary shoot bud proliferation was obtained in shoot cultures (85.7%). The number of axillary shoots formed were 1-5 per explants.

Rooting:

Both *in vitro* and *ex vitro* methods were tried for rooting microshoots. *In vitro* rooting was attempted by culturing shoots on MS supplemented with NAA, IAA and IBA alone and in combinations of two. Maximum rooting (75%) was obtained in medium supplemented with NAA and IBA. *Ex vitro* rooting was attempted on micro shoots by using different auxins at 250 ppm and NAA and IAA treatments gave good rooting (19.5%).

Acclimatisation:

In vitro rooted plantlets were potted in sterile potting mixture containing 1:1:1 of soilrite, sand and coconut pith. Initially the plantlets were covered with polythene bags to maintain high humidity. Gradually the humidity was reduced. The plantlets were irrigated with a low concentration MS salt solution. About 40 per cent of plantlets survived.

Ascptic culture of shoot explants (mature tree origin):

Field explants showed a higher rate of contamination in cultures. The trees were sprayed with Bavistin (0.2% w/v) and/or Dithane M-45 and streptocycline (100mg/1) to reduce contamination. Incorporation of oxytetracycline (50, 100ppm) into the medium reduced the contamination of cultures. Mercuric chloride at different concentrations (0.25-0.75%) was tried to reduce contamination of which dipping in 0.5 per cent mercuric chloride for 6 min gave effective control of contamination. Pre-treatment of explants with streptopencillin at 500 ppm for 60 min helped in controlling contamination. For esrablishment of shoot cultures, explants from both pruned and unpruned shoots were cultured on half strength MS medium supplemented with and without L-glutamine (400mg/1). Pruned shoots showed better establishment than unpruned and glutamine containing medium was better than glutamine free medium. Better establishment and viability of shoots was observed when explants from grafted seedlings and forced shoots on sterile sucrose medium was used in culture. Shoot tips of H 4 ? initially on B_5 medium with BA and NAA and subsequently on BA, IBA and GA_3 medium and culturing of shoot tips of VRI-1 in WPM medium with thidiazuron and NAA showed indication of shoot bud proliferation.

AGROTECHNIQUES

Different irrigation treatments influenced morphological characters particularly, height and spread which showed increasing trend with increased quantity of irrigation water. Increasing trend in light interception was observed with increased quantity of irrigation water from 20 l/tree to 80 l/tree through drip system. The difference is marked between irrigated and unirrigated trees. Net photosynthesis was minimum in the case of trees receiving no irrigation and it was maximum in the case of irrigated trees particularly 60 and 80 l/tree. Significant difference in yield was observed between irrigated and unirrigated trees as well as among different irrigation treatments. Significant difference in yield was observed between fertilized and unfertilized trees as well as among lowest dose fertilizer applied trees and highest dose fertilizer applied trees (250g and 750g N/tree).

Two years after the removal of forest species like acacia, casuarina and subabul and later planted with pineapple as intercrop the main crop (cashew) yield increased considerably. Higher yield was realised from plot intercropped with pineapple (originally pineapple as intercrop) while in plot intercropped with acacia yield was minimum even two years after the removal of acacia.

Maximum number of P solubilising bacteria, fungi and nitrogen fixing bacteria was observed in plots where pineapple and cover crops were grown with cashew alone and it was minimum in plots where (upto 5 years after planting) forest species like acacia and casuarina were previously grown as intercrops. P contents was maximum in pineapple and cover crop plots.

In cashew based cropping system, maximum yield was recorded in high density (400 plants/ha) planting compared to normal density (200 plants/ha) as well as when forest species were intercropped with cashew. In plots where combinations of acacia and casuarina were tried the yield was minimum indicating that four years after planting acacia and casuarina affected maincrop (cashew) though these were planted 3.5m away from the row of main crop.

Highest yield was realised in plots where spacing was 5m x 5m (449.95 Kg/ha - unpruned, 358.75 Kg/ha - pruned) and 5m x 4m (300Kg/ha - unpruned, 358.10 Kg/ha - pruned). Minimum yield per unit area was realised from plot where the spacing adopted was 8m x 8m and 6.5m x 6.5m.

Maintaining a plant density of 1111 trees/ha for the first seven years and 555 trees/ha after that has recorded highest yield of 711Kg/ha by 12 years after planting whereas cumulative yield was highest in plot where 625 trees/ha was maintained for the first ten years after planting and 312 trees/ha afterwards.

Studies on off-season grafting indicated that green scion sticks could be used successfully for soft wood grafting. Root stocks screened for dwarfing did not exhibit differences with respect to morphological characteristics. The cost of establishment and maintenance of top worked and replanted plots for five years is Rs. 4552 and 3553 respectively. The yield realised from top worked plot (97.9 Kg) was more compared to replanted plot (50.4 Kg).

Agr. III(a) : Economic feasibility of drip irrigation and graded doses of NPK on the productivity of cashew

(N. Yadukumar)

An experiment was laid out in 1989 to asses the efficacy of drip irrigation coupled with graded doses of NPK on the productivity of cashew. A plot without irrigation served as control plot. The main plot treatments are drip irrigation @ 20, 40, 60 and 80 litres per tree once in four days during dry months. The subplot treatments are-

1) No fertilizer
2) 250g N, 62.5g each of P_2O_5 and K_2O/tree
3) 500g N, 125g each of P_2O_5 and K_2O/tree
4) 750g N, 187.5g each of P_2O_5 and K_2O/tree

The experiment was laid out in split plot design with four replications.

Growth characters:

Observations on growth showed increased height, girth and ground coverage in the case of irrigated plants as compared to unirrigated plants (Table-6,7,8). The differences among irrigation treatments (I_1 to I_5) were not significant. Similarly, increased height, girth and spread were observed in the case of fertilized plants as compared to unfertilized plants except in the case of treatment M_1 (250g N, 62.5g P_2O_5 and 62.5g K_2O). The differences among fertilizer treatments (M_2 to M_4) however, were not significant.

Photosynthesis and other related physiological parameters:

Observations were taken on photosynthesis and other related physiological parameters by using LCA-3 photosynthesis system during peak summer season (Feb. - March). It is observed that irrigated plants intercepted maximum sunlight as compared to unirrigated plants. Among the irrigation treatments, increased light interception was observed with increased quantity of water. The difference, however, was not significant. Further light interception was more in fertilized plants when compared with that of unfertilized plants (Table-9). Observation on photosynthetic rate (Pn), transpiration (Eo), Stomatal conductance (gs), Intercellular CO_2 concentration (Ci) showed that there is a marked difference in Pn (net

Table 6: Height (cm) as affected by irrigation and fertilizer treatments.

Irrigation treatment	Fertilizer treatment				
	M_1	M_2	M_3	M_4	Mean
I_1 No irrigation	384	418	389	399	397.50
I_2 - 20 litres/tree	429	393	454	425	425.25
I_3 - 40 litres/tree	426	396	405	420	411.75
I_4 - 60 litres/tree	410	433	454	428	431.25
I_5 - 80 litres/tree	415	410	415	414	413.50
Mean	413.6	410.0	419.4	417.2	

Table 7: Girth (cm) as affected by Irrigation and fertilizer treatments.

Irrigation treatment	Fertilizer treatment				
	M_1	M_2	M_3	M_4	Mean
I_1 No irrigation	41.57	44.40	41.30	43.07	42.58
I_2 - 20 litres/tree	48.47	41.17	45.67	44.20	43.38
I_3 - 40 litres/tree	44.25	42.87	41.65	42.35	42.78
I_4 - 60 litres/tree	44.70	44.50	44.97	43.67	44.46
I_5 - 80 litres/tree	44.90	41.45	46.27	44.70	44.33
Mean	43.57	42.77	43.97	43.55	43.49
CD for irrigation (MP)			NS		
Irrigation			NS		

Table 8: Ground coverage (m^2) as influenced by Irrigation and fertilizer treatments.

Irrigation treatment	Fertilizer treatment				
	M_1	M_2	M_3	M_4	Mean
I_1 No irrigation	21.62	26.04	21.55	25.62	24.47
I_2 - 20 litres/tree	26.40	25.50	26.04	31.35	27.37
I_3 - 40 litres/tree	27.14	28.07	32.55	30.17	29.48
I_4 - 60 litres/tree	30.37	34.19	33.17	33.37	32.77
I_5 - 80 litres/tree	31.35	33.57	36.99	30.95	33.04
Mean	27.97	29.67	29.98	30.34	

Table 9: Light intercepted by the crop canopy (%)

Irrigation treatment	Fertilizer treatment				
	M_1	M_2	M_3	M_4	Mean
I_1 No irrigation	46.22	48.80	40.46	48.21	45.94
I_2 - 20 litres/tree	48.92	47.26	48.26	58.47	50.72
I_3 - 40 litres/tree	50.43	58.16	60.48	56.06	54.78
I_4 - 60 litres/tree	53.77	60.49	58.69	59.04	57.98
I_5 - 80 litres/tree	53.49	57.28	61.92	52.89	56.38
Mean	50.56	53.21	53.96	54.93	

photosynthesis) and Eo (Transpiration) between irrigated and unirrigated plants (Table 10). The difference among irrigation treatments (I_1 to I_4), however, is not significant. The Pn and Eo values for fertilized and unfertilized plants indicated no significant difference between unfertilized (M_1) and fertilizer applied plants (M_2 to M_4) and among different doses of fertilizer applied plants (M_2 to M_4).

Leaf water potential:

Leaf water potential (ψ) was determined by using pressure chamber in the field conditions to find out the difference among irrigation treatments as well as between irrigated and unirrigated plants during the peak summer season (March and April) when the irrigation was in progress. Leaf water potential was determined by using the matured (3rd to 5th) leaves in all the four directions of the tree just before the irrigation and soon after irrigation and two days and three days after irrigation. Leaf samples from control plot were also used for determining leaf water potential. The data are presented in Table 11. Leaf water potential was minimum in the case of plants receiving no irrigation (-3.26 bars) and was maximum in the case of plants receiving 80 liter of water/tree once in four days through drip system (-2.85 bars). Among the irrigation treatments the difference is not significant. The mean leaf water potential decreased from

Table 10: Physiological parameters as affected by different irrigation and fertilizer treatments

Treatment	Evaporation m mol H_2O m^{-2} s^{-1} (Eo)	Leaf temperature (°C) (Tl)	Stomatal conductance (mol m^{-2} s^{-1}) (gs)	Net photosynthesis (µ mol CO_2 m^{-2} s^{-1} (Pn)	CO_2 conc. mol/l (Ci)	WUE (µ mol CO_2/m mol H_2O
Main plot (Irrigation)						
I_1 No irrigation	8.22	30.05	0.30	12.72	253	1.54
I_2 - 20litres/tree	8.75	35.05	0.40	15.98	241	1.82
I_3 - 40litres/tree	9.65	36.80	0.46	15.58	246	1.61
I_4 - 60litres/tree	9.80	37.20	0.38	14.85	250	1.51
I_5 - 80litres/tree	10.26	35.66	0.41	16.66	245	1.62
Sub plots treatment (fertilizers)						
M_1 (No fertilizer)	8.82	35.15	0.35	14.48	251	1.64
M_2 85g N, 82.5g each of P_2O_5 and K_2O	8.58	35.89	0.35	14.76	249	1.72
M_3 - 300g N, 135g each of P_2O_5 and K_2O	9.47	37.58	0.39	15.57	242	1.64
M_4 - 730g N, 187.5g each of P_2O_5 and K_2O	10.48	38.46	0.42	15.82	253	1.52
CD for Main plot (Irrigation)	0.51	0.41	1.15	7.26	N.S.	
CD for Sub plot (Fertilizer)	0.55	0.62	1.16	7.38	N.S.	

Table 11: Leaf water potential (bars) as affected by irrigation treatments.

Irrigation treatment	Just before irrigation	On the day of irrigation	2 days after irrigation	3 days after irrigation	Mean
I_1 No Irrigation	-3.25	-3.28	-3.25	-3.20	3.25
I_2 - 20 litres/tree	-2.55	-2.45	-2.38	2.50	-2.47
I_3 - 40 litres/tree	-2.45	-2.35	2.30	-2.45	-2.38
I_4 - 60 litres/tree	-2.35	-2.25	-2.32	-2.35	-2.31
I_5 - 80 litres/tree	-2.30	-2.20	-2.25	-2.25	-2.25
Mean (I_2 to I_5)	-2.41	-2.31	-2.31	-2.38	

-2.31 to -2.38 on the day of irrigation to three days after the irrigation. The mean leaf water potential determined just before the next irrigation was -2.41 bars (Table-11).

Yield:

Significant difference in yield was observed between irrigated and unirrigated plants and among the irrigation treatments (Table-12). Among different irrigation treatments, the yield in the case of I_5 and I_4 (3.97 and 4.15 Kg/tree) was the highest as compared to I_2 and I_3 (3.07 and 3.08 Kg/tree). Significant difference in yield between plants receiving fertilizers and no fertilizers was also observed. Despite increasing trend in yield with increased fertilizer dose was observed, the difference was not significant (Table-12).

Table 12: Yield (Kg/tree) of individual tree as affected by different irrigation and fertilizer treatments (five years after planting)

Irrigation treatment	Fertilizer treatment				
	M_1	M_2	M_3	M_4	Mean
I_1 No irrigation	1.71	2.49	2.36	2.59	2.29
I_2 - 20 litres/tree	2.69	3.21	3.18	3.19	3.07
I_3 - 40 litres/tree	2.65	3.14	3.21	3.34	3.08
I_4 - 60 litres/tree	2.89	3.78	4.23	4.99	3.97
I_5 - 80 litres/tree	3.33	3.85	4.47	4.47	4.15
Mean	2.65	3.29	3.59	3.72	3.31

SEm for main plot (irrigation)	:	0.1868
CD (at 5%)	:	0.4330
SEm for subplot (fertilizer)	:	0.1486
CD (at 5%)	:	0.3512

Agr. IV : Cashew based cropping system - Inter and mixed cropping with cashew

(N. Yadukumar and B. Nagaraja)

An experiment was laid out in 1997 with an objective of finding out a suitable intercrop that could be profitably grown in the interspace of cashew rows during the pay back period of cashew orchard.

Photosynthesis and other physiological parameters:

Observations were taken on photon flux density, photosynthesis and other physiological parameters in cashew, two years after the removal of tree intercrops (acacia, casuarina and subabul). There was marked increase in photosynthetically active radiation (photon flux density) and net photosynthesis (PFD 1402, 1412 and 1419 µ mol CO_2 $m^{-2}s^{-1}$) (Table-13). The photon flux density (PFD) and net photosynthesis were as minimum as 97 µ mol $m^{-2}s^{-1}$ and 2.7µ mol CO2 $m^{-2}s^{-1}$ respectively in the case of cashew when grown with acacia before the removal of this tree species. Two years after the removal of acacia the photon flux density was 1418 µ mol m^{-2} s^{-1} and net photosynthesis was 8.8 µ mol CO_2 $m^{-2}s^{-1}$. Similar trend was observed before and after the removal of subabul and casuarina. This indicated that though the values for the above parameters were minimum when tree species were grown upto five years after planting, after the removal of these tree intercrops the main crop (cashew) picked up considerably. This was also reflected in increased yield two years after the removal of tree intercrops.

Microbial activity:

Microbial counts were taken in the soils where tree species (acacia, casuarina and subabul) were grown as intercrops during the

Table-13: Photosynthesis and other related parameters of cashew (maincrop) under different cropping systems before and two years after the removal of tree species.

Cropping system prevailing in 1997 i.e. upto five years after planting	PFD		P_n		g_s		Ci (ppm)		E		WUE	
	BRT	2 yrs ART	BRT	2 yrs ART	BRT	2 yrs ART	BRT	2 yrs ART	bRT	2 yrs ART	BRT	2 yrs ART
Cashew + mococroo	1392	1402	9.0	10.3	0.89	0.98	295	275	6.65	7.3	1.44	1.43
Cashew + acacia	97	1418	2.7	8.8	0.72	0.81	256	261	3.62	6.3	0.97	1.38
Cashew + casuarina	353	1416	4.6	8.9	0.83	0.89	284	274	7.24	8.4	0.58	1.05
Cashew + subabul	598	1484	6.1	9.8	0.79	0.91	314	253	7.00	8.8	0.86	1.11
SEm		- 0.420									SEm	0.089
CD		- 1.29									CD	0.2761

PFD - Photo Flux Density (µ mol $m^{-2}s^{-1}$), P_n - Net photosynthesis (µ mol CO_2 $m^{-2}s^{-1}$)

g_s - Stomatal Conductance (mol $m^{-2}s^{-1}$), Ci - Intercellular CO_2 concentration (ppm), E - Transpiration (m mol H_2O $m^{-2}s^{-1}$)

WUE - Water Used Efficiency (µ mol CO_2/m mol H_2O), BRT - Before Removal of Tree species, ART - After Removal of Tree species

initial five years of cashew (main crop) orchard by serial dilution and plating in various media. The population of bacteria, fungi, actinomycetes, phosphate solubilising bacteria, fungi and nitrogen fixing bacteria was enumerated. The results from the samples taken during December and January showed an increase in the population of actinomycetes and decrease in total bacteria, fungi, phosphate solubilising bacteria, and nitrogen fixing bacteria (Table-14) in plots where tree species acacia, subabul and casuarina were grown as intercrops for the first five years of the orchard life. This was also reflected in N and P_2O_5 contents of the soil in the above cropping systems (Table-15).

Nutrient content of the soil in the cropping system:

The soil samples taken for microflora studies were also analysed for nutrient content to understand the effect of growing intercrops on nutrient content of the soil. It has been found that nitrogen content was maximum in plot where cover crop was grown and minimum in plots where acacia, subabul and casuarina were grown as intercrops. The P_2O_5 content in these plots was also found to be minimum. This is in conformity with the reduced population of phosphorous solubilising bacteria and fungi (Table-13). Phosphorous content in pineapple plot (cashew + pineapple) was fairly high (43.8 Kg/ha). This

Table 14: Microbial population in different cropping systems (Population/g of dry soil)

Cropping system	Bacteria	Fungi	Actinomycetes	P. solubilising fungi	P. solubilising bacteria	N fixing bacteria
Cashew monocrop	18.87×10^5	24.12×10^3	34.25×10^4	19.5×10^2	22.87×10^3	16.87×10^3
Cashew + pineapple	29.5×10^5	25.75×10^3	34.75×10^4	19.75×10^2	17.37×10^3	16.37×10^3
Cashew + subabul	21.68×10^5	95.00×10^3	38.13×10^4	18.85×10^2	19.85×10^3	15.00×10^3
Cashew + acacia	14.15×10^5	17.85×10^3	16.87×10^4	19.5×10^2	12.85×10^3	7.75×10^3
Cashew + casuarina	11.25×10^5	15.75×10^3	17.00×10^4	25.25×10^2	4.27×10^3	9.13×10^3
Cashew + mucuna	17.50×10^5	27.25×10^3	35.75×10^4	21.19×10^2	13.25×10^3	13.62×10^3

Table 15: NPK and Ca content of soil under different cropping systems.

Cropping system	N (%)	P_2O_5 (Kg/ha)	K_2O (Kg/ha)	Ca (ppm)
Cashew monocrop	0.08	16.81	190.5	105
Cashew + pineapple	0.09	43.80	118.5	108
Cashew + acacia	0.06	10.50	92.5	78
Cashew + subabul	0.09	8.22	84.3	143
Cashew + casuarina	0.08	7.52	120.3	124
Cashew + covercrop	0.14	20.20	133.4	124

is mainly due to the build up of P content in soil as a result of yearly application of phosphorous in the form of rock phosphate over a period of five years in the cropping system where pineapple is grown as intercrop.

Yield:

The yield data during the first seven years after planting and two years after the removal of acacia, subabul and casuarina are presented in Table 16. In these plots, the tree species were grown for the first five years. Pineapple suckers were planted in trenches dug out across the slope between two rows of cashew one year after the removal of tree species (acacia, subabul and casuarina). The yield of main crop (cashew) increased considerably (12.12, 10.32 and 13.15 Kg/plot intercropped with acacia, subabul and casuarina respectively) when pineapple was planted after the removal of tree species. The yield recorded from the plot intercropped with pineapple right from 1987 was significantly higher than that of other plots. Lowest yield was recorded from the plot intercropped with acacia even two years after its removal. However, the yield of cashew in the plot where acacia was grown for the first five years and removed later has increased over the previous years almost by five folds. Such magnitude of increase in yield over the previous year was not observed in case of other plots where cashew alone, cashew with pineapple, cashew with casuarina and cashew with subabul were grown. This indicated that though acacia had affected yield of the main crop initially, later after its removal, the yield of cashew increased considerably. This is in conformity with the observations on photon flux density and net photosynthetic rate in the above plot (Table-13). The difference in yield of cashew among different treatments was not significant except in the case of cashew with pineapple where cashew yield was significantly superior to that of all other plots including control plot (cashew alone). Data on cumulative yield for the last six years also showed that combination of cashew and pineapple was the highest (61.41 Kg/plot). Minimum yield was obtained from the cashew with acacia combination (16.25 Kg) (Table 16).

Table-16: Yield of cashew two years after the removal of tree species and cumulative yield (Kg/plot of 384 square meter area)

Cropping System	6 yrs after planting and 1 yr. after the removal of tree species	7 yrs after planting and 2 yrs after the removal of tree species	Cumulative yield for the last 6 years
Cashew monocrop	7.78	14.42	34.74
Cashew + pineapple	14.37	28.34	61.41
Cashew + casuarina*	6.75	12.12	26.16
Cashew + acacia*	2.15	10.32	16.25
Cashew + subabul*	5.44	13.15	26.65
Cashew + mucuna	8.45	15.32	35.40
Cashew + guava	5.94	13.55	31.07
	SEm	2.29	
	CD(5%)	7.07	

* The intercrops existed upto 5 years. Pineapple was planted after removing the tree species.

Agr. V : Orchard Management-Comparison of hedge and square system of planting under pruned and unpruned conditions.

(MG Nayak and N Yadukumar)

This project was started with the main objective of increasing yield per unit area by adopting optimum population through proper spacing, System of planting and pruning. The experiment was laid out in 1990. The treatment details are given below.

Design : Split plot
Replications: 3

Treatment (Main plots)

1. 5mx5m square
2. 6mx6m square
3. 8mx8m square
4. 5mx4m square
5. 6.5mx4msquare
6. 8mx8m square

Treatment (Sub plots)

1. Pruned
2. Unpruned

During the year modified central leader system of pruning was imposed in subplot treatments. Besides this, initial training of the plants for attaining proper shape was also done. On an average 6.5 Kg of dry matter has been removed per tree to impose the above pruning and training treatment.

Observations on growth:

During the year, observations on growth parameters such as height, girth of trunk above and below graft joint, spread of the canopy and ground coverage were taken. Except spread and ground coverage in pruned and unpruned trees, the difference was not significant for all the above characteristics among different treatments (Table-17).

Photosynthesis and related physiological parameters

Observations taken on photosynthesis and related physiological parameters like transpiration and WUE by using LCA-3 photosynthesis system indicated that there is no difference among different treatments.

Table-17: Observation on growth as affected by different spacing treatments under pruned and unpruned conditions.

Treatment	Mean height(m)		Mean spread(m)		Mean girth (cm)				Percent ground area covered by the crop canopy	
					AGU		BGU			
	Pruned	Unpruned	Pruned	Unpruned	Pruned	Unpruned	Pruned	Unpruned	Pruned	Unpruned
5m x 5m	2.8	3.0	3.50	3.65	31	37	37	38	38.16	41.31
6.5m x 6.5m	2.4	2.6	3.25	3.20	26	24	28	28	18.73	18.98
8m x 8m	2.4	2.2	3.05	3.35	25	25	29	29	11.69	15.76
5m x 4m	2.7	2.7	3.50	3.40	29	31	32	35	48.08	39.69
6.5m x 4m	2.4	2.4	3.30	3.60	27	26	31	32	32.87	30.06
8m x 8m	2.6	2.3	3.40	3.80	30	27	33	30	28.35	25.12

AGU - Above graft union
BGU - Below graft union

Yield:

It has been observed that unpruned and untrained trees yielded better in the second harvest than trained trees (four years after planting). This is mainly due to the removal of biomass owing to the initial shape pruning (training) imposed. Under pruned condition, maximum yield was recorded in the case of 5mx4m and 5mx5m spacing (500 and 449.75 Kg/ha, respectively) and minimum yield was recorded in the case of 8mx8m and 6.5m x 6.5m spacings (116.79 and 195.08 Kg/ha, respectively). In the case of trees which have undergone shape pruning (training) maximum yield was recorded in the case of 5mx5m and 5mx4m spacing (358.75 and 358.1 Kg/ha, respectively) while minimum yield was recorded in treatments 8mx8m and 6.5m x 6.5m spacings (96.95 and 162.45Kg/ha, respectively) (Table-18).

Table 18. Yield as affected by different systems of planting under pruned and unpruned conditions

Spacing	Density No./ha	Yield(Kg/ha)	
		Pruned	Unpruned
Square system			
5m x 5m	400	358.75	449.75
6.5m x 6.5m	236	162.45	195.08
8m x 8m	150	96.95	116.69
Hedge system			
5m x 4m	500	358.10	500.00
6.5m x 4.0	384	295.75	301.78
8m x 4m	318	250.25	252.35
SEm for spacing : 28.01		SEm for pruning : 11.94	
CD for spacing : 71.78		CD for pruning : 29.83	

Agr. VI : Development of suitable cashew based cropping system.

(N Yadukumar and B Nagaraja)

In order to evolve suitable cashew based cropping system, two separate experiments, with forest tree species and fruit crops were laid out at Kemminje and Shantigodu, respectively after clear felling of existing cashew trees and forest trees in 1990.

Cashew with forest species:

Growth characters: Observations on growth characters revealed that growing forest tree species with cashew did not affect girth, height, spread and ground coverage of main crop (cashew) except in the case of combination of acacia and casuarina with cashew four years after planting (Table-19). Forest species were planted 3.5m away from cashew while spacing for cashew was 10m x 5m.

Net photosynthesis and other physiological parameters

Observations on net photosynthesis revealed that the Pn values for cashew when grown with acacia and casuarina were minimum indicating that retaining these forest species further in the plot would affect cashew crop (Table-20).

Table-19 Growth characters of cashew as affected by growing forest species in the interspace

Treatment	Population per plot of 1000 sq.m	Girth (cm)	Height (m)	Spread (cm)	Ground coverage (Sq-m)	Percent ground coverage
Cashew+casuarina+acacia	20+42+21	25.99	218.15	298.60	4.97	9.54
Cashew+acacia+casuarina	20+42+39	27.14	240.0	251.87	7.25	14.46
Cashew+ailanthus	20+57	31.33	280.0	305.59	7.94	15.88
Cashew+bamboo	20+15	31.88	265.0	318.04	7.67	15.34
Cashew high density	40	29.24	208.33	312.69	7.40	29.60
Cashew+subabul	20+225	30.55	253.33	307.07	7.18	14.36
Cashew monocrop	20	31.75	216.66	302.36	8.38	16.76

Table-20 Photosynthesis and other related physiological parameters as affected by growing forest species with cashew.

Treatment	PDF (μ mol $m^{-2}s^{-1}$)	Transpiration (m mol H_2O m^{-2} s^{-1} (Eo)	Stomatal conductance (mol m^{-2} s^{-1}) (gs)	Intercellular CO_2 conc. (mol/l) (ppm)	Net Photosynthesis (μ mol m^{-2} s^{-1}) (Pn)
Cashew+casuarina+acacia	706	6.8	0.55	240	7.2
Cashew+acacia+casuarina	689	6.2	0.29	250	6.2
Cashew+ailanthus	1512	9.0	0.56	268	8.8
Cashew+bamboo	1481	9.8	0.48	261	9.22
Cashew+subabul	1831	9.5	0.48	255	10.25
Cashew-high density	1510	8.9	0.44	262	10.12
Cashew monocrop	1590	8.9	0.38	243	11.00
CD (5%)	210	1.06	0.16	—	2.9

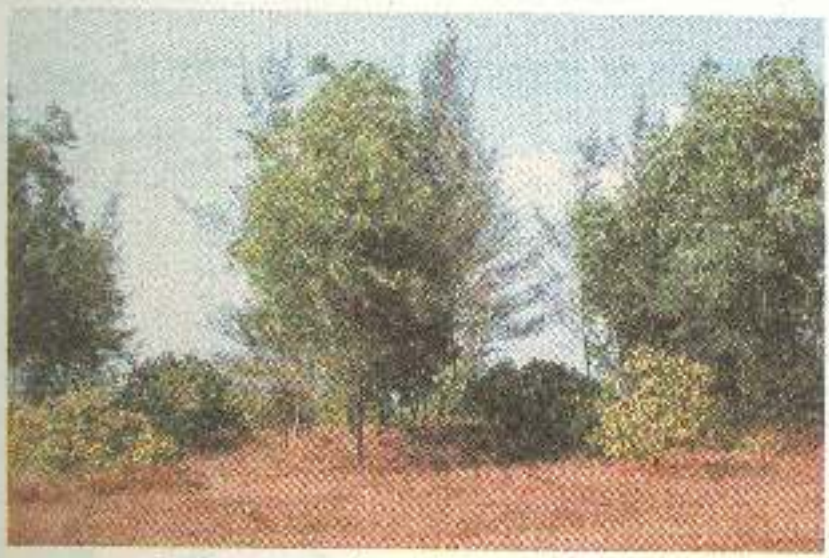
Yield:

For the first four years after planting, combination of casuarina and acacia affected cashew yield when grown as intercrops. Maximum yield (459.96/ha) per unit area was obtained from plot where high density planting of cashew was adopted (Table 91).

Cashew with fruit crops

Among the fruit crops, except gooseberry and garcinia, none of the crops established well indicating that under unirrigated conditions these crops do not come up well in coastal Karnataka. Instead of custard apple ramphal (*Anona reticulata*) was planted as per the decision of the Seventh Research Council Meeting. Another variety of gooseberry will be planted during this year in place of ber (*Zizipus mauritiana*).

Cropping system - cashew with silanthus



Cropping system - cashew with acacia and casuarina

Table 21. Cashew yield (Kg) as affected by growing various forest tree species when grown as inter/mixed crop for the first four years after planting.

Cropping system	Mean yield/plot of 300 sq.m (Kg)	Mean yield/ha (Kg)
Cashew + casuarina + acacia	3.5	116.35
Cashew + acacia + casuarina	2.9	96.57
Cashew + ailanthus	6.9	229.77
Cashew + bamboo	5.8	193.14
Cashew high density	13.0	432.96
Cashew + subabul	6.5	309.79
Cashew monocrop	7.2	239.76
SEM	0.337	
CD (5%)	1.028	

Agr VII : Comparative efficacy of slow release nitrogenous fertilizers for cashew

(N Yadukumar)

The experiment was laid out in 1990 by planting cashew grafts of M 44/3. During the year, treatments were imposed as per the technical programme. Instead of lac coated urea, it was decided to include biofertilizers as one of the treatments. The biofertilizers were procured from University of Agricultural Sciences, Bangalore. This treatment will be imposed during the following season. Chemical analysis of leaf for N content after the application of fertilizers showed no significant difference among different treatments (Table-22). Data on yield from second harvest, revealed no significant difference among different treatments (Table-23).

Table 22. N content in leaf as affected by fertilizer treatments (%).

Treatment	I year		II year	
	BFA	AFA	BFA	AFA
Urea split dose	1.83	2.06	1.853	2.067
Urea single dose	1.88	2.04	1.933	2.057
Urea in perforated bag once in a year	1.87	2.08	1.977	2.110
Urea in perforated bag once in 2 years	1.83	2.07	1.980	2.063
Urea formaldehyde once in a year	1.85	2.11	1.980	2.173
Urea formaldehyde once in 2 years	1.91	2.15	1.870	2.097
Neem coated urea once in a year	1.86	2.11	1.890	2.070
Neem coated urea once in 2 years	1.95	2.07	1.858	2.080
NP tablet once in a year	1.90	2.05	1.953	2.163
NP tablet once in 2 years	1.88	2.08	1.890	2.083
SEm	0.0364	0.04464	0.034	0.0248
F. Test	NS	NS	NS	NS

Table 23. Yield as affected by fertilizer treatments (kg/plot)

Treatment	Yield
Urea split dose	4.09
Urea single dose	3.94
Urea in perforated bag once in a year	3.69
Urea in perforated bag once in 2 years	3.60
Urea formaldehyde once in a year	3.55
Urea formaldehyde once in 2 years	3.99
Neem coated urea once in a year	4.18
Neem coated urea once in 2 years	3.75
NP tablet once in a year	4.50
NP tablet once in 2 years	3.61
SEm = 0.9467	F Test – NS

Phy. III : High Density planting of cashew

(N Yadukumar)

This experiment was initiated in 1982 to asess the effect of different plant densities on growth and yield.

Yield:

Maintaining the plant density of 555 trees/ha gave the highest yield/ha as compared to other treatments during 1994 (12 years after planting and five years after thinning from 1111 trees to 555 trees/ha) (Table-24). Cumulative yield data (from 4 to 12 years after planting), however, showed that maintaining plant population of 685 trees/ha for the first ten years after planting and thinning down to 312 trees/ha afterwards, gave the highest yield of 4944 Kg/ha.

Table 24. Cashew yield under differerent plant densities (kg/ha)

Plant density (No./ha)		Yield 12 years after planting	Cumulative yield (from 4 to 12 years after planting)
156		433.20	2279
278		660.50	3141
685	Upto 10 years and 312 after thinning	705.76	4944
1111	Upto 7 years and 555 after thinning	711.70	4985
3530	Upto 7 years and 685 after thinning	661.11	4548
		SEm = 36.34	
		CD (5%) = 108.97	

Hort. IV : Studies on off-season graft production in cashew.

(MG Nayak and KRM Swamy)

The project has an objective of finding the possibility of production of soft wood grafts during off-season (flushing/flowering period) and also improvement of the grafts success during drier months (summer months).

Grafts production with green scions

Results obtained so far indicated that the green scion sticks of above 60 days were superior for grafting. Hence, the study was continued with green scion sticks of 60 day and above. Soft wood grafts with green scion sticks of above 60 days were produced on commercial scale between November and December 1994 and the graft success was 54.2 per cent (Table-25).

Soft wood grafting under low cost midity chamber

This experiment was conducted us low cost humidity chamber to overcome problem of low graft success during d months (Jan - May). Fresh grafts immedia after grafting, were kept under low cost midity chamber and were maintained fo days. A similar set of grafts were produ and maintained as per normal practice control (putting cap on individual graft). graft success did not differ between the methods (Table-26).

Table 25. Graft success with green scions during flushing/flowering season (1994).

Month of grafting	No. of grafts produced	Graft success (%)
Nov.	6450	53.0
Dec.	4465	55.4
Total	10,915	54.2

Table 26. Graft success under low cost humidity chamber during 1995.

Month of grafting	Graft success (%)	
	Normal method	Low cost humidity chamb
Jan.	68.0	72.0
Feb.	69.0	67.0
Mar.	59.0	61.0
Apr.	61.0	64.0
May	63.0	69.0
Mean	64.0	65.2

(100 grafts prepared in each month)

Hort. V : Root stock studies in cashew

(MG Nayak and KRM Swamy)

This project was initiated with an objective of screening the root stocks at seedling stage for identifying dwarfing root stock.

Various root stocks screened did not differ with respect to their seedling height, girth at collar region, number of leaves, internodal length, total phenols, stomatal count and bark percentage in root and shoot. Thus, it was decided to evaluate the available semidwarf types in the field. Seedlings raised from seeds of Brazilian origin and other Indian types were also planted for initial evaluation. The height and stem girth of the seedlings were recorded (Table 27). The height of the plants in the case of semidwarf types ranged from 67.9cm to 111.4 cm and the stem girth was 7.6cm to 9.5cm after 18 month of planting. The height of the Brazilian types ranged between 114.00cm to 157.8cm and the stem girth ranged from 5.5cm to 12.6cm. Simultaneously root stocks of semidwarf types (VTH-76/4, S-11/1, VTH-703/3) were raised. Soft wood grafts on these root stocks were produced with their scions and those of NRCC Selection-1 and will be planted during next planting season.

Table 27. Mean plant height and stem girth of seedlings of Brazilian origin and semidwarf types after 18 months of planting in the field.

Type	Source	Plant height (cm)	Stem girth (cm)
Brazil - I		157.8	12.6
Brazil - II	Brazil	114.0	8.5
Brazil - III		130.5	10.1
H. Gollahalli	Mulbagalu Taluk, Kolar district	96.6	9.5
S-11/1	CPCRI (RS), Vittal	111.4	8.6
S-11/2	CPCRI (RS), Vittal	82.6	7.6
VTH-769/2	CPCRI (RS), Vittal	95.0	9.0
VTH-769/4	CPCRI (RS), Vittal	67.9	8.0
VTH-769/2 + VTH-769/1		53.7	8.7
S-12/1 + NRCC-Sel. 1		125.6	9.5
VTH-174 + VTH-769/4		45.0	6.0
Anacardium orthonianum		74.5	7.5

Hort. VI : Comparing the economics of top working with replanting of cashew

[KRM Swamy and PS Bhat, Mariamma Daniel CPCRI, RS, Vittal (collaborater)]

The objective of the project is comparison of the economics of top working with fresh planting or replanting with cashew grafts.

Trial at Shantigodu

Thirty cashew trees of 14 year old were top worked with VTH-30/4 during September/ October 1990 (0.9 ha area). In the adjacent plot, thirty cashew trees were completely removed and fresh planting was done with 30 grafts of VTH-30/4 (0.2 ha area), during July/ August 1990. Of the 30 top worked trees, 11 trees died due to stem and root borer infestation during the first year of establishment despite regular prophylactic treatment. During the year under report, swabbing the base of the trunk and exposed roots of top worked trees with carberyl (0.2%) was taken up once in three months as a prophylactic treatment against stem and root borer. One more tree was infested with stem and root borer during the year.

Observations on growth parameters such as plant height and trunk girth in replanted grafts and shoot length and girth in top worked trees were recorded during February 1995 (Table-28). In the case of replanted grafts, the plant height ranged from 300-400cm with a mean of 320cm, the trunk girth from 22-38cm with a mean of 31.3cm and the yield from 0.20-1.70Kg/plant with a mean of 0.47Kg. In the case of top worked trees, the length of grafted shoots ranged from 250-400cm with a mean of 315 cm, the shoot girth (above graft joint) from 16-41 cm with a mean of 26.3cm and the yield from 0.90-2.90 kg/plant with a mean of 1.64 Kg/plant.

The cost of establishment and maintenance of 0.2ha each of top worked plot and replanted plot during the last five years is Rs. 4452 and Rs. 5343 respectively. The cumulative yield of nuts obtained from both the plots is presented in Table-29.

Trial at Vittal

A trial on top working was initiated during August 1994 in the concluded manurial trial plot of cashew at CPCRI Regional Station,

Table 28. Plant height and trunk girth of replanted grafts and shoots length and girth of top worked plants at Shantigodu.

Plot		Plant height/ shoot length (cm)	Trunk shoot girth (cm)	Yield/ plant (kg)
Replanted plot.	Min.	300	22.0	0.20
	Max.	400	38.0	1.70
	Mean.	320	31.3	0.47
Top worked plot.	Min.	250	16.0	0.80
	Max.	400	41.0	2.90
	Mean	315	26.3	1.64

Table 29. Cost of establishment and maintenance of top worked plot and replanted plot (0.2 ha each) during the last five years at Shantigodu.

Year	Amount spent (Rs)		Yield (Kg)	
	Top worked	Replanted	Top worked	Replanted
1990-91	1941	650	---	---
1991-92	645	550	---	---
1992-93	956	609	35.65	---
1993-94	829	1000	34.37	10.00
1994-95	582	393	27.80	20.40
Total	4452	3552	97.80	30.40

Vittal. Before initiating the trial, weed growth was slashed and stem and root borer infested trees and dead trees (27 No.) were removed. Then 55 healthy cashew trees of 12 year old were treated with Bordeaux paste (10%) and the trunk portion was swabbed with carbaryl (0.2%). Swabbing the bark of the top worked trees was done at monthly intervals either with carbaryl (0.2%) or neem oil (2%) as a prophylactic control measure against stem and root borers.

Sprouting was observed after 45-50 days of beheading and after about 30 days of sprouting, the beheaded trees produced shoots of 25-30 cm length. The number of shoots produced by the beheaded trees ranged from 27-121 per tree. During November-December 1994, about 15-20 juvenile shoots of 30-40 cm length and of pencil thickness were grafted on each tree with scions of NRCC-Selection-1 by adopting soft wood grafting technique. In addition to the shoots selected for grafting, few extra shoots were also retained to avoid drying of the tree. When the growth from the grafted scions was abundant, the extra shoots (sap drawers) were removed. Of the 407 shoots grafted, 235 were successful with a mean graft success of 57.7 per cent. About 5-10 successful grafted shoots were retained on each tree and the remaining shoots were removed. Further thinning will be done. Of the 55 top worked trees, 11 trees (31.4%) died due to stem and root borer infestation inspite of regular prophylactic treatment given. Till March 1995, seven treatments with carbaryl (0.2%) and two treatments with neem oil (2%) were given. Drenching the soil with carbaryl (0.2%) was also done once after carefully loosening the soil around the tree trunk upto a radius of 45cm. Before giving the monthly prophylactic treatment the stumps of the top worked trees were inspected for the presence of stem and root borer eggs/grubs. Wherever the infestation was observed, the eggs/grubs were mechanically removed by chiselling out the bark. Then the carbaryl (0.2%) swabbing was given to the wounds made and to the whole stump. A total of 184 eggs and 118 grubs of stem borer were extracted from the infested stumps of top worked trees between September 1994 and May 1995. The number of eggs and grubs extracted from each infested tree ranged from 0-93 and 1-22, respectively. The peak activity of the adults was noticed in the months of March and April and about 90 per cent of eggs were collected during this period. The cost of establishment and maintenance of 55 top worked trees (0.2ha) during the first year (August 1994 to March 1995) was Rs. 3784 (Table-30).

Table 50. Cost of establishment and maintenance of top worked plot (0.2 ha) at Vittal during the first year.

Item of work	Amount (Rs.)
Slashing of weed growth	920.00
Cutting and removing the stem and root borer infested trees/dead trees (27 No. x Rs. 25)	675.00
Beheading of healthy trees (35 No. x Rs. 25)	875.00
Scion collection, grafting of shoots and further maintenance (11 md x Rs. 40)	440.00
Cost of scions (407 No. x Rs.1)	407.00
Plant protection chemicals (Carbaryl 840g and Neem oil 800ml)	267.00
Labour (5.5 md x Rs. 40)	220.00
Total	3784.00
Estimated cost of fuel wood (68 trees x 900 Kg = 18,400 Kg; @ Rs. 0.50 per Kg)	9200.00

Hort. VIII : Canopy management studies in cashew

(MG Nayak)

This project envisages to study the effects of pruning on dwarfing and canopy containment, flushing and flowering behaviour and branching habit. It is also contemplated to understand the mechanism of yield improvement due to leader shoot pruning.

A field trial with four cashew varieties namely VRI-1 (intensive branching and early flowering type), Ullal-1 (intensive branching and late flowering type), VTH-30/4 (extensive branching and late flowering type) has been laid out at Experimental Station, Shantigodu, in 1992 with three replications in a Completely Randomised Block Design (CRBD). During the year, modified leader system of training has been imposed on all the plants.

CROP PROTECTION

Prophylactic treatments with Limanool and RD 9 Repellin at three months intervals were effective in checking stem and root borer infestation. Carbaryl (0.2 per cent) with granular application of Sevidol G (75g/tree) and treatment with chlorphyriphos (0.2 per cent) was effective curative measure against this pest. *Beauveria bassiana* remained in soil for more than three months when mixed with neem cake at 4:1 ratio. A technique has been developed for efficient rearing of different stages of stem and root borer on host bark. A wind tunnel olfactometer has been fabricated to evaluate the attractants and to investigate the presence of sex phermone. Biochemical changes in cashew bark after grub feeding were also studied.

Telenomus sp. an egg parasitoid of tea mosquito bug was detected throughout the year. This parasitoid was also found to be prevalent in the areas surveyed in Goa. Ant movement was found to hinder parasite activity in cashew canopy.

Commercial neem formulations when sprayed retained oviposition deterrence property upto week. Among these formulations, Nimbecidine was effective under field conditions. In another field experiment, carbaryl Flo, a safer insecticide for beneficial insect, was comparable with carbaryl WP, in checking tea mosquito bug.

Ent. V : Developing Integrated Pest Management package against cashew stem and root borer *Plocaederus ferrugineus L*

(PS Bhat and TN Raviprasad)

This project was initiated for standardizing the prophylactic, curative, biological and other control measures against cashew stem and root borer *P. ferrugineus* in order to develop Integrated pest management packages.

(a) Prophylactic control measures

During the year, commercial neem pesticides such as Nimbecidine, Limanool RD-9 Repellin and Godrej Achook were tested as a prophylactic control measure. The treatments were given at three months intervals and the results are presented in Table-31. At the end of the year, Limanool and RD-9 Repellin treated trees were free of infestation. However, Nimbecidine and Godrej Achook recorded damage of 8.0 and 4.0 per cent respectively. The cost of application per tree per round ranged from Rs. 2.42 to 3.50.

(b) Curative control measures

The grubs present inside stem and root borer infested trees were mechanically removed and the insecticides listed in Table-32 were applied to the affected portion. Drenching the soil around the base of tree trunk was also done with the same insecticidal solution. Carbaryl (0.2 per cent) treatment along with granular application of Sevidol G (75g/tree) was helpful in saving the trees with survival of 85.3 per cent of the treated trees (Table-32). Similar response was also noticed with chlorphyriphos (0.2 per cent). The cost of treatment ranged from Rs. 2.90 to 5.72 per tree. The trees at middle and advanced stages of infestation didn't respond to curative treatments.

(c) Biological control studies

Studies were conducted to observe persistence of *Beauveria bassiana* which was found to be highly pathogenic to grubs under laboratory condition. The pathogen was mass cultured on lower grains and depending upon sporulation, 15-30 day old spawn was used

Table 31. Prophylactic control against cashew stem and root borer *P. ferrugineus*.

Treatment	Trees attacked (%)		Cost (Rs./tree/ round)
	Current year	Mean for two years	
Nimbecidine (0.5%)	8.0	4.0	2.45
Limanool (0.5%)	0.0	0.0	2.42
Godrej Achook (0.5%)	4.0	4.0	2.50
RD-9 Repellin (0.5%)	0.0	2.0	2.50
Neem oil (6%)	4.0	4.0	3.50
Control	12.0	10.0	–

Table 32. Curative control of cashew stem and root borer *P. ferrugineus*

Treatment	Trees attacked (%)		Cost (Rs./tree/ round)
	Current year	Mean for two years	
Chlorpyriphos (0.5%)	83.3	76.7	4.50
Carbaryl (0.5%)	75.0	72.5	2.62
Carbaryl (0.5%) + Sevidol (1.75g/tree)	83.3	81.7	5.72
Limanool (1%)	16.7	68.3	2.00
Control	16.7	13.3	—

for experimental purposes. For every 1000cc of soil 100cc of spawn was added and mixed thoroughly. This mixture was kept in earthen pots and soil samples were drawn at 15 day intervals. The grubs were allowed to crawl on this sample for two minutes. The mortality was 100 per cent in soil sample drawn after 15 and 30 days while it was 85.7 per cent in the sample drawn after 45 days (Table-33). The results indicated that the fungus could survive in the soil even in the absence of organic matter for a period of one and half months.

In the second experiment, sterilized soil was mixed with neem cake in the ratio of 4:1 and *B. bassiana* spawn was added as described above. The mortality was 100 per cent in the soil samples drawn after 90 days (Table-34) indicating the ability of fungus to survive in the soil for at least three months under favourable conditions.

Table 33. Infectivity of *Beauveria bassiana* when mixed with soil

Age of sample (days)	% mortality after		
	1 week	3 weeks	5 weeks
15	71.4	100.0	100.0
30	57.1	85.7	100.0
45	71.4	85.7	85.7
60	14.3	28.6	28.6

Table 34. Infectivity of *Beauveria bassiana* when mixed with soil + neem cake (4:1)

Age of sample (days)	% mortality after		
	1 week	3 weeks	5 weeks
15	28.6	71.4	100.0
30	57.1	100.0	100.0
45	42.9	100.0	100.0
60	42.9	57.1	100.0
90	28.6	85.7	100.0

(d) Field occurrence of *Metarhizium anisopliae*

M. anisopliae was found naturally infecting the grubs under field condition at KCDC plantations, at Kolle and Kunthur. This fungus was isolated and found to be pathogenic both to *Plocaederus ferrugineus* and *P. obesus* grubs.

Ent. VI : Biological control of tea mosquito bug, *Helopeltis antonii* Sign (Hemiptera : Miridae) and other sucking pests of cashew.

(TN Raviprasad)

The project deals with the seasonal incidence of sucking pests of cashew, their indigenous parasitoids and developing mass rearing technique for the host insect tea mosquito bug.

(a) Survey for natural enemies of TMB

During the present survey, it was observed that the pest population itself was low resulting in lesser number of eggs that could be sampled. The egg parasitoid *Telenomus* sp. however, prevailed throghout the year at varying levels. The egg parasitoids *Chaetostricha* and *Erythmelcus* spp. were not encountered during the present survey (Table 35). Survey was also conducted at Goa wherein upto 45.9 per cent parasitization by *Telenomus* sp. was recorded during March-April 94 (Table-36). Two new egg parasitoids emerged from the TMB eggs collected from Goa have been sent for identification.

Table 35: Details of egg parasitoids emerging from TMB eggs collected from various locations (1994-95)

Month of Survey	Mani			Pane Mangalore			Kanaje			Kemminje			Shantigodu		
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Apr.	27	4(1)	14.8	16	3	18.7	19	6(3)	31.5	7	1	14.2	9	5(1)	44.4
May	33	8(3)	24.3	21	4(1)	19.0	16	2	12.5	8	0	0	11	2(2)	36.4
Jun.	12	2(1)	16.7	6	0	0	5	0	0	11	3(1)	27.3	6	1	16.6
Jul.	10	4	40.0	18	2	11.1	11	3	27.3	4	1	25.0	7	1(1)	28.5
Aug.	28	7(5)	25.0	22	5(2)	22.7	31	9(4)	29.0	8	2	25.0	12	3(1)	25.6
Sep.	16	8	18.5	10	3	30.0	8	6(2)	75.0	5	0	0	4	0	0
Oct.	7	0	0	18	4(2)	38.3	9	1	11.1	5	1	20.0	8	3(1)	37.5
Dec.	15	7(2)	46.7	13	2(1)	15.4	21	6(4)	28.5	11	2(1)	18.2	16	3(1)	18.7
Jan.	8	1	12.5	6	1	16.6	5	0	0	10	1	10.0	12	5(2)	41.6
Feb.	17	3	17.6	15	4(3)	26.6	12	5(3)	41.6	5	0	0	8	1	12.5
Mar.	22	10(3)	45.5	18	6(4)	33.3	15	8(2)	53.3	6	2(1)	33.3	6	1(1)	16.6

Number in parantheses indicate number of parasites unemerged, but confirmed through egg dissection.
Zero values indicate absence of egg parasitoids

A = Total number of eggs collected
B = Total number of parasitised
C = Percentage parasitisation

Table 36. Details of egg parasitoid *(Telenomus sp.)* emerging from eggs collected from various locations of Goa.

Location of survey	Total no. of eggs collected	No. of parasitoids	% parasitation	Maximum time taken for emergence (days)
Ela	57	11(8)	52.8	37
Mapusa	49	14	56.5	41
Morod	88	9	56.4	33
Bantolim	57	17(1)	45.9	44
Ponda	16	5	51.5	33
Mandol	43	12	27.9	38

Figures in parantheses indicate number of unidentified new parasitoids collected.

(b) Ant activity in cashew tree canopy

This study was aimed to assess the influence of ants movement, on parasitization. The hourly observations were done on marked tertiary branches. The ant foraging was mainly observed during morning hours (8.30am) and pollination activity was higher during afternoon (3.30pm). Random movement of ants was observed in 46.88 per cent of total ants entering the marked branch which hindered parasite activity (Table 37).

Table 37. Ant activity observed in cashew tree canopy.

Variety	Time of observation	Pollination	Feeding extra-floral nectaries	Random running movements
Goa - 1/86	8.30 am	69 (53.48)	170 (70.84)	21 (8.74)
	3.30 pm	76 (36.37)	35 (16.75)	98 (46.88)
V-2	8.30 am	53 (30.94)	120 (70.88)	10 (6.13)
	3.30 pm	97 (45.75)	45 (21.25)	70 (33.02)
K-24	8.30 am	23 (25.0)	59 (64.64)	15 (10.39)
	3.30 pm	84 (63.64)	23 (23.17)	25 (13.19)
V-5	8.30 am	35 (25.46)	140 (64.81)	21 (9.73)
	3.30 pm	71 (47.08)	66 (43.05)	15 (9.83)

Figures in parantheses denote percentage of total ants. Values are the number of ants involved in each activity.

(c) Preparation and evaluation of semi-synthetic diet

A semi-synthetic diet was evaluated for it's suitability as a feeding substrate as well as for oviposition. The diet comprised of 100g of soaked green gram ground with cashew shoots (50g) and salt mixture(0.5g). This diet was thoroughly blended, sieved and autoclaved and provided in different forms: (i) soaking cotton wool in diet (ii) layering of diet between filter discs and (iii) diet turgidly held below parafilm membrane. Adult bugs were caged on these diets and observed for survival and keeping quality of diets. It was observed that adults survival was upto 40 per cent till 36hr in cotton wool soaked diet and 60 per cent till 36hr in diet layered between filter discs.

(d) Incidence of flower thrips

During the flowering season, severe incidence of two species of flower thrips, *Haplothrips ganglbaueri* (Sch.) and *Scirtothrips dorsalis H.* was noticed. Observations regarding percentage of panicles attacked indicated a maximum of 82.0 per cent and a maximum mean of thrips per panicle recorded was 12.5.

Symptoms of thrips infestation on cashew nut and apples

Ent. VIII : Testing the efficacy of plant products against tea mosquito bug, *Helopeltis antonii S.*

(PS Bhat)

This project was initiated to explore the possibility of inclusion of safe and eco-compatible plant based products in the management of tea mosquito. Commercial neem formulations were evaluated in laboratory for persistence of oviposition deterrence activity, toxicity and residual action. A field experiment was also conducted using the products found to possess insecticidal properties.

(a) Persistence of oviposition deterrence activity

Earlier studies have shown that commercial neem formulations act as oviposition deterrent against tea mosquito bug. In order to study the persistence of this property, gravid females were allowed to lay eggs on seedlings after 3,7 and 15 days of treatment with Godrej Ahook, Nimbecidine, Limanool and RD-9 Repellin at 1.0 per cent concentration. The number of eggs laid after 48hr of release were counted. The reduction in number of eggs laid (Table-38) suggested that deterrent action lasts for minimum of one week in most of the formulations.

(b) Evaluation of plant extracts

Aqueous extracts of *Strychnos nuxvomica* leaf and fruit and solvent extract of pongamia were evaluated for insecticidal properties. Mortality was observed only in case of *S. nuxvomica* fruit extract (Table-39). The damage rating on mid rib and lamina was lower than untreated control in most of the extracts tested.

The damage ratings after 5 and 7 days of treatment is presented in Table-40. Damage rating on mid rib and lamina was significantly lower in *S. nuxvomica* fruit extract compared to control.

Table 38. Persistence of oviposition deterrence activity of commercial neem formulation.

Commercial formulation	3 days after treatment		7 days after treatment		15 days after treatment	
	Mean no. of eggs	% reduction over control	Mean no. of eggs	% reduction over control	Mean no. of eggs	% reduction over control
Godrej Achook	10.6	25.4	11.6	21.6	14.4	14.3
Nimbecidine	11.0	22.5	12.0	18.9	17.6	0
Limanool	8.2	42.5	9.2	37.8	15.8	0
RD - 9 Repellin	10.2	28.2	10.8	27.0	16.6	01.9
Control	14.9	0	14.8	0	18.8	0

Table 39. Knock down action and feeding deterrence activity of certain plant extracts against tea mosquito bug.

Treatment	% mortality	Damage score on		
		Shoots	Mid rib	Lamina
S. nuxvomica leaf (5%)	0.0(4.1)a	3.00b	2.296c	1.96b
S. nuxvomica fruit (5%)	11.1(19.5)b	3.00b	1.77b	2.15b
Solvent extract of pongamia (1%)	0.0(4.1)a	3.00b	1.78b	2.25b
Monocrotophos (0.05%)	100.0(90.0)c	0.22a	0.15a	0.15a
Untreated control	0.0(4.1)a	3.07b	2.78c	2.30b
CD at 5%	9.9	0.62	0.84	1.00

Figures in parentheses are transformed values

Figures followed by common alphabet in each column are statistically on par

(c) Field evaluation of neem formulations

Neem oil, pongamia oil and three commercial formulations were evaluated for their insecticidal property under field conditions. The sprays were given at monthly intervals after flushing. The damage on shoot and damage score was recorded before treatment and after 30 days of each spray. The data obtained were subjected to co variance analysis to eliminate the treatment difference arising due to insect attack before spraying. The adjusted mean values are presented in Table 41. Among the neem formulations, Nimbecidine recorded significantly lowest damage on shoot and damage score after third round of spray. Limanool and pongamia oil were also found to be significantly superior to untreated control.

Table 40. Residual action of certain plant products against tea mosquito bug.

Treatment	Damage score on					
	3 days			7 days		
	Shoots	Mid rib	Lamina	Shoots	Mid rib	Lamina
S. nuxvomica leaf (5%)	3.00b	2.296c	1.96bc	3.00b	2.07bc	2.11b
S. nuxvomica fruit (5%)	3.00b	1.70b	1.59b	3.00b	1.48b	2.67b
Solvent extract of pongamia (1%)	3.00b	2.40bc	2.70cd	3.00b	2.41c	2.48b
Monocrotophos (0.05%)	0.98a	0.15a	0.15a	0.19a	0.15a	0.15a
Untreated control	3.00b	2.77c	2.41cd	3.00b	2.81c	2.41b
CD at 5%	0.19	0.70	0.57	0.19	0.92	0.92

Figures followed by common alphabet in each column are statistically on par

Table 41. Efficacy of neem, pongamia and commercial formulations against tea mosquito bug

Treatment	Damage one month after					
	I spray		II spray		III spray	
	%	Score	%	Score	%	Score
Neem oil (2.5%)	25.11	0.49a	29.95b	0.75bc	37.57bcd	0.99bc
Pongamia oil (2.5%)	28.68	0.69abc	22.02ab	0.39ab	25.47bc	0.46b
Godrej Achook (1%)	35.94	1.05bc	41.85c	1.2d	36.97d	0.86c
Linanool (1%)	21.51	0.36a	26.04b	0.40ab	25.97bc	0.56bc
Nimbecidine (1%)	23.41	0.51ab	23.74ab	0.44ab	20.2b	0.35ab
Carbaryl (0.1%) (Treated control)	15.85	0.80a	9.79a	0.15a	8.29a	0.10a
Untreated control	39.67	1.19c	40.69c	1.14cd	35.56cd	0.8c
CD at 5%	NS	0.56	13.92	0.47	11.43	0.33

All the percentage values are transformed and adjusted means

All the damage score values are adjusted means

Figures followed by common alphabet in each column are statistically on par

(d) Evaluation of carbaryl Flo

Field evaluation of carbaryl Flo was taken up along with carbayl WP, endosulfan, chlorphriphos and malathion for the control of tea mosquito bug for third year. Treatments were given at monthly intervals after flushing. The data obtained on shoot damage and damage score were subjected to covariance analysis. The adjusted mean values obtained after analysis are presented in Table. 42. Carbaryl Flo was found to be on par with carbaryl WP after one month of third spray in checking the insect build up and subsequent damage.

The data obtained for 1992-93, 1993-94 and 1994-95 were found to be homogeneous and so co-variance analysis was done after pooling the data. The adjusted mean values for different treatments after one month of each spray are presented in Table 43. Both shoot damage and damage score revealed that carbaryl Flo was on par with carbaryl WP after one month of third spray. Both these treatments and endosulfan were found to be statistically significant over control. Considering the safety of carbaryl Flo to natural enemies and pollinators, it can be incorporated in the management of tea mosquito bug.

Table 42. Efficacy of Carbaryl Flo and other insecticides against tea mosquito bug during 1994-95.

Treatment	Damage one month after					
	I spray		II spray		III spray	
	%	Score	%	Score	%	Score
Carbaryl WP (0.1%)	13.13a	0.38a	9.07a	0.31a	1.67a	0.01a
Carbaryl Flo (0.1%)	15.46a	0.45ab	11.05a	0.36a	6.37a	0.24ab
Endosulfan (0.05%)	30.41a	0.83ab	25.15ab	0.74ab	19.80ab	0.53b
Chlorpyriphos (0.05%)	40.30b	1.27cd	22.17ab	0.73ab	37.70c	1.13c
Malathion (0.1%)	26.92ab	0.70bc	24.81ab	0.81ab	23.10ab	0.98c
Control	39.61b	1.16cd	40.21b	1.31b	35.42bc	0.05c
CD at 5%	13.71	0.46	18.52	0.61	12.55	0.39

All the percentage values are transformed and adjusted means
All the damage score values are adjusted means
Figures followed by common alphabet in each column are statistically on par

Table 43. Efficacy of Carbaryl Flo and other insecticides against tea mosquito bug (pooled data of 1992-93, 1993-94 and 1994-95)

Treatment	Damage one month after					
	I spray		II spray		III spray	
	%	Score	%	Score	%	Score
Carbaryl WP (0.1%)	24.71	0.43	19.34	0.38a	12.95a	0.16a
Carbaryl Flo (0.1%)	25.36	0.62	23.93	0.57ab	11.59a	0.18a
Endosulfan (0.05%)	35.86	0.86	36.70	1.08ab	28.40b	0.58b
Chlorpyriphos (0.05%)	41.36	1.23	38.73	0.98ab	37.36c	1.06c
Malathion (0.1%)	34.46	0.70	33.14	1.07ab	30.09b	0.87c
Control	48.07	1.38	46.92	1.85c	42.04c	1.26d
CD at 5%	NS	NS	NS	0.77	6.14	0.17

All the percentage values are transformed and adjusted means
All the damage score values are adjusted means
Figures followed by common alphabet in each column are statistically on par

Ent. IX : Standardisation of mass rearing technique for the cashew stem and root borers, *Plocaederus* spp. and investigations for attractants and pheromones.

(TN Raviprasad, PS Bhat and KV Nagaraja)

This project contemplates to standardise the mass rearing technique using semi-synthetic diet, to survey for population dynamics and to investigate the presence of attractants/ pheromones.

(a) Survey for population dynamics

The grub population was high during pre-monsoon (March-May) and late monsoon season (Aug.-Nov.). Pupation occurred during the winter months (Nov.-Jan.) overlapping with adult emergence. Eggs were encountered mainly near the collar region and in the soil around the trunk.

The infestation pattern was in patches with a severely attacked tree being source of further infestation. Freshly laid eggs were noticed mainly on severely attacked trees. Of the two stem and root borer species, *P. ferrugineus* dominated considerably (70.8 per cent) over *P. obesus* (29.2 per cent) among the field collected and reared adults (Table-44).

(b) Mass rearing technique

A technique has been developed for efficient mass rearing of different stages of stem and root bores and is described below.

(i) Egg collection

Adult beetles emerging from the pupae were allowed for mating in 1ft acrylic cages. Stout cashew twigs wrapped with 2cm wide cotton tape were provided for egg laying. This stimulated the insertion behaviour of females

Table 44. Details of population survey conducted at various locations during 1994-95.

Month of Survey	NRCC Shantipodu			NRCC Kennanje			KCDC Kolla			KCDC Alanga	
	Egg	Grub	Pupa	Egg	Grub	Pupa	Egg	Grub	Pupa	Egg	Grub
Mar	8	82		5	8		14	189		10	49
Apr.	5	166					17	88		6	32
May		52					6	33		8	20
Jun.		130						14			17
Jul.		58									
Aug	3	12			6			10			36
Sep.		20			5			112	4		180
Oct		16			2	2					
Nov.		11						88	9		71
Dec.		10	4					12	6		8
Jan.		14	3								
Feb.	7	86			3	1	10	19	7		13
Mar.	11	143					19	62			44

and elicited higher oviposition (Table 45). Eggs were collected on alternate days by gently dislodging them using a camel hair brush. This method of egg collection elicited higher egg laying and easy dislodging without damage and has been used for further rearing activities.

(ii) Grub rearing

Eggs were counted and placed in a covered petridish and observed for hatching twice a day (Table 46). Nascent grubs were individually released into holes pierced on 2cm² bark pieces and these were placed in covered petridishes and moistened daily. Grubs were removed on 7th or 8th day and released on bigger bark pieces placed in rearing bottles. Autoclaved fibrous mass was added over the pieces to retain moisture in the bark.

(iii) Pupae collection and holding

Initiation of pupation was identified by reburgitated calcium smeared by the grubs. Such bottles were separated and inspected for completion of cocoon formation after

Table 45. Effectiveness of egg collection technique for cashew stem borer (1994-95)

Month of egg collection	*P. ferrugineus*		*P. obesus*	
	Eggs laid on cotton tape wrapped twig	Eggs laid elsewhere	Eggs laid on cotton tape wrapped twig	Eggs laid elsewhere
Aug.	75.83 (179)	26.17 (28)	68.48 (65)	31.52 (29)
Sept.	84.71 (268)	15.29 (48)	68.48 (55)	31.52 (29)
Oct.	84.82 (324)	15.18 (58)	78.25 (187)	21.75 (52)
Nov.	88.90 (349)	17.10 (79)	80.00 (244)	20.00 (61)
Dec.	79.08 (188)	20.96 (40)	76.85 (318)	23.15 (96)
Jan.	77.74 (834)	22.26 (67)	74.30 (240)	25.70 (83)
Feb.	83.06 (103)	16.94 (21)	76.71 (112)	23.29 (34)

Figures in parantheses indicate actual number of eggs.

Table 46. Details of egg collected and their hatchability (1994-95)

Month	*P. ferrugineus*			*P. obesus*		
	Total no. of eggs	% Hatch	Average fecundity	Total no. of eggs	% Hatch	Average fecundity
Aug.	215	43.9	30.7	0	0	0
Sep.	1050	63.6	44.9	178	66.5	49.5
Oct.	1330	67.4	50.5	1819	71.8	58.7
Nov.	920	61.9	43.7	1039	63.5	50.6
Dec.	346	73.4	46.8	994	78.3	63.8
Jan.	1250	74.6	61.0	556	59.1	54.5
Feb.	514	54.6	38.7	467	57.6	48.4
Mar.	116	51.0	28.0	112	46.2	33.4

$$\text{Average fecundity} = \frac{\text{Total No. of eggs collected}}{\text{No. of mated females}}$$

15-30 days. Completed calcareous cocoons were carefully pried out and kept *en masse* in 1ft wire mesh cage to conserve shelf space. Pupal periods observed during different seasons are presented in Table-47.

(iv) Adult rearing

Emerged beetles were collected daily and individual species were confined to different cages for egg laying. The beetles were provided with 10 per cent sucrose solution as food. As adults bit and mutilated each other when left alone, dried cashew leaves were also provided which acted as hiding niches. The sex ratio observed was 1:1 for both the species.

(d) Standardisation of semi-synthetic diet

The acceptance and keeping quality of various semi-synthetic diets prepared from bengalgram flour, wheat flour, and rice flour was evaluated. Excepting rice flour, the others formed firm diet chunks.

Addition of 800mg Griseofulvin, an antifungal antibiotic, per 100gm of diet, UV light exposure of prepared diet chunks for 4-6 hours, starving of borer grubs to induce defecation followed by surface sterilisation with 80 per cent ethyl alcohol resulted in lesser fungal contamination of the diet. The weight gained by the grubs on different diets is given in Table-48.

Feeding by grubs on young cashew bark for different periods of time resulted in decreased protein content in the bark (young bark : control 4.36mg/100g defatted cashew bark powder, fed for three weeks - 2.57mg/100g defatted cashew bark powder). Similar results were obtained when fed on old bark.

A wind tunnel type glass olfactometer having an uniform cross sectional area throughout was facricated to identify the presence or absence of pheromones and attractants. The olfactometer has dimensions of 150 x 30 x 30cm (LxBxH) with a bait chamber and a test chamber (each 30cm³) one each on either ends. A regulated airflow is provided at one end by a minifan. Moveable glass sheets form the inner wall of the test insects.

Table 47. Pupation details for field collected grubs reared on cashew bark

Period of grub collected	Pre-pupal period (days)	Pupal period (days)	Sex ratio
Mar. - May	35 - 54 (39.5)	59 - 92 (64.0)	1 : 1.10
Jun. - Aug.	30 - 61 (42.0)	68 - 110 (70.0)	1 : 1.08
Sep. - Nov.	40 - 67 (44.5)	76 - 121 (78.0)	1 : 1.05
Dec. - Feb	43 - 64 (51.0)	91 - 140 (95.5)	1 : 1.02

Figures in parentheses indicate mean values.

Table 48. Larval weight increase for *P. ferrugineus* fed on different semi-synthetic di

	Base material used	Initial weightht (g)	Increase in weight after 15 days (g)	% Increase
Expt. 1				
	Wheat flour	0.8015	0.1985	24.0
	Bengalgram flour	0.7940	0.1499	18.0
	Rice flour	0.8984	0.0912	11.0
	Control	0.7922	0.1109	14.0
Expt. 2				
	Wheat flour	0.9541	0.8856	31.0
	Bengalgram flour	0.9447	0.9456	38.0
	Rice flour	0.9387	0.1597	17.0
	Control	0.9372	0.1819	19.0
Expt. 3				
	Wheat flour	1.827	0.5115	28.0
	Bengalgram flour	1.886	0.4105	22.0
	Rice flour	1.841	0.8760	15.0
	Control	1.864	0.3353	18.0
Expt. 4				
	Wheat flour	1.973	0.7300	37.0
	Bengalgram flour	1.895	0.5874	31.0
	Rice flour	1.988	0.4572	23.0
	Control	1.981	0.4754	24.0

QUALITY ANALYSIS AND POST-HARVEST TECHNOLOGY

During storage of nuts of VRI-1 and VRI-2 both at ambient low temperature (6 °C), kernel triglycerides decreased while free sterols increased. Similar changes were noticed when bulk nuts were stored at ambient temperature. Electrophoretic studies of kernel proteins both under native and denatured conditions did not reveal major changes during storage of nuts.

Biochem-I : Studies on biochemical changes during storage of cashew nut and apples.

(KV Nagaraja)

The project was initiated in 1990 with an objective of studying the biochemical changes during storage of nuts and apples both at ambient and low temperature to arrive at a suitable temperature for storage.

Kernel triglycerides in the neutral lipid fraction decreased during storage of nuts both at ambient and low temeprature (6° C). Similarly, free sterols fraction increased during storage (Table 49). Similar changes were observed during storage of bulk nuts at ambient temperature (Table-50).

Electrophoretic studies of alkali extracted kernel proteins both under native and denatured conditions during storage of nuts both at ambient and low temperature did not reveal any major changes.

Samples of some of the factory kernel rejects received from M/s. Achal Industries

Table 49. Changes in composition of neutral lipids during storage.

Variety	Storage temp. (°C)	Storage period (days)	Hydro-carbons	Sterol esters	Triglycerides	Free sterol	Diglycerides	Monoglycerides
			% of neutral lipids					
VRI-1	30	0	1.1	0.9	88.4	7.1	1.1	2.5
		90	8.7	0.5	70.8	98.6	1.7	0.3
		450	–	–	–	100.0	–	–
		560	–	–	–	96.3	0.9	2.8
		700	–	–	–	96.7	0.7	2.6
	6	280	3.7	1.1	25.3	64.6	1.9	3.2
		420	–	–	–	100.0	–	–
		560	0.5	–	0.5	93.9	1.6	3.4
		700			1.3	98.9	0.1	0.7
VRI 2	30	0	1.3	0.9	89.3	06.5	1.8	8.9
		280	3.2	1.1	7.1	79.7	2.8	4.2
		420	–	–	–	100.0	–	–
		560	0.48	0.50	0.18	92.9	2.5	3.7
		700	0.41		0.32	98.1	1.98	5.97
	6	280	4.4	1.6	4.3	61.8	3.8	4.0
		420			–	100.0	–	–
		560	0.59	0.31	0.36	92.25	3.57	2.91
		700	0.34	0.29	1.00	95.07	2.50	2.60

Table 50. Changes in the composition of neutral lipids during storage of bulk nuts at ambient temperature.

Storage period (months)	Hydro-carbons	Sterol esters	Triglycerides	Free sterol	Diglycerides	Monoglycerides
	% of neutral lipids					
0	0.6	0.3	41.2	50.9	3.3	3.7
4	0.5	0.9	1.6	90.4	2.5	4.0
8	1.5	0.5	41.7	48.8	3.1	5.1
12	1.5	1.1	14.3	76.3	3.0	3.5
16A	1.4	0.3	1.7	93.4	1.6	1.4
B	1.4	–	1.5	93.0	2.1	1.9
20 A	1.2	1.4	1.5	93.7	1.1	1.0
B	5.5	–	10.4	71.9	5.7	6.5
24 B	1.3	–	85.3	58.9	7.1	8.4

A - Good with distinct stale smell

B - Completely spoiled

were analysed for moisture, protein and sugar contents. Both moisture (1.91 to 4.85%) and protein contents (55.15 to 78.12%) among different types of rejects were in agreement with the values for good kernels. Sugar content among different rejects (0.75 to 9.16%), however, was less compared to values for good kernels.

TRANSFER OF TECHNOLOGY

During the year a total of 45,245 grafts of different varieties of cashew were sold to farmers and developmental agencies with a realisation of Rs. 4,32,450. Successful grafts produced during the year were 40,200. Two training courses on "Cashew Production Technology" and one course on "Vegetative Propagation of Cashew" were conducted and a total of 49 persons were trained. Analysis of pre-evaluation and post-evaluation scores of trainees pertaining to course on Cashew Production Technology conducted during 1994 and 1995 showed that the trainees fared well in Crop Improvement, while their performance in Agrotechniques needed improvement. Educational qualification and official position of trainees were positively and significantly correlated with post-evaluation scores. Four more demonstrations were laid out on farmers' fields during the year bringing the total number of demonstrations laid out, so far to 54. A total of Rs. 16,983 was given as input support under the CSS of the DCD to 12 farmers.

Gen. 1 (443) : Maintenance of cashew scion bank and production of planting materials.

(KRM Swamy, B Nagaraja and MG Nayak)

The project was initiated in 1989 under the Revolving Fund Scheme with the objective of commercial multiplication of cashew varieties/elite materials for distribution to developmental agencies and farmers.

Maintenance of cashew scion bank

A total of 56,820 scions were collected and utilized for grafting during July-December 1994. Soft wood grafts of Kanaba (12 No.), Dhana (15 No.), Ullal-3 (15 No.), Chintamani-1 (25 No.) and Ullal-4 (40 No.) were planted in the scion bank at Shantigodu during the year. Soft wod grafts of Ullal-3 (20 No.) were planted in the scion bank at Kemminje also.

Supply of planting materials

During 1994-95 a total of 45,245 grafts of different cashew varieties/elite materials were distributed to farmers and developmental agencies. Revenue of Rs. 4,52,450 was realised from the sale of grafts.

Production of cashew grafts

During the year a total of 1,02,620 seeds (670Kg) were sown in polythene bags between May and September. A mean germination percentage of 75.1 was obtained (Table-51). During the year, a total of 56,820 soft wood grafts of different cashew varieties/elite materials were produced between July and December, of which 40,200 were successful with a mean graft success of 70.7 per cent (Table-52).

Table 51: Cashew root stocks raised during 1994

Month of sowing	No. of seeds sown	No. of seeds germinated	Germination percentage
May	12,020	10,020	83.3
Jun.	24,680	19,075	77.3
Jul.	18,900	14,570	77.0
Aug.	36,620	27,180	74.2
Sep.	10,500	6,275	59.7
Total	1,02,680 (670 Kg)	77,100	75.1

Table 52: Cashew grafts produced during 1994.

Month of grafting	No. of grafts prepared	No. of grafts Successful	Grafts success (%)
Jul.	5,750	4,805	81.0
aug.	11,205	7,805	69.6
Sep.	12,170	10,800	88.7
Oct.	13,825	9,400	68.1
Nov.	9,365	5,400	57.6
Dec.	4,465	2,100	47.0
Total	56,820	40,200	70.7

Extn. I (443) : Training extension and research workers and farmers.

(Sreenath Dixit and KRM Swamy)

During the year, a training course on "Vegetative propagation of cashew" was conducted from 19-20 October, 1994, and was attended by the field staff of the State Departments of Horticulture/Agriculture and Cashew/ Forest Development Corporations of different States. Two training courses on "Cashew Production Technology" were conducted during the year for middle level officials of departments engaged in cashew development activities. Statewise participation in the training courses is given in Table-53. Besides these courses, a one day refresher course was conducted for senior level officials of the Department of Agriculture and Cooperation, Ministry of Agriculture/Horticulture, Coconut Board and Directorate of Cashewnut Development, Cochin. A two day orientation course on Cashew Production Technology was also conducted for the officials of ARCPC, Myanmar.

Performance of trainees in the training programmes conducted during 1994 and 1995 (sample size 60) was assessed and correlated with their age, educational qualification, official position, experience in the present post and number of training courses attended on cashew. The correlation matrix (Table-54) showed that trainees' educational qualification and official position were significantly and positively related with their post-evaluation scores.

Table 53:Statewise participation in Training course (1994-95)

States	Vegetative propagation of cashew	Cashew Production Technology	Total
Andhra Pradesh	5	6	11
Karnataka	11	3	14
Kerala	4	2	6
Meghalaya	—	12	12
Tamil Nadu	2	4	6
Total	22	27	49

Analysis was further carried out to know the trainees comprehension of the course lectures on "Cashew Production Technology". Pre-evaluation and Post evaluation scores of the trainees were compared section wise. The major sections on which comparison was made, were (i) Crop Improvement (ii) Agro-techniques (iii) Crop Protection.

Crop Improvement : Three major points considered in this section were (i) grafting (ii) top working (iii) pruning

(i) Grafting : Most of the trainees (60.1%) believed that epicotyl grafting was a commercially viable technique of Vegetative propagation of cashew before undergoing training. Their opinion, however, changed remarkably after they underwent the course. The post evaluation showed that majority of (80.2%) the trainees were convinced that soft wood grafting is the method which is commercially viable in cashew. Further, 80.1 per cent of the trainees could also state the correct age of root stock for grafting.

Table 54: Correlation Matrix

	Age	Educational qualification	Official position	Experience in the present post	Training course attended	Post evaluation score
Age	—					
Educational qualification	-0.442**	—				
Official position	0.310	0.517**	—			
Experience in the present post	0.319*	-0.108	-0.845	—		
Training courses attended	-0.037	-0.017	-0.097	0.104	—	
Post evaluation scores	-0.151	0.321*	0.389**	0.068	-0.133	—

* Significant at 5 per cent level

** Significant at 1 per cent level

(ii) Top working: Before undergoing the training course 55 per cent of trainees knew that top working in cashew is a technique for rejuvenating unthrifty trees. After the course was over, nearly 3/4 (73.5%) of the trainees could also mention the correct height (1m) at which top working should be attempted.

(iii) Pruning: Though 51.8 per cent of trainees had thought that pruning cashew was harmful before undergoing the course, about 55 per cent of them could indicate the correct time of pruning in the West Coast after the course was over.

2. Agrotechniques: Spacing, intercrops and fertilization were the three aspects considered for comparison in this section.

(i) Spacing: In the pre-evaluation, it was observed that 89 per cent of the trainees were knowing the spacing to be adopted (8m x 8m) in cashew.

(ii) Intercrops: The trainees, however, did not seem to be convinced on the spacing to be adopted for intercropping under hedge row system (10mx5m) of planting. The post-evaluation showed that only 20 per cent of the trainees could mention the correct spacing for hedge row system of planting. By this, it can be inferred that either the trainees did not follow the concept of hedge row system as dealt in the course or they could not accept it having strong conviction on the spacing to be adopted (8m x 8m) in cashew. The trainees (71.4%), however, were found to be convinced on the period for which one could take intercrops.

(iii) Fertilization: In the pre-evaluation, though 61.8 per cent of the trainees agreed that cashew responded for N application, majority of the trainees (68.3%) could not recollect the recommended dose of NPK for cashew, taught during the course of lectures. This was evident from their post-evaluation

scores in which only 19 trainees (31.7%) could indicate the recommended dosage of NPK for cashew.

3. **Crop Protection:** In the pre-evaluation, 65 per cent of the trainees were found to be aware of the two important pests of cashew viz; tea mosquito bug (TMB) and stem and root borer (SRB). After the completion of course, 76.4 per cent of the trainees were able to indicate the stages of TMB attack on cashew, and 63.5 per cent of the trainees could differentiate between the treatment for SRB and TMB.

Entn. IV (443) : Research cum demonstration plots.

(Sreenath Dixit and PS Bhat)

Four more demonstration plots were laid out on farmers' fields during the year. With this, the total number of demonstrations laid out since 1988, came to 54. At present, 12 plots are receiving input support from Directorate of Cashewnut Development, Cochin, under Central Sector Scheme (CSS). The amount disbursed under the CSS so far, is detailed in Table-55.

Table 55: Input support provided by DCD under CSS

Year	Amount (Rs.)
1988-89	12,311
1989-90	20,646
1990-91	28,169
1991-92	28,554
1992-93	23,770
1993-94	30,089
1994-95	16,895
Total	1,51,360

Yield data were collected from all the plots which have completed five years of existence, ie., plots which were established during 1988, 1989 and 1990. Details are provided in Table-56.

All the plots were regularly monitored during the year. A survey was conducted to enumerate the pest complex in the four taluks where demonstrations have been laid out. Apart from tea mosquito which was noticed in 73.5 per cent of the plots, other pests noticed were thrips (44.1%) and apple and nut borer (44.1%). A meeting of old and new demonstration farmers was held on May 4, 1995.

Table 56: Yield recorded in demonstration plots.

Category	1988 planted		1989 planted		1990 planted	
	4th harvest		3rd harvest		2nd harvest	
	Kg/plot*	Kg/ha	Kg/plot*	Kg/ha	Kg/plot*	Kg/ha
Highest	360	450	460	575	130	163
Lowest	81	75	58	73	Nil	—
Mean	166	208	138	173	50	63

* Plot size 0.8ha. No. of plants 120

Extn. V(443) : Communication behaviour and socio-economic characteristics of cashew demonstration farmers - A study in Dakshina Kannada

(Sreenath Dixit)

Knowledge and adoption items of the questionnaire were finalysed by evaluating experts' responses in consultation with statistician. Further, a scale prepared by Varadaraju (1983) to study communication behaviour of contact farmers was modified to suit the purposes of the present study. Finally, a questionnaire was developed including questions to collect information on the variables considered for the study. The questionnaire was modified based on the feedback obtained through pre-testing the same by interviewing farmers.

As part of the above study, performance indices were computed for demonstration farmers by scoring for items such as soil fertility, gradient of the plot, general maintenance of the plot, response to guidance and nut yield per plot. It was observed that all the plots falling under the category "very good" had a yield level above 250Kg/plot, while, those in "average" and "poor" categories had yield ranging between 100-149 Kg/plot and less than 100Kg/plot, respectively (Table-57). Despite periodical monitoring and offering technical advice, poor yield was realised in some plots. This could be attributed to poor soil as noticed in a plot in Bantwal taluk where yield was as low as 75Kg due to the presence of hard pan below obstructing root growth. High incidence of tea mosquito infestation coupled with failure to take up timely spraying of insecticides also resulted in lower yields (<130Kg) in several plots in Belthangadi taluk. There were also instances of low yield (100Kg) due to sheer negligent attitude of the farmer concerned despite having fertile land. A thorough analysis of the success and failure of demonstration farmers is being attempted.

Table 37: Performance of demonstation farmers and yield (Kg/plot*) obtained.

Performance category	Yield				
	above 250	150-249	100-149	less than 100	Total
Very good	11	—	—	—	11
Good	—	6	—	—	6
Average	—	—	12	—	12
Poor	—	—	—	7	7
Total	11	6	12	7	36

* plot size 0.8 ha

CONCLUDED PROJECT

Agr.I (b) : Response of high yielding varieties of cashew to different levels of nitrogen (1982-1994)

Project leaders : Dr. K.V.J. Mohan (1982-83), Dr. R.C. Mandal (1983-84), Dr. K.B.A. Khader (1984-86), Shri N. Yadukumar (1986-94)

Associates : Dr. R.C. Mandal (1986-88), Mr. N.T. Bhat (1988-89), Mr. Thimmappaiah (1988-91)

Objectives:

1. To evaluate eight promising selections identified from the germplasm collection
2. To compare seedlings and grafts of the above selections
3. To assess the response of above selections to three levels of nitrogen in terms of growth, flowering habit and yield.

Mother trees, eight in number were selected from (a) comparative yield trial and (b) germplasm plots planted at CPCRI (RS), Vittal, in 1972. The trees were adjudged for its elitist performance on the score of multiple positive attributes, particularly that of consistent high yield, medium nut size, high shelling percentage.

A record of performance of the eight selected trees are given in the Table-1. Of the types, M-44/3 (VRI-2) variety has been outstanding for the better family performance also something suggestive of prepotency phenomenon. M-10/4 (VRI-1) with fairly good performance is also another released variety in Tamil Nadu.

The experiment was laid out in 1982 at CPCRI (RS), Vittal.

Layout plan and experimental details are given below.

Design : Split plot

Replication : 2

Plot size : a) Main plot : 156.8 Sq. m
b) Sub-plot : 19.6 Sq.m

Total experimental area : 2.03 hs.

Number of trees per plot : a) Main Plot -32
b) Sub Plot - 4

Spacing adopted : 7m x 7m

Total No. of experimental trees : 384

Total No. of trees including border : 601

Treatments:

Main Plot: Factorial combination of 3 levels of Nitrogen with grafts and seedlings

Sub Plot: 8 varieties

Nitrogen levels:

N_1 = 250g/tree/year
N_2 = 500g/tree/year
N_3 = 750g/tree/year

A uniform basal dose of 125g of P_2O_5 and K_2O per tree per year was applied in splits, one in pre-monsoon and the other in post monsoon season.

In the first year 1/3rd, 2nd year 2/3rd and 3rd year onwards full dose of fertilizers was applied.

Table 1: Performance of 8 selected trees for three years

Varieties	Original number	VTH accessions	Yield Kg/tree			Nut wt.	Shelling %
			80-81	81-82	82-83		
V-1	WBDC-V (Vpl)	CYT I 3/9	5.50	11.35	10.5	5.1	31.9
V-2	M-6/1 (Vrd)	CYT I 10/5	3.95	16.80	12.0	4.6	30.3
V-3	M-10/4 (Vrd)	CYT III 11/7	2.40	11.70	9.4	5.4	30.2
V-4	M-44/3 (Vrd)	CYT I A/2	10.60	15.10	17.5	5.0	31.0
V-5	A-18/4 (Vrd)	GM I 30/4	3.10	11.60	12.4	6.0	38.0
V-6	T.No.1 (Bla)	CYT II 34/8	4.80	18.50	5.9	6.3	38.9
V-7	Kodur-13/2 (Bla)	GM I 59/9	12.30	17.80	18.1	5.4	32.4
V-8	Bla-139-1 (Ank)	CYT III 150/4	5.72	12.80	9.6	5.5	31.0

The following observations were taken.

1. Observations on flowering, sex and fruit size.
2. Yield attributes like individual nut weight and shelling percentage.
3. Recording yield and expressed as total weight of raw nuts.
4. Nitrogen content of leaf and soil, and organic carbon and P_2O_5 K_2O content of soil
5. Insect damage score
6. Benefit/cost analysis of treatment plots.

Observations on flowering

Among the varieties M-6/1, M-10/4 and BLA-139-1 were found to be early in flowering, whereas, the varieties M 6/1, M-10/4, M-44/3 and A-18/4 have shown profused flowering nature. With regard to duration of flowering M-10/4, M-44/3 and A-18/4 varieties exhibited short flowering phase. The impact of fertilizer was seen with nitrogen application causing protracted period of flowering.

Observations recorded on onset of flowering in different months indicated that with increase in N levels there was an increase in

Table 2: Percentage of plants flowering in different months as affected by N levels.

Type of planting material	N_1 (250g N/plant)			N_2 (500g N/plant)			N_3 (750g N/plant)		
	Nov.	Dec.	Jan.	Nov.	Dec.	Jan.	Nov.	Dec.	Jan.
Grafts	31.5 (33.93)	63.5 (53.28)	5.3 (12.35)	52.6 (46.52)	47.4 (43.44)	— (1.81)	77.6 (69.15)	22.4 (27.83)	— (1.81)
Seedlings	41.1 (39.85)	58.9 (50.19)	—	53.1 (46.80)	46.9 (43.59)	—	35.4 (36.51)	64.6 (53.38)	—
Mean	36.2	61.2	2.6	52.9	47.1	—	36.5	43.5	—

CD at (1%)		Grafts	Seedlings
CD for fertilizer (N levels)	=	0.92	0.45
CD for Months	=	3.98	2.06

Figures in parentheses represent transformed values

Table 3: Percentage of plants in different duration of flowering as affected by N levels.

Type of planting material	N_1 (250g N/plant)			N_2 (500g N/plant)			N_3 (750g N/plant)		
	Short	Medium	Long	Short	Medium	Long	Short	Medium	Long
Grafts	9.8	77.0	13.2	4.9	66.1	29.0	3.5	75.4	21.3
Seedlings	5.0	66.7	28.3	1.8	71.0	27.4	0.5	70.4	11.1
Mean	7.4	71.8	20.7	3.3	68.6	28.2	6.4	77.4	16.8

the percentage of plants flowering early in the season (Table-2). At N_1 level (250 N/plant) the percentage of plants flowering in November was 31 and this increased to 77.6 per cent at N_3 level (750 g/plant). This was particularly evident in grafts because the planting material was uniform. Among the varieties M-6/1 and M-44/3 and to some extent A-18/4 flowered early. With regard to flowering duration, with increase in levels of N upto 500g/plant there was an increase in the percentage of plants having longer duration (Table-3).

Detailed observations on sex count were recorded. It was noticed that the perfect flowers ranged from 27.6 to 40.6 and male flowers ranged from 113.2 to 257.9. The varieties M-10/4 and M-6/1 had significantly more number of perfect flowers. However, with regard to total number of perfect flowers, apart from M-10/4 and M-6/1 two more varieties viz., M-44/3 and 13/5 Kodur, also showed more number of flowers (Table-4).

Table 4: Distribution of perfect and male flowers in different varieties as affected by N levels.

Varieties	Flowers/Panicle	
	Perfect	Male
WBDC-V	30.9	146.9
M-6/1	32.5	228.2
M-10/4	40.6	257.9
M-44/3	35.9	223.1
A-18/4	35.5	205.9
T.No.1	27.6	113.2
Kodur-13/5	39.1	213.0
BLA-139-1	30.8	150.2
F-test	=	NS
Nitrogen doses (g/plants)		
250	34.5	181.4
500	30.0	185.4
750	38.0	220.9
F-test	=	NS

Fruit set

Among the varieties, the fruit set was relatively high in M 6/11, M 10/4 (4.7/panicle), WBDC-V (4.4/panicle) and Kodur 13/8 (4.2/panicle) and low in M44/3 (4.4/panicle), A-18/4 (4.2/panicle) and T.No.1 (3.7/panicle).

Nut weight and shelling percentage

Application of different levels of nitrogen did not have any effect on individual nut weight and shelling percentage. In the case of seedlings nut weight was maximum in variety BLA-139-1 (7.22 g/plant) and minimum in WBDC-V (4.83 g/nut) whereas, in the case of grafts it was maximum in A-18/4 (6.89 g/nut) and minimum in M-10/4 (5.5g).

Insect damage score

Tea mosquito damage score ranging from 0-4 (minimum and maximum) was taken as the criterion to indicate the scoring of dam-

age caused in the months of February and March. It was found that though not statistically significant both in seedlings and grafts the score was maximum of 0.9 and 1.05 in the case of plants applied with higher dose of Nitrogen (N-750g/tree). Nitrogen caused more damage to the cashew panicles. Among the varieties maximum damage was noticed in T.No.1 (seedling 0.9 and graft 0.8) and next to this M-6/1 (seedling 0.6 and graft 1.1). Minimum damage was noticed both in seedlings and grafts of varieties M-10/4, M-44/3 and A-18/4 (Table-5).

Organic carbon, P_2O_5 and K_2O contents of the soil

The soil samples were analysed for organic carbon, P_2O_5 and K_2O content and it was found that organic carbon was 1.26 per cent and P_2O_5 and K_2O were 18.25 and 132 ppm respectively at the top 0-25cm depth of the soil. The contents decreased at lower depths (26-50 and 51-75 cm).

N content of leaf

Fourth or fifth matured leaf collected before fertilizer application and 30 to 45 days after the application of fertilizers was analysed for N content. Chemical analysis for N content of the leaves collected before the application of fertilizers showed that N content did not increase significantly with the increased application of N from 250 to 750g N/tree (applied 3.5 months earlier to leaf sampling). Increasing trend in N from 1.48 per cent to 1.54 per cent was, however, observed in plants receiving 250 to 750g N/tree respectively. The leaf N content did not vary significantly among the varieties also (Table-6).

Chemical analysis for N content of the leaves collected 30 to 45 days after the application of fertilizers showed that the N content of leaf increased from 1.81 per cent in the case of 250 N applied plant to 2.01 per cent in the case of 750g applied plant (Table-7).

Yield:

The cumulative yield data during the initial period of the orchard (1987 to 1990) showed that the yield of grafts was better than seedling progenies of the eight varieties (Table-8). Among grafts, M-6/1, BLA-139-1 and

Table 5: Insect damage score (0-4)

Variety	Seedlings				Grafts			
	N 250	N 500	N 750	Mean	N 250	N 500	N 750	Mean
WBDC-V	0.5	0.0	0.8	0.4	0.2	0.2	2.5	0.9
M-6/1	0.4	0.5	1.0	0.6	0.7	1.5	1.5	1.1
M-10/4	0.1	0.2	0.5	0.4	0.4	0.1	0.1	0.2
M-44/3	0.2	0.0	0.9	0.4	0.0	0.4	0.6	0.3
A-16/4	0.7	0.0	0.9	0.5	0.0	0.1	0.2	0.1
T.No.1	1.4	0.2	1.0	0.9	1.2	0.1	1.1	0.8
Kodur-13/5	0.3	0.0	1.8	0.5	0.6	0.1	1.6	0.8
BLA-139-1	0.9	0.2	0.6	0.6	0.5	0.8	1.2	0.6
Mean	0.56	0.13	0.9		0.42	0.31	1.05	
NS								

Table 6: Leaf N content (%) as affected by N levels before the application of fertilizers.

Variety	N level (g)			
	N 250	N 500	N 750	Mean
WBDC-V	1.52	1.50	1.49	1.53
M-6/1	1.45	1.51	1.52	1.49
M-10/4	1.49	1.64	1.55	1.56
M-44/3	1.50	1.60	1.54	1.55
A-18/4	1.57	1.55	1.54	1.55
T.No.1	1.46	1.52	1.60	1.53
BLA-139-1	1.50	1.52	1.46	1.49
Kodur-13/5	1.41	1.47	1.61	1.50
Mean	1.48	1.54	1.54	
CD (5%) = NS				

Table 7: N content as affected by different levels of N (%)

Variety	N level (g)			
	N 250	N 500	N 750	Mean
WBDC-V	1.75	2.05	1.89	1.89
M-6/1	1.74	1.83	1.89	1.82
M-10/4	1.74	1.90	2.05	1.89
M-44/3	1.89	1.88	2.17	1.96
A-18/4	2.31	2.80	2.84	2.85
T.No.1	2.17	1.96	2.10	2.07
BLA-139-1	1.75	2.05	1.96	1.91
Kodur-13/5	1.86	1.89	1.82	1.89
Mean	1.91	1.85	2.01	1.96

Kodur-13/5 gave higher yield than other varieties and among seedling progenies, M-6/1, Kodur- 13/5 and A-18/4 gave higher yield than other varieties. The cumulative yield increased from 4.25Kg to 5.52Kg/tree with increased application of N from 250g to 750g/tree.

The cumulative yield data during the seven years of harvest and for the first ten years after planting showed that there was linear response to N application. Varietal response to different doses of Nitrogen however differed in different years. Highest yield was recorded both in seedlings and graft population of variety M-6/1 (Table-9).

Benefit/cost analysis

Cumulative cost of cultivation and net

Table 8: Cumulative yield for 4 years (Kg/tree) as affected by different levels of nitrogen (1987 to 1990)

Variety	N level (g)			Mean	Grafts	Seedlings
	N 250	N 500	N 750			
WBDC-V	3.91	3.45	5.22	4.19	4.70	3.70
M-6/1	5.98	5.36	6.53	5.95	6.77	5.13
M-10/4	4.82	3.94	5.82	4.86	4.95	4.74
M-44/3	3.83	3.07	5.12	4.67	5.35	3.96
A-18/4	3.40	4.25	5.82	4.49	4.14	4.84
T.No.1	3.32	4.37	4.31	4.00	4.26	3.74
Kodur 13/5	4.72	5.10	6.39	5.40	5.88	4.92
BLA-139-1	4.03	5.30	4.97	4.76	6.14	3.38
Mean	4.25	4.61	5.52		5.27	4.20

Table 9: Cumulative yield data for seven years from 1987 to 1993 (Kg/tree)

Variety	N level (g)			Mean	Grafts	Seedlings
	N 250	N 500	N 750			
WBDC-V	9.77	9.54	14.9	11.17	10.55	11.79
M-6/1	15.48	16.55	20.3	17.45	15.44	19.46
M-10/4	12.14	12.06	14.96	13.05	12.97	13.13
M-44/3	10.41	13.00	16.15	13.18	10.88	15.48
A-18/4	10.45	13.69	16.28	13.46	14.93	12.00
T No.1	8.66	10.80	13.36	10.94	9.85	12.05
Kodur-13/5	10.81	11.70	14.72	12.41	11.81	13.04
BLA-139-1	10.82	12.87	15.32	12.33	10.40	14.25
Mean	11.07	12.53	15.41	12.99	12.10	13.90

CD for Main plot = 1.62
CD for sub plot = 2.85

profit realised for the first ten years after planting at three levels of N applications are presented in Table-10. Increase in net profit by Rs. 15,692/ha was observed in plot receiving the highest dose of N fertilizer (750g/tree) as compared to the lowest dose of N fertilizer (250g/tree). The corresponding increase in profit from N_1 (250g/tree) to N_2 (500g/tree) was marginal (Rs. 4044/ha). The increase in cost of cultivation was only Rs. 5580/ha due to increase in fertilizer application from 250g N to 750g N/tree.

The calculation presented in Table-10 is based upon the rates for cashewnut as per the prevailing market price for the corresponding years as follows:

1986 to 1988 (3 years to 5 years after planting) Rs. 14.00/Kg
1989 (6 years after planting) Rs. 20.00/Kg
1990 (7 years after planting) Rs. 25.00/Kg
1991 (8 years after planting) Rs. 30.00/Kg
1992 & 1993 (9 and 10 years after planting) Rs. 32.00/Kg

Conclusion

Linear response for yield was observed for N application from 250g to 750g/tree. The yield at the lowest dose (250gN) was 11.05 Kg/tree and at highest dose (750g N) was 15.4 Kg/tree. Among the varieties, highest yield was recorded in M-6/1 (seedlings and grafts) and lowest in T.No. 1.

Net profit realised at the lower fertilizer dose (250g N/tree) was Rs. 15,461/ha and it doubled to Rs. 31,158/ha in the case of highest dose (750g N).

Table 10: Benefit/cost analysis for the first ten years after planting

N fertilizer levels g/tree	Cumulative cost of cultivation (Rs/ha)	Yield (Kg/ha)	Value (Rs/ha)	Net profit (Rs/ha)
250	36989	2271	52450	15461
500	39571	2555	59076	19505
750	42219	3175	73372	31153

SUMMARY REPORT OF ALL INDIA COORDINATED RESEARCH PROJECT ON CASHEW

Summary Report of All India Coordinated Research Project on Cashew

The All India Coordinated Spices and Cashewnut Improvement Project was started during fourth five year plan in 1971 with the project coordinator's cell at Central Plantation Crops Research Institute, Kasaragod. During the seventh plan the on going project was bifurcated into two separate projects, one on cashew and another on spices. During the same plan period the coordinator's cell for cashew was shifted to the newly established National Research centre for Cashew, Puttur.

The All India Coordinated Research Project on cashew has eight centres and one sub centre of which four were started at the inception of AICS and CIP in the year 1971 (Bapatla-APAU; Anakkayam-KAU; Vengurla-KKV and Vridhachalam-TNAU). One centre at Bhubaneswar (OUAT) during fifth plan period and two more at Ihargram (BCKVV) and Chintamani (UAS) during sixth plan period were added. During eighth Plan one centre at Jagdalpur and one sub centre at Pilicode were also started. The budget allocation of the project for the year 1994-95 was Rs. 49.52 lakhs (Rs. 37.14 lakhs ICAR Share) and the expenditure was 31.31 lakhs (Rs. 23.48 lakhs ICAR Share).

The Project's mandate is to increase production and productivity through:

1. Evolving high yielding varieties with export grade kernels, tolerant/resistant to pests and diseases.
2. Standardizing agrotechniques for the crop under different agroclimatic conditions.
3. Evolving cost effective and efficient pest and disease management practices.

CROP IMPROVEMENT

A total of 866 cashew germplasm accessions (Bapatla - 155; Bhubaneswar - 79; Chintamani - 116; Jhargram - 127; Madakkathara - 120; Vengurla - 161 and Vridhachalam - 130) are being maintained and evaluated in different centres. During the year a total of 71 new collections (Bapatla 8; Bhubaneswar 4, Jhargram 9; Madakkathara 5; Pillicode 15; Vengurla 15; Vridhachalam 17) showing promising characters were added to the germplasm at different centres. The highest nut yield of 6.46kg/tree was recorded in Vengurla-3 at chintamani.

In multilocation trials, varieties collected from different centres are being evaluated. The highest yield was recorded in BPP-2/16 (7.05kg) at Bhubaneswar; H-1608 (6.25kg) and M44/3 (6.24kg) at Chintamani; VTH 59/2 (5.17kg.), H-2/16 (6.35kg) and VTH-30/4 (6.28kg) at Ihargram for the reported year and at Madakkathara the maximum nut yield (for six years) was recorded in H-1598 (12.17kg) and V-5 (12.10kg).

Evaluation of F_1 hybrids showed that three hybrids from Bapatla viz., Hy 4/1 (1x100) gave the maximum yield of 18kg and remaining two Hy 3/10 (T.No. 56xT.No.40) and Hy 1/7 (1x4) gave an yield of 10kg each. A hybrid Hy 13 (M 26/2x M 26/1) from Vridhachalam gave the yield of 4.17kg/year and a mean yield of 4.21 kg per five years.

CROP MANAGEMENT : A. AGRONOMY

In NPK trial, application of 1000g N, 250g P and 250g K ($N_2P_2K_2$) per tree per year gave the highest nut yield (11.34kg) compared to the control at Chintamani. Foliar application of urea with 2 per cent insecticides recorded the maximum nut yield of 8.266kg/plant at Bhubaneswar.

In spacing trial, the maximum yield/plant and yield/block were recorded in 10mx5m rectangular system with no thinning of plants and 6mx6mx6m triangular system at Jhargram centre, respectively.

In cashew based cropping system trial at Bapatla cluster bean and cowpea gave an yield of 1094kg/ha and 195kg/ha, respectively whereas, horse gram and sesamum did not perform well.

CROP MANAGEMENT : B. HORTICULTURE

Soft wood grafting was found to be the most successful method for vegetative propagation of cashew. The percentage of graft success ranged between 71.7 to 83.0 per cent during January, February and September at Bapatla; 79.0 to 77.0 per cent (July September) at Bhubaneswar; 63.0 per cent (October and November) at Chintamani; 49.0 to 59.0 per cent (June, August and September) at Jhargram; 60 to 75 per cent (January, February and July) at Vridhachlam.

A good graft success in top working was obtained at Bapatla (80.0%) and Bhubaneswar (75.60%) centres. In top worked trees with scions of V-4 at Vengurla, an average of 8.64kg nuts/tree and maximum yield of 14.78kg nuts/tree was recorded.

Screening of vigorous and less vigorous cashew types at Madakkatara revealed the possibility of identifying the less vigorous from the more vigorous using morphological characters at the seedling stage. At Vengurla growth analysis of 17 rootstocks is in progress.

CROP PROTECTION

Spraying of monocrotophos (0.05%), endosulfan (0.05%) and carbaryl (0.1%) at new flushing, panicle emergence and fruiting stage was found to be superior over other treatments in controlling tea mosquito bug at Chintamani and Bapatla centres whereas, spraying of monocrotophos (0.05%) at flushing and endosulfan (0.05%) at flowering stage at Vengurla and endosulfan (0.05%) at flowering and carbaryl (0.1%) at fruiting at Madakkathara were found to be superior.

In the trial on control of foliage/inflorescence pests of cashew with neem products, neem cake extract (5%) at Bapatla was found to be effective.

At Bapatla and Madakkathara neem oil (5%) swabbing upto 1m height from the base of the trunk acted as a good prophylactic measure upto 90 days for stem and root borer. Neem oil + Sevidol 4g at Bhubaneswar and Sevidol 4g (50g/tree) at Jhargram were found to be effective against stem and root borer.

In the survey for pest incidence in Andhra Pradesh, incidence of tea mosquito noticed was confined mostly to the northern coastal districts and stem borer to coastal sandy soils. Mild to moderate incidence of tea mosquito bug was prevalent at Bhubaneswar. In Jhargram the survey revealed leaf and blossom webber, leaf miner

and inflorescence thrips was more severe than tea mosquito in cashew growing tracts of West Bengal. The important predators noticed on cashew inflorescence in unsprayed area were the spiders, mirid bugs and *Chrysopa* larvae at Madakkathara.

Screening of germplasm to locate tolerant/resistant types to major pests of the region has been carried out. V-5 showed the least infestation for shoot tip caterpillar at Bhubaneswar. Twentyone accessions namely, BZL-120, BZL-939, BZL-944, Anakkayam-1, Madakkathara-1, K-22-1,H-3-13, H-3-17, H-680, H-688, H-719, H-1596, H-1597, H-1598, H-1600, H-1602, H-1608,H-1610, M-1-2, A-26-2 and K-16-1 at Madakkathara were found to be comparatively less suceptible to tea mosquito infestation during fourth year of planting.

GENERAL INFORMATION

STAFF OF THE INSTITUTE

(As On 31-03-1995)

Managerial

Director	Dr. MK Nair, Director CPCRI, Kasaragod (Additional charge)
Project Coordinator (Cashew)	Dr. EVV Bhaskara Rao, Ph.D Project Coordinator (Palms) (Additional charge w.e.f. 14.11.94)

Scientific

Agronomy

Principal Scientist	Vacant
Scientist	Sri N Yadukumar, M.Sc. (Agri.) Scientist SG

Plant Breeding

Principal Scientist	Vacant
Senior Scientist	Dr. PM Kumaran, Ph.D (Relieved on 20.5.94)
Senior Scientist	Dr. MG Bhat, Ph.D. (From 15.5.94 and Scientist in-charge from 1.10.94)

Horticulture

Principal Scientist	Vacant
Senior Scientist	Dr. KRM Swamy, Ph.D
Scientist	Sri M Gangadhara Nayak, M.Sc. (Agri.)
Scientist	Vacant

Entomology

Senior Scientist	Sri D Sundararaju, M.Sc. (Agri) Scientist (SG) (On study leave)
Scientist	Sri P. Shivarama Bhat, M.Sc. (Agri)
Scientist	Dr TN Raviprasad, Ph.D

Biochemistry	
Senior Scientist	Dr. K V Nagaraja, Ph.D. (Scientist in-charge till 30-9-1994)
Soil Science	
Scientist	Vacant
Plant Physiology	
Scientist	Vacant
Statistics	
Scientist	Vacant
Genetics and Cytogenetics	
Senior Scientist	Sri Thimmappaiah, M.Sc. (Agri.) Scientist (SG)
Scientist	Ms Shirly Raichal Samuel, M.Sc. (From 24.8.94)
Agricultural Structures and Process Engineering	
Scientist	Sri D Balasubramanian, M.Tech. (From 03-8-94)
Agricultural Extension	
Scientist	Dr Sreenath Dixit, Ph.D.
Technical	
Farm Superintendent	Sri B Nagaraja, B.Sc. (Agri.) T-6
Farm Superintendent	Sri K Lakshminarayana, B.Sc. (Agri.) T-6
Technical Information Officer	Dr (Ms) Uma Jayaraman, Ph.D., T-6
Administration	
Assistant Administrative Officer	Sri Ajit Kumar Bolar (From 22.10.93)
Assistant Finance and Accounts Officer	Sri A Keshava Shabaraya
Office Superintendent	Sri K Sanjeeva (From 16.9.94)

INSTITUTE JOINT COUNCIL

OFFICIAL SIDE

Dr. MK Nair	Chairman
Dr. PM Kumaran	Member (Till 20-5-94)
Dr. KV Nagaraja	Member
Sri M Gangadhara Nayak	Secretary
Sri A Keshava Shabaraya	Member
Sri Ajit Kumar Bohr	Member

STAFF SIDE

Sri MS Sathyanarayana	Secretary
Sri KR Padmanabhan Nair	CISC Member
Sri P Ravindran	Member
Sri B Ramaprasad	Member
Sri K Balappa	Member
Sri P Krishnappa Poojary	Member

PARTICIPATION IN SYMPOSIA/CONFERENCES/TRAININGS

1.	Training course on Pesticide Residue Analysis, CPPTI, Hyderabad	TN Raviprasad	1 Jun to 31 Aug 1994
2.	National Workshop on non-pesticidal approach to pest management - A new direction, NAARM, Hyderabad	PS Bhat	20-22 Sep 1994
3.	International symposium on plantation crops PLACROSYM XI, Calicut	MG Bhat KV Nagaraja N Yadukumar KRM Swamy PS Bhat TN Raviprasad	30 Nov to 3 Dec 1994
4.	National Workshop on Manpower development, in extension education, NAARM, Hyderabad	Sreenath Dixit	13-16 Feb 1995
5.	DBT sponsored short term training course on 'Application of tissue culture technology for micropropogation and regeneration of agroforestry species' at CAZRI, Jodhpur	Shirly R Samuel	20 Feb 11 Mar 1995

RESEARCH/POPULAR PUBLICATIONS

1. Nagaraja, K.V., Bhavanishankar Gowda, P.V., Venugopal Krishna Kurup, V., and Joy N. John., 1994. Biochemical changes in cashew in relation to infestation by tea mosquito bug. ***Plant Physiol & Biochem*** 21(2) : 91-97.

2. Nagaraja, K.V., 1994. Utilisation of cashew apple. ***Cashew Day Souvenir***, OUAT., Dec. 1994.

3. Swamy, KRM. 1994. Nursery management in cashew. ***Cashew Day Souvenir,*** OUAT, Dec, 1994.

4. Yadukumar, N., Nagaraja, B., and Dixit, S., 1994. Pineapple as an intercrop with cashew. **SAIC Newsletter**. 4:(2)P.6.

PAPERS PRESENTED IN SYMPOSIA/WORKSHOP

1. Bhat, P.S., and Raviprasad, T.N., 1994. Pathogenicity of entomopathogenic fungi against cashew stem and root borer ***Plocaederus ferrugineus*** Linn. (Coleoptera : Cerambycidae In International Symposium on plantation crops (PLACROSYM XI). November 30-3, December 1994, Calicut, India.

2. Bhat, P.S., Sundararaju, D., and Raviprasad, T.N., 194. Evaluation of some plant products against tea mosquito bug ***Helopeltis antonii*** Sig., a serious pest of cashew. In National Workshop on non-pesticidal approach to pest management- A new direction. September 20-22, 1994 at NAARM, Hyderabad.

TECHNICAL REPORTS/BULLETINS/COMPENDIA

1. NRCC Annual Report 1993-94, September 1994, pp. 107. (Compiled and edited by KV Nagaraja, Sreenath Dixit and Uma Jayaraman)

2. All India Coordinated Research Project on Cashew. Annual Report 1993-94, November 1994, pp. 122. (Compiled and edited by EVV Bhaskara Rao, KV Nagaraja and Uma Jayaraman).

3. NRCC Research Highlights 1994-95, March 1995, 16 pp. (Compiled and edited by KV Nagaraja and Sreenath Dixit).

RADIO TALKS DELIVERED

1. Cashew Research and Development activities at NRCC, Puttur-Interview with KV Nagaraja, broadcast from All India Radio, Mangalore on 20 July 1994.

2. Intercropping and its importance in cashew plantation - Interview with N Yadukumar, broadcast from All India Radio, Mangalore on 8 August 1994.

3. Pruning in cashew - Interview with M Gangadhara Nayak, broadcast from All India Radio, Mangalore on 15 January 1995.

4. Plant protection in cashew - Interview with TN Raviprasad, broadcast from All India Radio, Mangalore on 9 February 1995.

5. Advantages of tissue culture and its importance - Interview with Thimmappaiah, broadcast from All India Radio, Mangalore on 15 February 1995.

6. NRCC in the service of cashew development - Interview with Sreenath Dixit, broadcast from All India Radio, Mangalore on 23 February 1995.

7. Cashew varieties for coastal region and their characteristics-Interview with KRM Swamy, broadcast from All India Radio, Mangalore on 28 February 1995.

BOOKS/CHAPTERS

1. Bhaskara Rao, EVV and Swamy, KRM., 1994. Genetic resources of cashew. In : Advances in Horticulture vol. 9 - Plantation and Spice Crops part-1 (Eds. KL Chadha and P Rethinam). Malhotra Publishing House, New Delhi. pp. 79-97.

2. Swamy, KRM., 1994. Vegetative propagation in cashew. In: Advances in Horticulture. Vol. 10 - Plantation and Spice Crops part-2. (Eds. KL Chadha and P Rethinam). Malhotra Publishing House, New Delhi. (November 1994). pp.

IMPORTANT VISITORS

03 May 1994	Dr. S.R. Sreerangaswamy, Professor& Head, Centre for Plant Molecular Biology, TNAU, Coimbatore -641 003.
29 Dec 1994	Dr. M.V.R. Prasad, Director, Directorate of Oil Seeds Research, Hyderabad - 500 030.
30 Dec 1994	Prakash S Velip, MLA and Chairman of Adarsh Krishi Kharidi Vikri Prakriya Sahakari Saunstha, Maryadit, Bendurde Balli, Goa.

WEATHER DATA 1994-95

Month	Temp (°C)		Humidity		Total Rainfall (mm)	Rainy days	Sun shine (MRS)	Evaporation (mm)	Wind Velocity (Km/hr)
	Max.	Min.	FN	AN					
Apr	34.8	23.0	90	49	152.80	9	9.1	5.9	1.4
May	33.6	24.4	89	59	156.60	11	7.4	5.6	1.8
Jun	28.1	23.0	96	91	1431.0	27	1.1	1.6	1.5
Jul	27.3	22.5	97	90	1646.5	35	0.4	3.3	1.8
Aug	28.3	23.3	96	79	349.60	23	2.0	2.9	1.3
Sep	30.4	22.3	94	64	163.00	14	5.7	5.5	0.6
Oct	31.8	22.4	96	68	557.90	23	5.2	2.8	0.5
Nov	*	21.0	79	45	004.70	2	8.5	4.3	1.2
Dec	*	17.9	82	38	000.00	0	9.9	4.5	1.3
Jan	*	19.6	93	44	000.20	1	9.3	4.7	0.5
Feb	*	20.6	92	39	000.00	0	10.3	5.6	0.2
Mar	*	21.7	90	44	000.00	0	9.8	6.4	0.09
Total					4861.7				

*Not available