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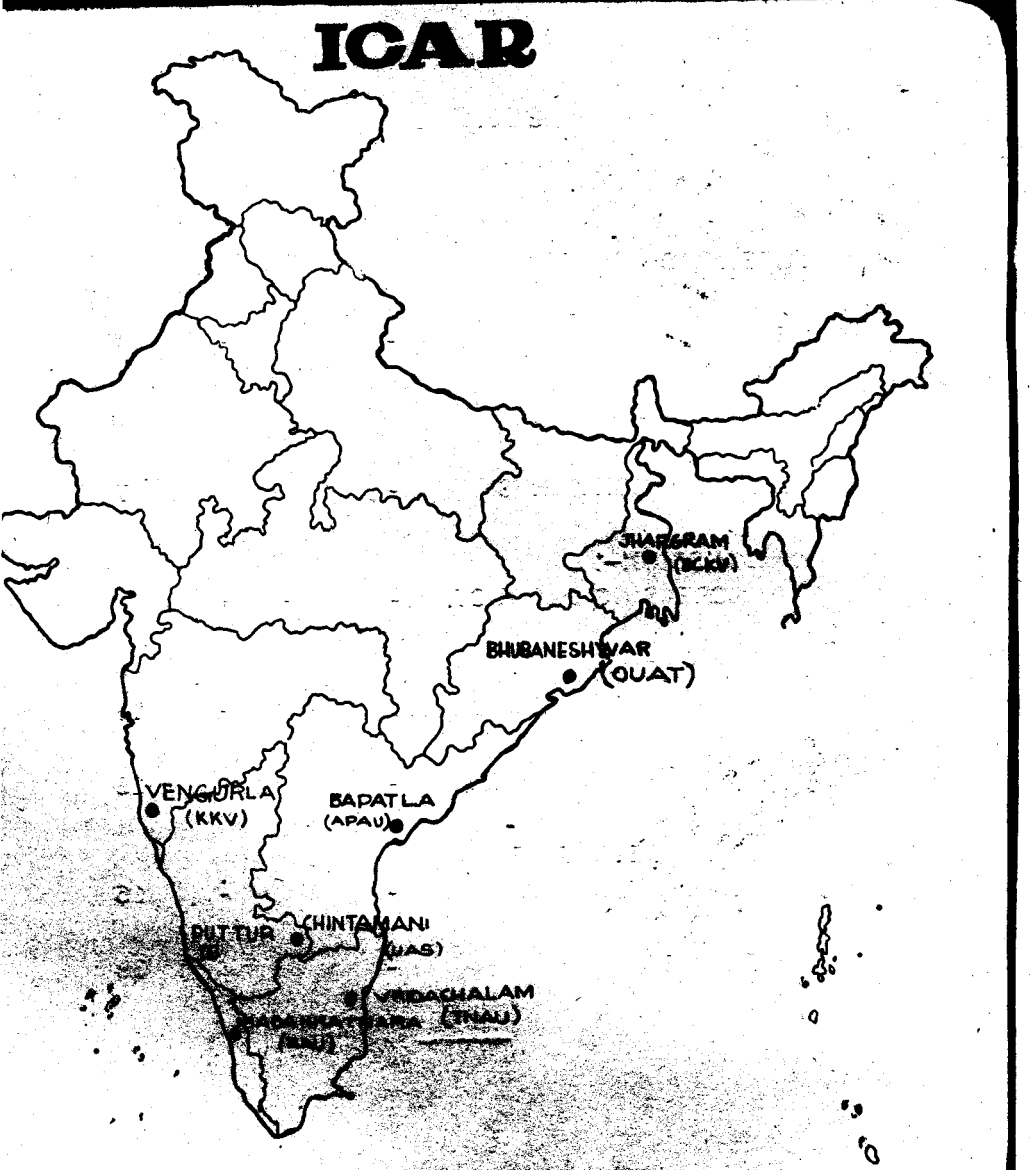
ASHEW RESEARCH UNDER



FOREWORD

India is one of the pioneering countries which entered into export trade of cashew in the early part of this century. Among the plantation crops introduced into India, cashew with the export earnings over Rs. 330 crores, ranks third after tea and coffee among the agricultural commodities. Currently with an area of over 5 lakh ha and production of 2.11 lakh tonnes ranks first in the world in both area and production. Research efforts on cashew dates back to 1950s which were coordinated with the inception of Central Plantation Crops Res. Institute and All India Coordinated Spices and Cashewnut Improvement Project in 1970 and 1971, respectively. After a decade of systematic research efforts, further strengthening came in the way of World Bank aided Multi State Cashew Research Project (MSCRP) which was operated in four States (Andhra Pradesh, Orissa, Karnataka and Kerala) during 1982 to 1986.

Considering the importance of Cashew in the economy of the country, the Indian Council of Agricultural Research established the National Research Centre for Cashew with its headquarters at Puttur, Dakshina Kannada, Karnataka during the VIIth plan, based on the QRT recommendations of CPCRI. Simultaneously, an independent coordinated project on cashew was also started during the current plan period with the bifurcation of the ongoing All India Coordinated Cashewnut and Spices Improvement Project.

The National Research Centre for Cashew started with the deployment of staff from the CPCRI who were already working in cashew research projects of CPCRIas well as Multi State Cashew Research Project. In order to strengthen the research efforts, the ongoing research projects were suitably modified to fulfil the mandate namely, Increasing Production and Productivity of Cashew, identified for this National Research Centre. 15 scientists working in 9 disciplines are to take up research projects in two minimissions namely, Increasing Production and Increasing productvity and other supporting research programmes.

This is the first annual report of the NRC-Cashew after its inception in which an effort has been made to document the programmes and priorities of National Research Centre for Cashew and the achievements made during the current year.

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RETROSPECTIVE

History and Development

Cashew (*Anacardium occidentale* L.) is one of the important plantation crops introduced into India during 16th Century. With the export earnings over Rs. 330 crores, it ranks third after tea and coffee from the agricultural commodities. Eventhough the crop was in cultivation for well over four centuries, the first attempts of research in cashew in India dates back to 1950s. Indian Council of Agricultural Research (ICAR) for the first time in 1952 sanctioned an ad-hoc scheme to be located in Kerala (Kottarakara) to intiate research on cashew. From the modest beginning, the scheme got extended to four more centres located in Karnataka (Ullal) in 1953, Andhra Pradesh (Bapatla) in 1955, Assam (Deregaon) in 1956 and Maharashtra (Vengurla) in 1957.

Cashew research at CPCRI

The research component on cashew got its desired thrust from the ICAR with the establishment of Central Plantation Crops Research Institute (CPCRI) in 1970 with its headquarters at Kasaragod, Kerala. The mandate of the institute included research on cashew along with other plantation crops such as coconut, arecanut, cocoa and spices. The CPCRI Regional Station, Vittal initiated systematic research efforts in this direction by maintaining a large assemblage of cashew accessions. Further impetus came in the way with CPCRI establishing a Cashew Seed Farm at Shantigodu, Puttur Taluk, Karnataka in 1974.

Thrust areas of cashew research under CPCRI

i. Collection, cataloguing and evaluation of cashew germplasm.
ii. Varietal improvement programme through selection and hybridization.
iii. Chemical control of pest complex.
iv. Studies on nutritional requirement.
v. Vegetative propagation studies.

Cashew research under AICCSIP

An All India Co-ordinated Cashew and Spices Improvement Project (AICCSIP) with its headquarters at CPCRI, was established in 1971 by ICAR in which five centres (four University centres and one institute-based centre) were identified. These centres were located in Andhra Pradesh (Bapatla, APAU), Tamil Nadu (Vridhachalam, TNAU), Kerala (Anakkayam later shifted to Madakkathara, KAU), Maharashtra (Vengurla, KKV) and Karnataka (CPCRI Regional Station, Vittal). Later on three more centres located in Orissa (Bhubaneswar, OUAT) in V Plan; West Bengal (Jhargram, BCKV) and Karnataka (Chintamani, UAS) in VI Plan were added. Systematic research on crop improvement, crop management, crop protection programmes were drawn up and implemented at both CPCRI and University centres since 1971.

Thrust areas of cashew research under AICCSIP

i. Evolving high yielding and disease resistant varieties in cashew.
ii. Developing efficient agrotechniques suitable to different agroclimatic regions.

iii. *Evolving better and efficient management system for control of major pests and diseases.*

iv. *Working as an* interface *and feed back between the Agricultural Universities and CPCRI/ ICAR.*

Multi State Cashew Research Project (MSCRP)

After a decade of Systematic research efforts, further strengthening came in the way of world bank aided Multi-State Cashew Research Project (MSCRP) which was operated during 1982-86 with a financial outlay of Rs. 83.77 lakhs (ICAR'S contribution being Rs. 8.38 lakhs). The five implementing agencies were :

i. *CPCRI Regional Station at Vittal & Shantigodu*
ii. *Kerala Agricultural University at Madakkathara*
iii. *University of Agricultural Sciences at Ullal and Bramhavar*
iv. *Andhra Pradesh Agricultural University at Bapatla*
v. *Orissa University of Agriculture and Technology at Bhubaneswar.*

Thrust areas of cashew research under MSCRP

i. *Evoloving high yielding varieties*
ii. *Standardisation of vegetative propagation techniques for large scale adoption under field conditions*
iii. *Large scale multiplication and supply of elite materials*
iv. *Establishing demonstration plots with selected cashew varieties*
v. *Standardisation of agronomic practices*
vi. *Chemical and sanitational control of major pests*
vii. *Imparting training in vegetative propagation and plantation management.*

Recommendation of Quinquennial Review Team (QRT) 1982

The ICAR Constituted a team of 8 Scientists with Dr. A. Abraham as Chairman to review the work of the Central Plantation Crops Research Institute and All India Co-ordinated Cashew and Spices Improvement Project (AICCSIP) for the period 1974-75 to 1982-83. The team had expressed satisfaction over the ongoing research work in cashew and suggested the following new lines of research in addition to existing research activities:

i. *Identification of plants having reduced period of flowering*
ii. *Standardisation of hormonal spraying schedules to induce synchronous flowering*
iii. *Studying the effect of pruning, high density planting and canopy size, on yield per tree and per unit area*
iv. *Studying the effect of reducing apple size on nut yield and shape*
v. *Stock-scion relationships and efforts to identify a proper stock which would produce a dwarfing effect and perhaps also ensure some degree of resistance to stem borers.*

The team considering the importance of various crops had recommended trifurcation of CPCRI Kasaragod into three independent institutions including the setting up of National Research Centre for Cashew. They had stated that "this National Research Centre will carry out basic or pioneering research on cashew and its findings will be tested further in the Co-ordinated Project".

To further ensure undivided attention to the research efforts on cashew, the team recommended the separation of co-ordinated research programme on cashew from the All India Co-ordinated Cashew and Spices Improvement Project.

National Research Centre for Cashew (NRCC)

In view of the significant importance of cashew in the national economy, its growing demand from the cashew processing

industries and in the light of recommendations made by QRT, the Indian Council of Agricultural Research established the NATIONAL RESEARCH CENTRE FOR CASHEW with its headquarters at Puttur, Dakshina Kannada, Karnataka, during VII Plan. The centre is located at 5 kms. away from Puttur Town. It lies on 12.25° north latitude and 75.42° east longitude. The altitude of the station is about 90 m above mean sea level. The soil at the station is typically lateritic and is admixed with sand, alluvium and gravel. The Cashew Seed Farm at Shantigodu which was earlier with CPCRI, Kasaragod, has been brought under NRCC to function as an Experimental Station. The farm has 80 ha land obtained on lease (30 years period) from Govt. of Karnataka and is located 12 kms. away from Puttur.

ABOUT NRCC

Mandate

The National Research Centre for Cashew is established with the mandate "To develop high yielding varieties with desirable characters, multiple resistance and better quality which are package responsive even under average farmers conditions".

Objectives

The objectives of the NRCC to work on the given mandate are:

i. *Evolving high yielding varieties of cashewnut.*
ii. *Identification/breeding varieties for resistance/ tolerance to pests, such as tea mosquito.*
iii. *Evolving varieties with higher protein, lysine and other biochemical quality parameters.*
iv. *Standardisation of agro-techniques for achieving higher production and productivity.*
v. *Transfer of technology to farmers and extension agencies in improved crop production techniques through training, demonstrations and extension literatures.*

For achieving these objectives, research programmes in NRCC are organized into :

Minimission-1 : Increasing production
Minimission-2 : Increasing productivity
Supportive Programmes.

Minimission-1 : Increasing production

The present level of cashew production in the country is to the tune of 2.1 lakh tonnes per year whereas the processing capacity of the factories is around 4.5 lakh tonnes of raw nuts. This necessiates, immediate efforts in increasing production to meet the growing demands of the industry. As a short-term goal the priority is to standardise the agrotechniques which can increase production in existing cashew gardens. The research programmes contemplated aims at rationalising fertilizer inputs to both seedlings and grafts, developing orchard management techniques through judicious pruning of the plant canopy, developing suitable croping system models using fruit crops, food crops, and forest species as intercrops for enhancing the returns to the farmers during the initial years of orchard life, and studying the efficacy of water saving irrigation systems.

Minimission 2: Increasing productivity

At present the productivity ranges from 2.5 to 4 kg. per tree in different cashew growing states. Efforts need to be made by propagating genetically superior elite and released varieties which are package responsive for increasing productivity. The priority is to establish a National Cashew Gene Bank with clonal progenies of available variability in the country. A number of parents with desirable attributes which can contribute to high production potential such as short flowering phase, early bearing habit, compact canopy, bold nuts, high shelling percentage and possible tolerance/ resistance to tea mosquito are identified and are used in varietal improvement programmes. The available germplasm collection of 379 accessions are also being screened for locating tolerance / resistance to tea mosquito adopting the procedure which is standardised under MSCRP programmes.

Supportive programmes

For supporting the missions on increasing production as well as productivity, the priority item is to make available elite planting material as well as demonstration of improved technology in farmers fields. Propagation studies which has already indicated the success of 'soft - wood' method of propagation are being continued to increase the production potential during summer months by utilising mist-chamber. Efforts need to be made in establishing bud-wood orchards in all cashew growing states with released and recommended varieties.

For efficient monitoring of both research and administration, computerised data base management is planned.

Infrastructural facilities

The headquarters of the centre located at Puttur has 14.9 ha land with a proposal to acquire an additional area of 43.5 ha by the end of this plan period.

The experimental station at Shantigodu has 80 ha land. Farm office, laboratory building and 7 residential quarters are located at this place.

Staff strength

The centre was established with the deployment of staff from the CPCRI who were earlier working in cashew research projects of CPCRI as well as Multi-State Cashew Research Project.

Staff working on cashew

Category	VI Plan (CPCRI)			VII Plan (NRCC)			
	Non Plan	Plan (MSCP)	Total	Non Plan	Plan	Total	Posts Vacant
Scientific	7	7	14	14	1	15	6
Technical	4	5	9	9	5	14	9
Administrative	1	4	5	6	2	8	4
Supporting	26	—	26	31	5	36	10
Auxiliary	—	2	2	2	—	2	—
Total	36	18	54	62	13	75	28

Financial Outlay

Particulars	Plan (Lakh Rs.)	Non-Plan (Lakh Rs.)
Outlay for the current plan period	98.50	58.00
Expenditure incurred 1985-86	9.45	11.15
1986-87	10.54	12.12
Total Expenditure (i)	19.99	23.27
Anticipated Expenditure 1987-88	26.72	12.25
1988-89	45.04	18.75
1989-90	29.25	20.73
Total anticipated expenditure (ii)	101.01	51.73
Total requirement for the plan period [(i) + (ii)]	121.00	75.00
Additional demand over the approved outlay	22.50	17.00

RESEARCH HIGHLIGHTS

Minimission - 1 : Increasing Production

Graded doses of nitrogen application has resulted in significantly increased yield with a linear trend in the case of plants raised through air-layers. Application of 750 g N/tree has yielded 5.46 kg. whereas application of 250 g N / tree has yielded 2.95 kg. Another trial for studying the response of high yielding varieties of cashew grafts/seedlings to different levels of nitrogen is in initial stage.

Orchard management in the existing garden by way of leader shoot (severe) pruning done in months of July and August doubled the yield (9.29 kg / tree) over the control (4.32 kg/tree). Lateral shoot (mild) pruning done during August month is also found to be effective in increasing the yield substantially. Preliminary studies on high density planting of cashew have shown better growth for the widely spaced trees. In order to avoid over-crowding of trees among closely - spaced, Orchard management techniques such as "Modified Leader System" has been attempted.

Chemical control trial for the control of tea mosquito incidence on cashew tree showed that Decamethrin sprayed at 0.02% concentration is most effective. Monocrotophos and Endosulfan were also found to reduce the tea mosquito incidence.

Minimission - 2 : Increasing Productivity

A germplasm collection of 379 cashew accessions are assembled at this Centre. These include 161 accessions at Vittal, 131 at Shantigodu and 87 at Puttur. At Vittal, 19 accessions have been found to give consistently high yield with cumulative yield (1977-'86) ranging from 41 kg. to 56 kg. nuts/tree with nut weight varying from 4.7 to 7.0 gm. Among these VTH 52, VTH 20 and VTH 12 are found to be better ones. With reference to individual tree performance 36 elite trees have been identified of which VTH 52/2 tree gave the highest yield of 10.37 kg. nuts/tree/yr. Similar evaluation at Shantigodu highlighted VTH 539 as the best accession and VTH 445/5 tree as the best tree yielding as high as 9.35 kg. nuts/tree/yr.

Coastal districts of Andhra Pradesh were surveyed and 24 trees were marked for desirable characters. The scion material from these have been collected and grafted on the common root-stock VTH 539.

Yield maximisation plots which includes M 10/4 and M 44/3 varieties have been established at Puttur.

Quality evaluation of 16 high yielding varieties with regard to lysine resulted in identification of seven varieties viz., M 76/1, M 10/4, M 44/3, Bla 256-1, Bla 139-1, Morgaon and WBDC-V which have shown lysine level over 50 μg/mg protein.

Varietal reaction to tea-mosquito bug for grafts of Vengurla-1, VTH 12, VTH 13 and VTH 35 along with a susceptible check was attempted and no difference in the reaction was observed. However, at KCDC, Kunthur Plantation one high yielding tree (T. No. 24) with a fair degree of field resistance to tea mosquito bug has been identified.

Supportive Programmes

Standardization of techniques for vegetative propagation of cashew has been achieved. 'Soft - wood' grafting done during July month was found most successful with 83.1% success. Altogether 25,200 grafts were produced during the year for distribution among farmers and various Departmental Agencies/Cashew Development Corporations.

MINI MISSION - 1

INCREASING PRODUCTION

Graded doses of nitrogen application resulting in a significant increase in cashew yield in the case of air-layers has been observed. Orchard management in the existing garden by way of leader shoot (severe) pruning during July and August months doubles the yield potential. Chemical control trial for the tea mosquito highlights the efficacy of Decamethrin insecticide.

1. Increasing Production

At present cashew production in the country is around 2.1 lakh tonnes per year (1986-'87) which is much lower than the processing capacity of the factories established in the country. Therefore to meet the urgent need of making available raw nuts as per the growing demand from the industry, it is essential that production needs to be doubled within the next few years. As planting material of new varieties that is being generated now, will contribute to the production only during the next plan period a mission-oriented approach has been contemplated to develop technologies for increasing the production from the existing orchards with the following research programmes.

1.1. Rationalization of fertilizer input

The experiments conducted so far on the manurial requirement indicated that cashew responds to the fertilizer application at a dose of 500 g N, 125 g P_2O_5 and 125 g K_2O.

While these experiments are conducted on plant material with unknown potential, efforts are now under way to examine nutritional requirement of elite vegetative material as well as seedling progenies.

1.1.1: Agr. I (176) (a) - Effect of graded dose of NPK fertilizers on the productivity of cashew layers and seedlings.
(RC Mandal, KBA Khader, NT Bhat)

With a view to study the nutritional requirement of cashew plants raised by seedlings and air-layers, two experiments separately for seedlings and air-layers laid out in a 3^3 factorial confounded design were initiated during 1978 at NRCC Experimental Station, Shantigodu.

The levels of N, P and K were

Upto 1983	Modified from 1984 onwards
N = 150, 300, 450g/tree	250, 500, 750g/tree
P_2O_5=50, 100, 150g/tree	75, 150, 225g/tree
K_2O =50, 100, 150g/tree	75, 150, 225g/tree

Data on yield of nuts was recorded during the year and statistically analysed. The result did not show any significant difference among the different treatments in the case of seedlings because of the large variability in yield from plant to plant. However, graded doses of nitrogen was found to be highly significant with a linear trend in the case of air-layers (Table 1.1).

Table 1.1 Yield of nuts(kg./tree)in Air-layers

	P_{75}	P_{155}	P_{225}	Mean
N_{250}	3.07	3.60	2.19	2.95
N_{500}	4.66	4 94	4.31	4.64
N_{750}	5.91	4.98	5.50	5.46
Mean	4.55	4.51	4 00	

C D. (5% level) for comparing N Means=0.61

Application of 750 g N/tree had resulted in significantly the highest yield (5.46 kg) followed by application of 500 g N/tree (4.64 kg)

1.1.2: Agr. I (176) (b) - Response of high yielding varieties of cashew to different levels of nitrogen.
(RC Mandal, KBA Khader)

This experiment was planted during 1983 at CPCRI Regional Station, Vittal with eight varieties of cashew viz., WBDC-V, M 6/1, M 10/4, M 44/3, T.1-Bla, A-18/4, Kodur 13/5 and Bla 139-1 as sub-plot treatments and three levels of nitrogen viz., 250, 500 and 750 g / tree together with

two types of planting materials viz., seedlings and grafts as main plot treatments. A uniform dose of 125 g each of P_2O_5 and K_2O per tree were applied to all treatments.

Observations on flowering behaviour, yield and growth characters viz., height, girth, vertical and lateral spread were recorded during the period under report.

Higher dose of nitrogen application had significantly increased the flowering(Table 1.2). Application of 750 g of nitrogen per tree had resulted in significantly more number of plants flowered as compared to no nitrogen both in seedlings as well as grafts. The varieties M 6/1 and M 10/4 had showed earliness in flowering.

No significant differences were observed in the first year's yield amongst different varieties. An increasing trend in yield (Table 1-2) with the increase in the dose of nitrogen was observed. The highest yield was obtained from the variety M 10/4.

1 2. Orchard management

Cashew hitherto has been grown and treated as a tree grown under forest environment without receiving much attention in the orchard management like other horticultural crops. This concept is now being changed due to obvious reasons. Trials conducted on pruning have clearly indicated that pruning of laterals and leaders during July-August has a beneficial effect in increasing the yield by about 80 percent. It is also recorded that a simple practice of removal of deadwood and criss-cross branches can increase the nut yield per tree substantially. As per earlier recommendation the spacing between two cashew trees is 8 m. Efforts are being made to study the effect of varying plant densities, simultaneously incorporating orchard management techniques.

Table 1.2 Response of cashew varieties to N-levels

(a) Trees flowered (%)

Planting material	Varieties							
	WBDC-V	M 6/1	M 10/4	M 44/3	T.1 Bla	A 18/4	Kodur 13.5	Bla-139-1
Seedlings	50	79	92	42	88	50	83	54
Grafts	33	77	87	50	69	44	71	56

(b) Yield of nuts (gm/tree)

Planting material	Fertilizer doses			
	N_{250}	N_{500}	N_{750}	Mean
Seedlings	340	430	810	527
Grafts	130	330	180	213
Mean	235	380	495	

2.1 : Hort. II (176) - Effect of time and severity of pruning in cashew. (E. Mohan)

A field trial to study the effect of time and severity of pruning in cashew was laid out in a Randomised Block Design with three replications at NRCC Experimental Station, Shantigodu in 1984. Trees (raised through seedlings) of M 76/2 (VTH 539) were utilised for the study and the experiment was carried out for two cropping seasons. The trees were of 9 years old with an average yield of 5 kg. per tree.

Two methods of pruning viz., lateral shoot (mild) pruning and leader shoot (severe) pruning were done in four consecutive months starting from May to August in 1984 and 1985. About 60 percent of the shoots were pruned per tree and the weight of biomass was recorded.

The leader shoot (severe) pruning during July and August months showed significant differences (Table 1.3) over the control for all the characters studied viz , number and length of laterals produced, per cent productive laterals, number of leaves and leaf area per shoot, total flowers and bisexual flowers per panicle and yield per tree. Whereas the lateral shoot (mild) pruning during August recorded significantly higher values for the per cent productive laterals and yield per tree over control.

Comparison between the methods of pruning in various months indicates that leader shoot pruning in July month and both leader shoot and lateral shoot pruning in August month significantly out yield over the rest.

In general the leader shoot (severe) pruning done in the months of July and August doubled the yield per tree (9.29 kg) over the control (4.32 kg) and also recorded higher values for all the characters analysed.

Table 1.3 Effect of time and severity of pruning in cashew (Average for years 1984-85 and 1985-86)

Treatments		Laterals produced			Leaves/ lateral	Leaf area (cm^2)	Flowers/ panicle	Bisexual flowers/ panicle	Yield/ tree (kg.)
Month	Shoot pruning	Number	Length (cm)	%					
May	Lateral	2.6	14.5	44.6	8 6*	750	247	53 9	5.14
May	Leader	2.4	17 6	36.5	9.3*	958*	271	66.6	3.26
June	Lateral	3.0*	16.6	49.6*	8.8*	883*	300	59.7	4.91
June	Leader	3.7*	20.6*	51.3*	11 7*	1019*	323	72.8	6.07
July	Lateral	2.2	15 9	40.3	8.3*	990*	403*	109.3*	4.24
July	Leader	4.8*	20.8*	58.0*	10.0*	1152*	384*	111.4*	9.22*
August	Lateral	2.7	17.4	58 8*	8 0	740	340*	77.3	7 98
August	Leader	4.1*	24.6*	69.0*	11 5*	1310*	343*	97.7*	9.36*
Control		2.1	14.1	39.0	7 0	666	256	58.7	4 32
CD		1.6	5.3	7.9	1.8	254	81	25.5	2.90

* Significant at 5% level.

1.2.2: Phy. III (176) - High density planting of cashew. (LP Misra)

The experiment on high density planting of cashew was laid out at NRCC Experimental Station, Shanthigodu, during July 1982 with 5 treatments (spacings: 8m×8m, 6m×6m, 4m×4m, 3m×3m and 2m×2m thus accommodating 156, 278, 625, 1111 and 2500 trees/ha respectively) replicating 5 times. Recommended dose of fertilizer was applied in two split doses and phytosanitary measures were taken. Growth measurements recorded in respect of trunk girth (15 cm above ground), tree height and canopy spread (maximum and minimum) showed significant differences (Table 1.4) minimum being in 2m×2m and maximum in 8m×8m spaced trees.

Table 1.4 Morphological observations

Spacing	Height (cm)	Girth (cm)	Max spread (cm)	Min. spread (cm)	Canopy height (cm)
8m×8m	479	36	368	328	397
6m×6m	472	37	343	309	375
4m×4m	451	34	328	376	372
3m×3m	437	32	303	280	358
2m×2m	399	31	222	207	320
CD	7.3	1.7	9.7	7 9	4 8

By and large, trees spaced wider grew better as they were free from competition. Based on the canopy spread, area covered by trees in all treatments were worked out (Table 1.5). It was found that trees in 2m×2m covered only 3.6m² area whereas 9.4m² area was covered by the trees in 8m×8m spacing. When this figure was computed on hectare basis, the trees in 2m×2m have fully covered the given area whereas the trees in 8m×8m have covered only 1478m² (area/ha being 10,000m²) or about 1/6 of the given area and trees in 3m×3m have covered 7/10 of the area.

Table 1.5 Canopy covered by the cashew trees.

Spacing	Trees/ha (No)	Area covered/tree (m²)	Area covered/ha (m²)	% of area covered
8m×8m	156	9.4	1478	14.8
6m×6m	278	8.2	2307	23 1
4m×4m	625	7.1	4456	44.6
3m×3m	1111	6 3	7003	70 0
2m×2m	2500	3.6	9018	90.2

Pruning and heading-back of the trees in 2m×2m treatment was done during August 1986. On an average, 2.4 kg/tree fresh pruning weight was removed. This was done to avoid over-crowding of trees in this treatment and also to train the trees like "Modified leader system". Suckers arising from the base of the tree trunk was also removed. After pruning, Bordeaux paste was applied on the cut ends to protect it from rot-causing organisms.

Studies regarding soil moisture status in different planting density was also undertaken (Table 1.6). For soil moisture status, soil samples were drawn at 0-30 cm and 30-60 cm depth from all the treatments. During the initial two months of post-monsoon period (November and December) and during the dry spell (February, March and April) there was not much variation in the soil moisture status amongst various spacings. However, during January month, the soil moisture showed an increase in trend as the planting density increased.

1.3 : Pest Management

For achieving the objective of doubling the production, one of the immediate priority is to develop effective pest management package for both small farmers as well as for large plantations which are being managed by the State Horticulture/ Agriculture Departments, State Cashew Development Corporations and Forest Corporations.

Soil Moisture status

	Depth (cm)	Soil moisture %					
		Nov	Dec	Jan	Feb	Mar	Apr
8m × 8m	0-30	25.6	22.6	19.2	17.0	13.6	12.0
	30-60	27.0	26.9	24.5	19.5	14.5	14.0
6m × 6m	0-30	24.2	24.0	22.4	15.8	12.8	11.8
	30-60	26.5	26.5	24.8	17.8	13.9	12.5
4m × 4m	0-30	23.8	24.0	24.1	16.5	14.2	12.4
	30-60	27.0	27.2	25.6	19.0	15.8	13.0
3m × 3m	0-30	24.5	25.0	24.5	18.5	11.9	9.6
	30-60	26.5	25.6	24.9	19.5	13.0	11.0
2m × 2m	0-30	26.8	27.0	25.9	19.0	12.6	9.0
	30-60	27.2	27.2	26.2	19.5	14.0	10.9

Trials in the pest control clearly indicated that tea mosquito bug which is estimated to be causing an average crop loss of 30 per cent, can be effectively controlled through aerial spraying for large plantations (Endosulfan @ 750 ml. per hectare at 0.1% conc.) or with hand spray in small gardens (Endosulfan @ 1350 ml. / ha at 0.05% conc.) Sprays given during the appropriate period i.e., at the time of flushing, flowering and fruiting, is observed to have resulted in effective control of the pest.

Similarly "stem and root borer" which leads to the death of plants in the orchards can be effectively controlled by maintaining sanitation in the gardens as well as by regular surveillance. When the pest is detected in the initial stages, it can be controlled by either swabbing the infested tree base with 0.1% BHC after removal of damaged tissues or bark application of monocrotophos (stem padding with cotton wool soaked in monocrotophos @ 30 ml. per tree) was found to be very effective. Further studies have been conducted in the following experiments.

1.3.1 : Ent. III (176) - Chemical control of pests of cashew
(AS Sukumaran)

A field trial on chemical control of pest complex of cashew with 3 replications and 10 treatments was laid out in a R B D including 9 insecticides viz; endosulfan 0.05%, quinalphos 0.05%, monocrotophos 0.05%, carbaryl 0.1%, BHC 0.1%, phosalone 0.07%, dimethoate 0.05%, chlorpyriphos 0.05% and decamethrin 0.02% at Cashew Progeny Orchard, Adhur, Kasaragod.

Pre-treatment observations were recorded on incidence of various pests like *Helopeltis antonii, Acrocercops syngramma, Macalla moncusalis Panrosema, Planococcus lilacinus, Monolepta longitarous, hyllocerus discolor, Oligonychus* sp. etc. from ten selected leaders tagged in each experimental tree. Three rounds of spraying were given and observations recorded at 10 days interval after each round of spraying.

Pooled analysis of the data (1985-'86 to 1986-'87) analysis of the data showed that decamethrin is most effective in reducing

the tea mosquito infestation (Table 1.7) which is followed by monocrotophos and endosulfan. Phosalone, quinalphos and carbaryl were also found to reduce the tea mosquito intensity. However, dimethoate, BHC and chlorpyriphos were not found effective in controlling tea mosquito infestation.

Table 1.7 Tea mosquito intensity (Index)

Treatments	Years		Mean
	1985-'86	1986-'87	
1. Endosulfan (0.05%)	43.2	23.4	33.3
2. Quinalphos (0.05%)	68.5	19.1	43.8
3. Monocrotophos (0 05%)	35.6	14.9	25.3
4. Dimethoate (0.05%)	77.1	38.3	57.7
5. Carbaryl (0.1%)	67.6	22.9	45.3
6. BHC (0.1%)	80.3	38.7	59.5
7. Phosalone (0.07%)	59.4	22.2	40.8
8. Chloropyriphos (0.05%)	69.1	31.9	50.5
9. Decamethrin (0.02%)	12.4	7.1	9.8
10. Control	81.2	55.9	68.6
Mean	59.42	27.43	43.4

CD ($P \leq 0.05$) for mean values = 21.23

Even with regard to control of tea mosquito incidence (Table 1.8) decamethrin was found consistently the most effective insecticide followed by monocrotophos and endosulfan.

1.3.2 : Ent. IV (176) - Chemical control of root and stem borer. (Mariamma Daniel)

An observational trial was laid out in October 1983 at Karnataka Cashew Development Corporation Plantations at Aryapu, near Puttur, D. K. The pre-treatment level of infestation was 4%. Pretreatment observations on the intensity of attack and age and growth of trees were recorded.

Table 1.8 Percentage of tea mosquito incidence.

Treatments	Years		Mean
	1985-86	1986-87	
Endosulfan [0.05%]	53.27	42.05	47.66 [53.61]
Quinalphos [0.05%]	98.62	41.29	59.96 [68.59]
Monocrotophos [0.05%]	49.50	34.25	41.89 [44.72]
Dimethoate [0.05%]	79.15	52.67	65.91 [78.97]
Carbaryl [0.1%]	81.78	45.53	63.65 [73.95]
BHC [0.1%]	81.97	56.21	69.09 [82.85]
Phosalone [0.07%]	73.25	42.61	57.93 [67.23]
Chloropyriphos [0.05%]	76.49	46.04	61.26 [73.14]
Decamethrin [0.02%]	29.86	24.50	27.18 [21.44]
Control	77.86	62.21	70.03 [86.65]
Mean	68.17	44.74	

CD [$P \leq 0.05$] for mean values = 12.86.
values in Mean parenthesis are transformed values [arcsine transformation].

A total of 52 trees were treated and the treatment included monocrotophos 'padding' to the trunk / branch of the tree and application of HCH 10% dust in and around the bole of the trees. Monthly observations were recorded on the recovery of the trees and reinfestation / feeding, if any, on treated as well as the healthy trees in the plot

In addition, one more trial was laid out in July 1985 at the germplasm collection plot at Nelligudde, CPCRI, RS, Vittal, in which a total of 72 trees were treated.

The trial laid out at Aryapu, was concluded in October 1986. The data were analysed for the number of reinfestation and time taken for reinfestation after the treatment. In the initial stage of attack, five trees were free of infestation after

treatment and in the medium stage of attack, only one tree was free of attack in the three year period (Table 1.9).

Table 1.9 Effect of monocrotophos and HCH on control of root and stem borer (total 52 treated trees)

Nature of attack	No. of trees free of attack after treatment	Infestation noticed atleast once	Av. time taken for reinfestation
Initial	5 [31.3%]	11 [68.7%]	10.3 months
Medium	1 [50.0%]	19 [95.0%]	6.1 months
Advanced*	10	6	3.5 months

*Most of the trees in this group were removed by the villagers in the course of study time.

At the germplasm collection plot about 62.5% trees (45/72) were free of infestation after the treatment in the last round of observation taken in December 1986.

1.4. Imparting training

There are proven technologies available for increasing the production from the existing gardens for effective field implementation of these technologies, the plantation managers, departmental officials and farmers were trained at NRCC by conducting training programme entitled 'Cashew Production Technology'. In addition to explaining the available technologies during the course of training, the trainees were also given field orientation for better understanding.

1.4.1: Extn. I (443) - Training of extension and research workers and farmers. (KRM Swamy)

Three training programmes (Table 1.10) were organised for the officials of State Departments (Agriculture / Horticulture Central/State Farms, Forest Development corporations and Directorate of Cashewnut Development at National Research Centre for Cashew, Vittal.

Table 1.10 Training Programmes conducted at NRCC

Course No.	Course title	Date	No. of participants
12	Cashew production technology	7-11 Jan 86	5
13	Vegetative propagation in cashew	5-8 Aug 86	6
13	Vegetative propagation in cashew	21-24 Oct 86	2

MINI MISSION - 2

INCREASING PRODUCTIVITY

Of the 379 cashew accessions assembled at NRCC, 36 elite trees have been identified based on high cumulative yield. In the family mean performance VTH 52, VTH 20, VTH 12 and VTH 539 performed better. Seven varieties viz., M 76/1, M 10/4, M 44/3, Bla 256-1, Bla 139-1. Morgaon and WBDC V have shown lysine level over 50 µg/mg protein highlighting the better quality. A high yielding tree (T.No. 24) at KCDC, Kunthur plantation has been identified which has a fair degree of field resistance to tea mosquito bug.

2. Increasing Productivity

At present the productivity ranges from 2.5 to 4 kg/tree in different cashew growing states. Efforts need to be made for propagating genetically superior elite and released varieties which are package responsive for increasing the productivity.

2.1. Establishment of National Cashew Gene Bank

For exploiting the variability available within the country, germplasm collection is being carried out since 1972. So far 379 accessions are assembled of which 161 accessions (seedling progenies) are maintained at Vittal, 131 accessions (seedling progenies) at Shantigodu and 87 accessions (clonally propagated material) at Puttur. These accessions will constitute the nucleus material for the gene bank. Within next 3–4 years, it is proposed to complete survey and collection in all cashew growing states (in collaboration with Agricultural Universities, State Departments of Agriculture/Horticulture and Coordinating Centres of AICCIP).

Cataloguing of the available material is also underway and will be completed within the next two years. Emphasis is given for collection of plant types with desirable characters such as compact canopy, synchronised early flowering, short-flowering phase, high yield, bold nuts and high shelling percentage. Pest and disease reaction is also being monitored during the collection. Only vegetatively propagated material (soft-wood grafts) will be planted in the conservation blocks of National Cashew Gene Bank. Sub-samples of these collections will also be maintained in the respective states. Project for establishing National Cashew Gene Bank is being carried out as under.

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

(Krishnan Swamy, Thimmappaiah)

Seedling progenies of cashew accessions [illegible] CPCRI Regional Station, [illegible] Experimental Station, [illegible] were evaluated to identify elite [illegible]

2.1.1. Evaluation of germplasm at CPCRI Regional Station, Vittal

The 161 cashew accessions (RBD; 2 replications; 4 trees/plot; spacing 8m×8m) planted in the year 1973 at Vittal, were evaluated for their yield potential. During 1986, VTH 96 gave the highest mean yield of 6.95 kg/tree followed by VTH 100 (5.24 kg/tree) and VTH 59 (5.0 kg/tree). Ten years cumulative yield data (1977 to 1986) showed that 19 accessions gave a cumulative yield ranging from 41 kg to 56 kg. per tree (Table 2.1). The highest

Table 2.1 Cashew accessions giving a mean cumulative yield of 41-56 Kg/tree

VTH No.	Yield/tree (kg) 1977-86	1986	Duration of flowering [1]	No. of fruits per bunch [2]
52	55.8	3.87	Medium	Medium
20	52.5	3.25	Medium	High
12	51.0	2.78	Medium	High
57	49.6	3.46	Medium	High
40	49.5	3.00	Short	Medium
142	48.9	4.19	Short	Medium
145	48.7	3.91	Medium	Medium
139	48.2	2.40	Medium	Medium
27	47.3	2.62	Medium	Medium
22	46.2	0.74	Medium	High
50	45.7	1.33	Short	Medium
13	45.0	3.51	Short	Medium
146	44.1	1.37	Medium	Medium
100	43.2	5.24	Medium	Medium
79	43.1	0.25	Short	Medium
144	42.6	2.42	Medium	Medium
147	42.5	2.88	Medium	High
62	42.3	1.63	Medium	Medium
119	41.7	3.64	Medium	Medium

1 - Short : Upto 60 days Medium : 61-80 days
2 - High : More than 5 Medium : 2-5

cumulative yield was given by VTH 52 (55.78 kg/tree), followed by VTH 20 (52.50 kg/tree) and VTH 12 (51·01 kg/tree). All these accessions excepting VTH 100, were early flowering types and they all produced medium sized nuts(4.7-7.0g).

Table 2.2 Individual trees giving a cumulative yield of 75.0-104.0 kg./tree (1977-1986)

VTH No / tree No.	Source	Cumulative yield (kg.)	Av.nut weight (g)
II 52/2	10/2 Stuartpuram-Bapatla	103.7	5 3
I 79/1	8/1 Kodur-Bapatla	99 5	6 6
I 22/4	M 54/4 Vridhachalam	96 0	4 7
75/1	6/14 Morampudi-Bapatla	89 5	5 4
I 13/2	M 76 1 Vridhachalam	88.4	6.5
I 19/2	M 33/3 Vridhachalam	88.1	5 8
I 50/2	9/8 Epurupalam-Bapatla	87.5	6.1
I 31/3	E2/4 Vridhachalam	85.1	5 2
I 119/4	1/1 Ceylon-Bapatla	85.0	4.6
I 27/4	A 5/2 Vridhachalam	83 4	5 3
I 30/2	A 18/4 Vridhachalam	82.0	5.7
I 38/4	1/11 Dicherla - Bapatla	82 0	7.0
I 79/2	8/1 Kodur - Bapatla	81.8	5.4
I 40/1	2/9 Dicherla - Bapatla	81 3	9 6
II 52/4	10/2 Stuartpuram - Bapatla	81.3	5 6
I 50/3	9/8 Epurupalam - Bapatla	81 2	6.0
I 100/4	2/4 Anbugam - Bapatla	70.6	4.6
I 59/3	13/5 Kodur - Bapatla	80.4	6 3
I 27/3	A 5/2 Vridhachalam	80 0	5 6
I 59/2	13/5 Kodur - Bapatla	79.8	6 5
II 12/2	M 44/3 Vridhachalam	79.7	5.5
I 16/1	M 16/1 Vridhachalam	79 3	7 0
I 51/1	9/10 Darivadakothur-Bapatla	79.0	6.0
I 62/3	1/3 Mittapalam-Bapatla	78.9	5 5
I 39/3	2/6 Dicherla-Bapatla	78.5	6 1
I 69/1	5/10 Sajada/ira-Bapatla	77 1	5 0
I 15/2	M 15/1-Vridhachalam	77 0	6.5
I 34/4	T No. 1 - Bapatla	76.9	5.2
I 57/1	12/2 Kaviti-Bapatla	76 7	5.4
I 54/4	10/8 Epurapalam-Bapatla	76.5	6.4
I 40/3	2/9 Dicherla-Bapatla	76.3	6 0
I 20/4	M 37/3 - Vridhachalam	76.2	5.9
I 40/4	2/9 Dicherla - Bapatla	76 0	6.6
I 96/1	1/4 Anbugam - Bapatla	75 3	5.8
I 110/1	4/4 Araku-Bapatla	75.1	5 1
I 29/1	A 6/1 - Vridhachalam	74 9	5 8

From the available germplasm collection, 36 elite trees have been identified which gave a cumulative yield of more than 75kg (Table 2.2) and which produced medium sized nuts. Majority of them were early in flowering with medium duration of flowering (60 - 80 days). Amongst these VTH 52/2 tree gave the highest cumulative yield of 103.73 kg. followed by VTH 79/1 (99.54 kg), VTH 22/4 (96.01 kg), VTH 75/1 (89.48 kg) and VTH 13/2 (88.37kg).

2.1.2. Evaluation of germplasm at NRCC Experimental Station, Shantigodu.

Seventy three accessions were evaluated for their yield potential. In the family mean performance, VTH 539 gave the highest yield (4.99 kg/tree), followed by VTH 666 (3.95 kg/tree), VTH 501 (3.82 kg/tree), VTH 626 (2.67 kg/tree) and VTH 546 (2.48 kg/tree). However, individual trees in some of the accessions gave more than 8 kg. They are VTH 445/5 (9.35 kg),VTH 501/2 (9.10 kg),VTH 539/2 (11.73 kg),VTH 539 10 (8.0 kg), VTH 539/21 (9.0/kg), VTH 539/22 (8.11 kg), VTH 539/42 (11.22 kg) and VTH 539/44 (11.99 kg).

2.1.3. Collection from Andhra Pradesh

The coastal districts of Andhra Pradesh (Viz, Chittoor, Nellore, Prakasam, Guntur, Krishna, East Godavari and West Godavari) were surveyed and 24 trees were marked for desirable characters such as high yield, big sized nuts, high shelling percentage, off-season flowering, cluster bearing, apple colour and size etc. (Table 2.3)

Table 2.3 Grouping of germplasm collection based on desirable characters collected from Andhra Pradesh

Characters	No. of collection	AP collection number
High yield (more than 30 kg/year)	9	1, 2, 16, 19, 20, 21, 22, 24, 25
Big sized nuts (more than 7 g)	11	1, 5A, 6, 8, 10, 12, 15, 19, 24, 25, 29
High shelling percentage (more than 30%)	11	2, 4, 8, 12, 13, 15, 16, 20, 21, 22, 26
Flowering twice in a year	1	2
Cluster bearing	11	1, 3, 6, 7, 8, 9, 13, 20, 21, 24, 26
Compact canopy	13	1, 2, 3, 5, 6, 7, 8, 9, 13, 16, 20, 25, 28
Red apple	2	5A, 15
Very big apple	1	29
Very small nut and apple, profuse flowering but no fruit set	1	28
White bark	1	19

The scion material from these 24 selected trees viz., AP 1 to 5, 5A, 6 to 10, 12, 13, 15, 16, 19 to 22, 24 to 26, 28, 29 was collected. In addition, 6 high yielding varieties of CRS, Bapatla viz., BPP-1 to 6 have also been collected and grafted on the common root-stock VTH 539 at NRCC Experimental Station, Shantigodu.

2.1.4. Planting of clonal material

The clonal material of 56 cashew accessions viz., NRC -1 to 56 have been planted in the Germplasm Conservation Block at NRCC, Puttur. In each accession, 6 plants were planted giving a spacing of 6m×6m. The total area planted is about 1.21 ha. The grafts are establishing well.

2.2. Hybridization

The elite materials identified from the National Cashew Gene Bank and which is screened for biochemical parameters as well as pest reaction are being utilised in the hybridization programme to develop synthetic varieties in which the yield potential, quality parameters and pest resistance are incorporated. The research project which is on going with this objective is as follows.

Gen. II (176) - Varietal improvement of cashew (Thimmappaiah, KRM Swamy, PM Kumaran and Regy Lukose),

Evaluation of three progeny trials have been done to study the performance of various hybrids and selfs.

2.2 1. Hybridization and selection

Observations on morphological characters like girth (25 cm above ground), plant height, lateral spread (EW & NS), no. of laterals and leaders/m^2 and leader to lateral ratio and flowering characters were recorded in two field trials laid out with hybrids viz., Progeny trial I (18 combinations; RBD; 3 replications and 6 trees/plot) and Progeny trial III (15 combinations; RBD; 2 replications and 4 trees/plot). In the progeny trial II in which seven selfed progenies are included, similar observations were collected.

In progeny trial-I, the various hybrid combinations differed significantly with regard to girth and no. of laterals/m^2. Amongst these VTH 120×VTH 8, VTH 120×A 18/4, VTH 20×A 18/4 and VTH 120×13/5 Kodur had thicker girths (25cm) than others, whereas the hybrid combinations A 18/4×A 18/4, VTH 120×VTH 8, M 10/4 × WBDC V, VTH 93 × M 64/3

VTH 20 × T. No. 1 had more number of laterals/m². Out of 324 plants in the trial, 135 plants (42.3%) started flowering. In general the flowering was more in hybrids (44%) compared to selfs (32.9%).

In progeny trials II & III there were no significant differences among the hybrid combinations for all the morphological characters studied. Out of 176 plants in the trial, 74 came to flowering (42.0%).

Hybridization between 11 selected parental trees viz., M 10/4 (VR-1), M 44/3 (VR - 2), T. No. 56, BLA 139 - 1, A 18/4, 13/5 Kodur and VTH 20, 66, 77, 79, 93 resulted in 492 hybrid seednuts of 31 combinations. These seednuts were sown in polybags and the hybrid seedlings have been raised. The available hybrid seedlings (150 Nos.) will be planted.

2.2.2. Clonal multiplication of high yielding varieties for distribution

About 400 grafts of A 18/4 and 500 grafts of 13/5 Kodur have been produced at NRCC Experimental station, Shantigodu for distribution.

2.2.3. Maximisation plot with released varieties

Yield maximisation plots which includes M 10/4 and M 44/3 varieties were established at NRCC Puttur. In each variety, 50 grafts have been planted providing a spacing of 7.5m×7.5m. The total area planted is about 0.56 ha. The grafts have established well and are being properly maintained.

2.2.4. Evaluation of recommended varieties

Clonal material of 12 recommended varieties Viz., M 10/4 (VR - 1), M 44/3 (VR-2), T. No. 1, T. No. 56, EPM 9/8, H. 2-11, H 2-12. BLA 139 - 1, H 3 - 17, BLA 39-4, H 3-13 and Ullal 1 (8 46) were planted at NRCC Puttur, using RBD in 3 replications. In each plot 6 plants were planted providing a spacing of 7.5m×7.5m The variety H 4 - 7 has been planted alround the experimental area in order to minimise the border effects. The total area of the experiment is about 1.22 ha. The grafts are growing well and are being properly maintained.

2.2.5. Comparative yield trial

Seedling progenies of 16 cashew varieties planted in the year 1972 (RBD; 3 replications; 8 trees/plot; spacing 7.5m×7.5m) at Vittal have been evaluated. The statistical analysis of the data revealed that the varieties did not differ significantly for mean yield/tree. All the varieties produced medium size nuts (4.9 to 6.6g). The experiment will be concluded this year.

2.3. Biometrical studies

Most often the realised yield in a perennial crop like cashew is influenced by the various seed, seedling and morphological characters. To assess most of these yield components in relation to yield the work is being carried out under the project.

Stat. III (443) - Multivariate treatment and interpretation of the available data on plantation crops (S. Bhagavan)

From the data on seed and seedling characters, juvenile characters and yield characters (in all 30) recorded for the cashew germplasm experiment at NRCC experimental station, Shantigodu, data belonging to 4 promising accession VTH 31, 155, 174 and 199 were subjected to correlation studies Initial selection of 20

ncipal variables were made, by observ- their correlation pattern with yield. attempt was made to orthogonalise the a using principal component analysis, t since the latent roots were not conver- g, this was not possible. Further udies through step - wise regression and th co-efficient analysis for the selection principal variables which bears direct indirect influence over the yield charac- rs is in progress.

4. Developing varieties with better quality

At present no emphasis is placed on he quality aspects of cashew kernel. But with increasing competition from African countries in the international market, it is essential to breed varieties with superior quality. Data collected so far from defat- ted kernel flour indicated that there is considerable variability for protein ranging between 32-44g% Lysine 35-73 μg/mg protein, Vit-C, 144-274 mg% and kernel sugars 10-19g%. It is felt desirable to identify the varieties with the protein level over 35g%, lysine level over 50 μg/mg protein and sugar content not more than 14.0 g%.

Phy. V. (176) - Quality evaluation in cashew. (KV Nagaraj)

Lysine in the cashew kernel proteins of sixteen high yielding varieties was estimated by TNBS method (Table 2.4). Seven varieties viz., M 76/1, M 10/4, M 44/3, Bla 256 - 1, Bla 139 - 1, Morgaon and WBDC-V have shown lysine level over 50 μg/mg protein. Amongst these M 76/1 has significantly higher lysine content over most of the varieties.

Total lipid extracted from cashew kernel of 16 high yielding varieties was fractionated into neutral, glyco and phospholipids.

Table 2.4 Lysine content of cashew kernel proteins of high yielding varieties of cashew

Variety	Lysine (μg/mg protein)1
Tr-273-Bla	36.0
Tr-40-Bla	37.7
Vetore-56	40.9
Tr-56-Bla	41.5
Ansur-1	44.4
Bla 266-1	44.9
H-3-17	45.0
M 6/1	47.0
Tr-1-Bla	47.4
WBDC-V	53.8
Morgaon	54.4
Bla 139-1	54.4
Bla 256-1	59.3
M 44/3	62.3
M 10/4	65.5
M 76/1	73.1
CD ($P \leq 0.05$)	16.9

1-Values are mean of three individual estimations

The major fraction was found to be neutral lipid (96%). The neutral lipids were further fractionated by silicic acid chromatography into triglycerides, monoglycerides and free sterols, whereas the glycolipids were fractionated into acyl sterol glycoside monogalactosyl diglyceride, sterolglycoside and digalactosyl diglyceride and the results are given in Table 2.5. No varietal difference was noticed for any of these compositions.

The fatty-acid composition of cashew kernel lipid are given in Table 2.6. As triglycerides are rich in unsaturated fatty acids and glycolipids are rich in saturated fatty acids, a variety with higher triglyceride and lower glycolipid content will be preferable.

Cashew kernels from some of the released varieties viz., Ven 1 to 5 were characterised with respect to their protein, lysine and sugar contents (Table 2.7).

Table 2.5 Composition of cashew kernel neutral lipids and kernel glycolipids

Variety	% of total neutral lipid			% of total glycolipids			
	Triglyceride	Monoglyceride	Free sterols	Acyl sterol glycoside	Monogalactosyl diglyceride	Sterol glycoside	Digalactosyl diglyceride
H-3-17	3 7	15.6	80.7	44.2	17.5	12.0	26.3
Tr-56-Bla	7.7	8.3	83.9	45.9	14.3	12.9	26.9
Bla 256-1	9.9	8 5	81.5	47.4	15.4	10.5	26.6
Tr-1-Bla	10 0	14.0	75 9	38.8	15 5	15.0	30.7
WBDC-V	13.1	12.6	74.3	42 1	20.6	8 7	28.6
M 44/3	16.2	10.6	73.1	48.2	14.7	8.5	28 5
Bla 266-1	17.1	33.6	49.3	41.0	17.2	13.4	28.3
Tr-273-Bla	17.4	10.8	71.7	50.2	18 9	12.3	18.6
M 76/1	25.2	14.1	60.7	51.3	14.6	8.4	25.7
Tr-40-Bla	25.3	12.3	62.4	36.8	16.1	14.8	32.3
Ansur-I	33.7	9.9	55.2	55.3	13.6	8.1	22.9
Bla 139-1	37.1	9.4	53.4	43.8	15.5	11.1	29.6
Morgaon	64.1	5.4	30.5	44.1	17.4	6.6	31.9
M 10/4	65.1	5.2	29.7	62.5	14.7	6.5	16.3
Vetore-56	65.3	4.5	30.1	39.9	17.9	9.3	32.9
M 6/1	71.0	4.6	23.9	61.2	15 9	7.1	15.6

Table 2.6 Fatty acid composition of cashew kernel lipid

Fatty acids	Neutral lipids		Glycolipid	Phospholipid
	Triglycerides	Monoglycerides		
	Percent of total fatty acids			
12 : 0	0.7	5.8	53.9	—
14 : 0	0.8	5 4	23.6	2.6
16 : 0	11.9	13.5	5.4	29.6
18 : 0	—	—	8.9	—
18 : 1	73.4	55.8	3.7	50.9
18 : 2	11.9	19.5	4.2	16.3
20 : 0	1.1	—	—	—
Unsaturated/ saturated	5.9	3.0	0.1	2.0

Table 2.7 Cashew kernel protein, lysine and sugar contents of Vengurla varieties

Variety	Protein	Lysine	Sugars
Ven. 1	36.4 ± 0.79	64 8	8.08
Ven. 2	50.6 ± 2.80	50.9	5.97
Ven. 3	40.1 ± 1.04	76.8	8.65
Ven. 4	42.5 ± 3.12	66.9	7.10
Ven. 5	29.9 ± 1 37	89.8	8.43

Protein and sugars are expressed as g/100 g defatted cashew kernel flour

Lysine content is expressed as μg/mg protein

Values are mean of three individual estimations ± sem

2 5. Developing varieties with pest resistance

The varietal screening carried out so far, for reaction against tea mosquito also indicated that considerable variability exists in reaction to this pest. Field evaluation carried out has indicated that score ranges between 3.0 (moderately tolerant one) to 7.6 (susceptible one) in the scale of 0-9. It is proposed to screen the varieties with the score less than 4.6 for achieving better pest management efficiency in the field and also identify the mechanism of resistance to tea-mosquito with reference to biochemical aspects. In addition, programme to identify natural enemies of TMB is being persued to develop biological control technique.

Ent· I (176) - Biology and bionomics of insect pests of cashew (PSPV Vidyasagar)

In depth study of biology and bionomics of tea mosquito bug has been carried out under this project

2.5.1. Monitoring of tea mosquito bug (TMB)

Monitoring of TMB population on unsprayed trees at Experimental Farm, Shantigodu, was discontinued, since the population build up was negligible.

2.5.2. Population dynamics of TMB

In the Laboratory reared insects, males outnumbered females in all the months contrary to earlier reports. The ratio of females to males emerging in the Laboratory from January to December is 1:1.14; 1:1.26; 1:1.56; 1:2.20; 1:3.27; 1:1.80; 1:2.67; 1:1.58; 1:1.48; 1:1.48; 1:2.20; 1:1.54

2.5.3. Varietal reaction to TMB

Grafts of Vengurla 1, VTH 12, VTH 13 and VTH 35 along with a susceptible check were screened in the laboratory against TMB. No difference in the reaction was observed. At KCDC, Kunthur plantation, one high yielding tree (T. No. 24) with a fair degree of field resistance to TMB has been identified (Table 2.8) Further studies are in progress.

Table 2.8 Varietal reaction to TMB

Sl. No.	Var./Type	1985-86 season		1986-87 season	
		Score	Reaction	Score	Reaction
1.	M 76/1	4.2	MS	3.6	MS
2.	Vengurala 1	3.8	MS	2.0	MR
3.	Lopalaparamba	3.9	MS	1.0	MR
4.	5/23 Kundapura	4.1	MS	1.8	MR
5.	9/66 Chirala	4.2	MS	2.2	MS
6.	VTH 35	7.6	HS	3.2	MS
7.	Vengurla 2	4.8	MS	3 9	MS
8.	Vengurla 3	6 2	HS	4.0	MS
9.	Vengurla 4	6.0	HS	3.8	MS
10.	New Tree No. 24	3.0	MR	Nil	R Promising

0-1=R, 1.1-2.9=MR, 3-4.5=MS, 4 5-6=S, 6.1-9=HS

2.5.4. Mass rearing of TMB

The technique of mass rearing TMB in the laboratory has been further refined. With the present technique, upto 534 nymphs (Table 2.9) could be maintained every day. Certain artificial diets were also tried during the period under report and further testing is in progress.

2.5.5. Pheromone studies

A few preliminary studies were made using wind tunnel and olfactometer. These studies showed that males attract the females. This indicates the presence of a possible sex pheromone in males. Further testing is in progress.

Table 2.9. Laboratory Rearing of TMB

Month	Total nymphs	Daily av. of nymphs	Highest no. on a day	Hatching days	Total hatching	Daily av. hatching	Adult emergence days	Total adults emerged
Jan.	67	3.35	23	6	—	—	4	60
Feb.	78	3.90	22	5	—	—	8	70
March	83	4.15	25	6	—	—	4	46
April	143	6.22	35	10	—	—	6	16
May	841	36.57	69	12	—	—	10	47
June	3555	154.57	206	16	—	—	18	160
July	597	25.96	117	15	—	—	9	70
Aug.	1502	65.30	100	21	252	12.00	17	116
Sep.	2097	91.17	209	20	193	9.65	12	119
Oct.	1639	102.43	202	13	359	27.61	14	228
Nov.	3178	138.17	235	17	383	22.53	16	317
Dec.	8204	315.54	534	21	1175	55.95	16	584

2.5.6. Effectiveness of Neemrich-I and Neemrich-II

Neemrich - I an ovipositional deterrent when tested against TMB, reduced oviposition considerably (20.5% and 17.46%) in TMB both in the laboratory and field conditions. However, Neemrich-II which was supposed to be a feeding deterrent, did not alter feeding behaviour. Moreover, all the nymphs developed normally when repeatedly fed on the treated food. This indicates that Neemrich-I should be further tested intensively for this purpose.

2.5.7. Effect of Nitrogen on TMB incidence

Observations on the incidence of TMB in different Nitrogen fertilizer treatments were recorded. Preliminary analysis of the data showed no significant differences among various treatments.

SUPPORTIVE PROGRAMMES

'Soft - wood' method of propagation during July month gave 83.1% success. Altogether 25,200 grafts were produced during the year for distribution among farmers and various Departmental Agencies/Cashew Development Corpora-

3. Supportive Programmes

For supporting the missions on increasing production as well as productivity, the priority item is making available elite planting material as well as demonstration of improved technology in farmers fields.

3.1 Planting material

At present the potential for multiplication of the released varieties is very limited. In most of the cases only few plants of released variety are available in the research centres, thereby imposing limitation in availability of scion material.

The immediate priority will be to establish budwood orchards in all cashew growing states with released and recommended varieties. It is also proposed to establish scion banks in all the research centres for making available nucleus material for establishing budwood orchards. At NRCC, all the recommended and released varieties and also those which are now in pipeline (25 varieties) are being planted in scion bank. This scion bank will be able to support production of about 1 lakh grafts by the end of the plan period. A project which aims at standardising the propagation techniques is as follows.

Hort. III (176) - Propagation studies in cashew
(Room Singh)

Various propagation methods have been attempted to standardize the method of vegetative propagation and also to determine the suitable period for propagation.

3.1.1. Generation of planting material

Keeping in view the target of 10,000 grafts to be produced during the year under report, three different methods of propagation namely, soft - wood, epicotyl, and veneer were tried from March 1986 to November 1986 i. e. for nine months. A total of 43,295 grafts were made and the average success for the year was 58.2 per cent. Thus the total number of successful grafts was 25,200, As such, the production was 2.5 times more than the target given for 1986.

3.1.2. Period of propagation

With regard to the period of propagation (Table 3.1) July month proved to be the best which gave an average success of 74.0 per cent followed by August (64.2%). The June and September gave more than

Table 3.1 Propagation studies in cashew

Month (1986)	Soft wood		Epicotyl		Veneer		Total	
	No. done	Success %	No. done	Success %	No. done	Success %	No. done	Success %
Mar.	150	5.3	150	24.7	—	—	300	38.0
April	2200	60.8	950	27.5	—	—	3150	50.7
May	2000	62.3	957	30.1	—	—	2957	51.9
June	3000	67.5	1010	32.8	—	—	4010	58.8
July	6500	83.1	1200	47.8	675	32.6	8375	74.0
Aug.	4500	73.6	1200	40.2	415	31.3	6115	64.2
Sep.	4500	67.9	1100	32.7	468	28.2	6068	58.5
Oct.	6000	66.9	1490	29.2	430	27.4	7920	57.7
Nov.	3000	36.1	1000	21.6	400	16 8	4400	31.0
Total	31850	67.7	9057	32.9	2388	27.9	43295	58.2

58 per cent success closely followed by October (57.7%). The April and May could give 50.7 per cent and 51.9 per cent success respectively. The remaining two months i. e., March and November did not prove much beneficial as they gave 38 per cent and 31 per cent average success. Therefore, it is clear that maximum efforts should be put for the large scale multiplication during July and August and the period may be extended from June to October only. Almost similar results were obtained during 1985.

3.1.3. Propagation methods and its success

(i) Soft- wood method

In soft-wood method of propagation the age of seedling varied from 30 to 40 days after germination. Out of three methods tried softwood proved to be the best followed by epicotyl and veneer grafting.

During July the success was as high as 83.1 per cent followed by August (73.6%). June and September gave about 68 per cent success closely followed by October (66.9%). April and May also gave about 61 per cent. The success in March was 51.3 per cent whereas the November gave 36 per cent only.

(ii) Epicotyl method

The age of the seedlings used in this method varied from seven to ten days after germination. In this method too the highest success was recorded in July i. e., 47.8 per cent followed by August (40.2%). June and September gave almost similar results in this method and gave 32.8 per cent and 32.7 per cent respectively followed by October (29.2%). The success varied from 21.6 to 30.1 per cent in the remaining period of the year.

(iii) Veneer method

In this method of multiplication, much older seedlings are used. The age of the seedlings varied from 6 to 9 months. This method was not tried from March 86 to June 86 due to the non-availability of the grown up seedlings. However, in the remaining months i. e., from July to November the highest success was recorded in July which gave 32.6 per cent and closely followed by August (31.3%). September and October gave 27 per cent and 28 per cent success whereas in November the success was only 16.8 per cent.

3.1.4. Training of labourers as malies

Out of 16 supporting staff grade mazdoors (Class IV) available at NRCC Experimental station, Shantigodu, 4 SS. Grade mazdoors have been trained successfully in vegetative propagation, whose services may be utilised for multiplication in future programme, if required.

3.2. Demonstration of improved technology

While every effort is being made to develop suitable agro-techniques and generation of elite planting material, simultaneous efforts to demonstrate the transfer of technology are being carried out under the project.

Extn. IV. (176) - Research - cum - demonstration plots (KRM Swamy).

Two farmers having cashew plantations of 4-5 years were selected during the year 1984 (Mr. B. Abdul Rahiman Haji, Bannur Katte, Puttur Taluk and Mr. Monappa Poojary, Vittal Mudnur, Bantwal Taluk) for

demonstrating the advantages of adopting package of practices. Frequent field visits were made and the farmers were given timely advice regarding fertilizer application, basin making, spraying against tea mosquito bug. The farmer at Bannur Katte could harvest 102 kg. of nuts from the 40 trees (av. 2.5 kg/tree).

In order to test the performance of improved varieties of cashew under farmers' field conditions two plots, one at Vittal (Bantwal Taluk) and another at Mura (Puttur Taluk) are selected. Soft wood grafts of VTH 154 and VTH 174 have been supplied to these farmers and they are being monitored.

SUMMARY REPORT OF AICCIP and MSCRP

Summary of work done under the All India Coordinated Cashew Improvement Project and Multi-State Cashew Research Project

The AICCIP was initiated as separate project during the current year after the bifurcation of ongoing All India Coordinated Spices and Cashewnut Improvement Project. In order to give more concentrated efforts for evolving high yielding varieties tolerant to pests, diseases, standardisation of agro-techniques for the crop under different agro-climatic regions and for evolving control measures for the major pests and diseases. Work is in progress in seven Centres, viz., Jhargram (West Bengal), Bhubaneshwar (Orissa), Bapatla (Andhra-Pradesh), Vridhachalam (Tamil Nadu), Madakkathara (Kerala), Chintamani (Karnataka) and Vengurla (Maharashtra).

The Multi - State Cashew Research Project was initiated in 1982 with the World Bank aid with the major objectives:

1) Standardisation of vegetative propagation technique for large scale adoption

2) Chemical and sanitational control of cashew pests

3) imparting training on vegetative propagation and plantation management

4) establishment of demonstration plots with elite materials-

CPCRI was provided additional support to intensify work on breeding for high yield and resistance to tea mosquito, effect of high density planting systems and quality analysis of nuts and apples and storage studies. The work is in progress at Vittal/Shantigodu (CPCRI), Madakkathara (KAU), Ullal/Brahmavar (UAS), Bapatla (APAU) and Bhubaneshwar (OUAT). The major research findings of these two projects during the year are summarised below

Crop production

The germplasm collections are being maintained at seven Centres of All India Coordinated Cashew Improvement Project and also at Vittal/Shantigodu. At Vittal 161 accessions are maintained. During the current year 76 accessions were collected from Goa. 10/2 Stuartpuram, BLA 266-1 and M 33/3 gave an yield of over 20 kg/tree. At Madakkathara out of the 93 collections Adhoor-2 gave the maximum yield. Out of the 197 collections at Bapatla three trees 71, 275 and 232 yielded more than 40 kg An isolated tree yielding over 80 kg per year was located near Rajamundhry by this Centre. At Vridhachalam 196 accessions, Vengurla 143 accessions, Jhargram 97 accessions and Chintamani 16 accessions are being maintained and evaluated.

In the seedling selection trials, seed weight, seed length, length from cotyledons to first leaf showed positive correlation of adult plant nut yield. By utilizing the selection criteria developed based on these seedling parameters a genetic advance of 5.37% and a relative improvement of 47.8% due to discriminant function percentage over straight selection at 10% intensity can be predicted.

Evaluation of 163 F_1 hybrids at Madakkathara, 77 hybrid progenies at Vridhachalam, 212 F_1 progenies at Vengurla, 40 progenies at Bapatla and hybrid progenies of 10 selected trees at Vittal are under evaluation. The hybrid 24 of Vengurla was released as Vengurla-5 and maximum yield (31 3 kg nuts/year) was obtained in T. No. 29 (Mysore Kotekar 6/1 × Ansur early).

In a comparative yield trial NDR-2-1 at Madakkathara, BLA 139 - 1 at Bapatla, M 44/3 and M 76/1 at Vridhachalam, Vengurla 36/3 and M2/4 at Bhubaneshwar, BLA 139-1 at Jhargram and M 44/3 and M 10/4 at Vittal gave highest yields.

Crop propagation

Major emphasis during the year has been on standardising vegetative propagation technique for multiplication of released varieties. So far 16 varieties were released by different Coordinating Centres for cultivation in the respective areas. M 44/3 from Vridhachalam was recommended for release at the national level. The best method for vegetative propagation was found to be soft wood grafting. In this method root stock of 2 to 3 months were used for grafting. Precuring the scion for a week was found to be advantageous in realising highest success in grafting. Leaving one or two pairs of leaves on the root stock enhanced success percentage. By this method it is possible to make the grafting in all seasons with varying degrees of success ranging between 20% to 90%. The highest success is in summer months (March to June) in different Centres. During the current year over 50,000 grafts were produced by the project Centres.

For rejuvenation of old and unthrifty plantations top working was standardised at Ullal and Bhubaneshwar Centres. The success ranged between 60 to 80%. In the second year after top working the yield realised was 2.5 to 3 kg compared to 500 g that was being harvested from the old trees.

Crop management

Among the different methods of fertilizer application tried at different Centres, broadcasting within the drip line and incorporating into the soil was found to be best over circular trench or band application. The maximum response was to 500 g N, 125 P_2O_5 and 125 g K_2O per tree per year given in two split applications.

At Shantigodu and Ullal pruning trials have indicated that there is a two fold increase in yield of raw nuts per tree when the pruning was done during July-August months. Trials conducted at Ullal Centre indicated that by removal of dead wood and criss cross branches the yield of the tree can be substantially improved.

Crop protection

At the Vridhachalam Centre, Methyl parathion (0.05%) spray was found to be most effective against tea mosquito. Aerial spraying trials conducted for three consecutive seasons under the Madakkathara Centre and at the PCK estates at Kasaragod/Muliyar have conclusively proved that Endosulfan 35 EC at 750ml/ha was superior to all the other insecticides tested for the control of the pest complex occuring on the inflorescence.

Prophylactic application of HCH 0.1% in the collar region in May and again in December was effective against the stem

borer *Plocaeperus ferrogineus* at Madakkathara.

Stem padding with cotton wool soaked in monocrotophos @ 30ml/tree was found to be most effective in controlling stem borer infestations under Goa conditions.

Against the leaf eating weevil Myllocerus sp. quinalphos 0.05%, carbaryl 0.15% were found to be effective at Bapatla.

Monocrotophos 0.05% and Methyl parathion 0.05% in that order were effective against floral thrips in Vengurla.

APPENDIX II

PARTICIPATION IN SYMPOSIA / CONFERENCES

Workshop on 'Impact of Drought on plantation Crops' organised by ISPC, CPCRI and RRII at CPCRI, Kasaragod.	RC Mandal EVVB Rao S Bhagavan	May 26-27
Kisan Mela at CPCRI Kasaragod	RC Mandal EVVB Rao N Yadukumar	Aug 29
Workshop on 'Beneficial Microbes in Tree crops Management' organised by CPCRI at CPCRI Kasaragod	RC Mandal EVVB Rao	Sept 9
PLACROSYM VII organised by ISPC, RRII, CRI, Cardamom Board, UPASI and CPCRI at UPASI, Coonoor	EVVB Rao S Bhagavan	Oct 16-18
Workshop on 'Role of slow Release Fertilizers in Plantation Crops' organised by CPCRI at CPCRI, Kasaragod	RC Mandal EVVB Rao	Nov 25-26
First Kisan Mela of NRCS at Peruvannamuzhi	EVVB Rao	Dec 11

APPENDIX III

RESEARCH PUBLICATIONS:

Bhagavan, S and Nair, BP 1986. Vigour index as an additional parameter in identifying elite palms in arecanut. In Proc. VII Annual Symposium on Plantation Crops.

Bhaskara Rao, EVV 1986. Plantation crops genetic resources research in India. In Proc. VII Annual Symposium on Plantation Crops (Lead paper in session on Germplasm)

Nagaraja, KV and Namputhiri, VMK. 1986. Chemical characterization of high yielding varieties of cashew (*Anacardium occidentale* L). Qual. Plant Foods Hum, Nutr. 36 ; 201-6.

Sosamma, VK, Koshy, PK and Bhaskara Rao, EVV. 1986. Response of coconut cultivars to the burrowing nematode *Radopholis similis*. In proc. National conference on Plant Parasitic Nematodes in India: Problems and Prospects.

TECHNICAL PUBLICATIONS :

Multi State Cashew Project : Report on Research Projects upto March 1986 (Ed: Bhaskara Rao EVV) CPCRI, RS, Vittal. 23 pp (memiographed) (prepared in connection with IDA Review Team's visit in April 1986).

Proceedings of Horticulture Group Discussion 21-23 August, 1986 (Ed : Bhaskara Rao EVV) CPCRI, RS, Vittal, 13 pp (Memiographed).

Summary Report on Research Projects of MSCP upto 30 September, 1986, (Ed : Bhaskara Rao EVV) CPCRI, Kasaragod, 37 pp. (Memiographed).

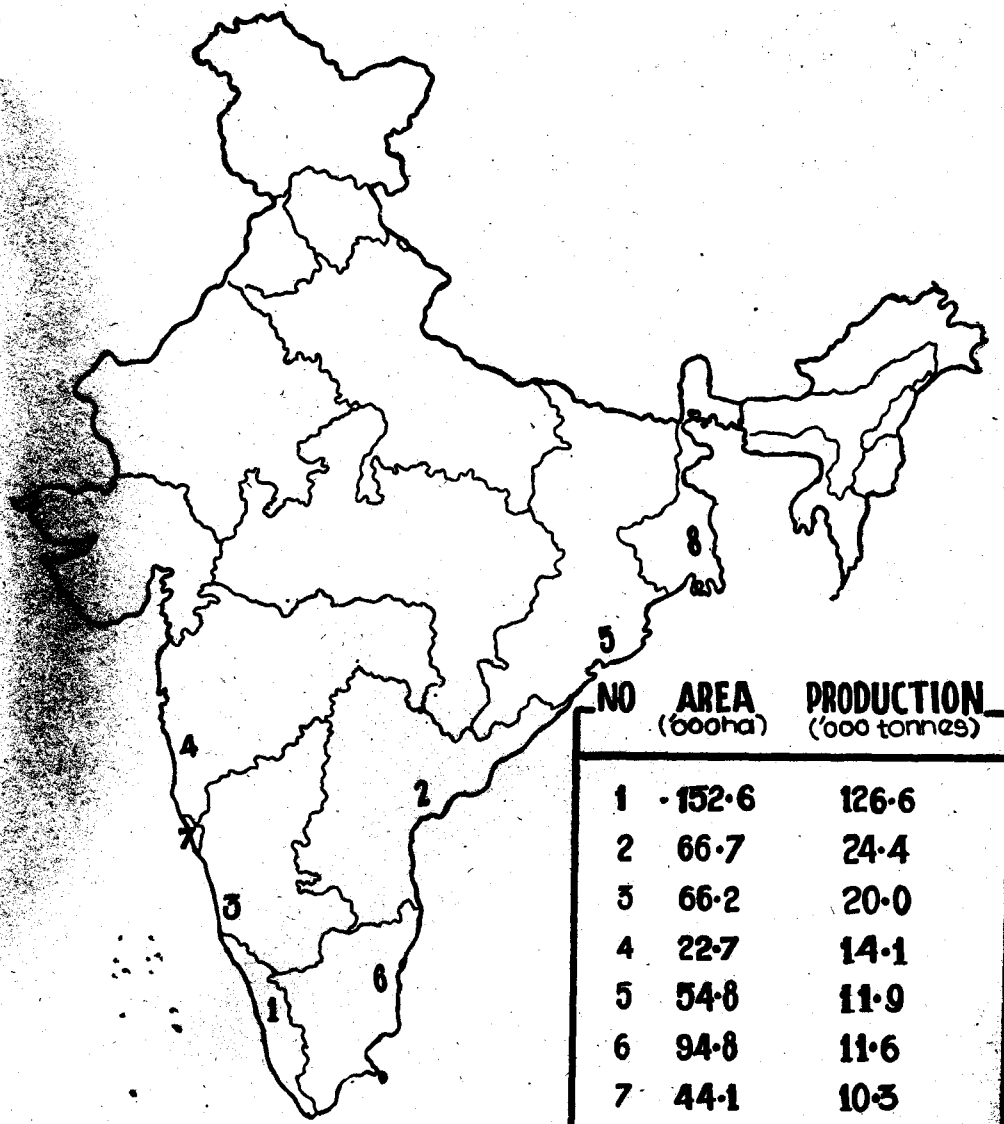
APPENDIX IV

CASHEW IN INDIA

YEAR	AREA (lakh ha.)	PRODUCTION (lakh tonnes)	PRODUCTIVITY ('000 kg. / ha.)	IMPORT (lakh tonnes)	EXPORT (lakh tonnes)	EXPORT EARNINGS (Million Rs.)
1955 - 56	1.10	0.79	0.72	0.63	0.31	12.9
1956 - 57	1.10	0.80	0.73	0.51	0.31	14.5
1957 - 58	1.21	0.93	0.77	0.99	0.36	15.1
1958 - 59	1.30	0.99	0.76	1.25	0.41	15.8
1959 - 60	1.40	1.07	0.76	0.95	0 39	16.1
1960 - 61	1.76	1.11	0.63	1.18	0.44	18.9
1961 - 62	1.85	1.13	0.61	1.02	0.42	18.1
1962 - 63	2.12	1.20	0.57	1.55	0.49	19.3
1963 - 64	2.24	1.33	0.59	1.57	0.51	21.4
1964 - 65	2.32	1.41	0.61	1.91	0.56	29.0
1965 - 66	2.41	1.44	0.60	1.61	0.51	27.4
1966 - 67	2.49	1.49	0.60	1.41	0.51	42.8
1967 - 68	2.57	1.57	0.61	1.68	0.51	43.0
1968 - 69	2.66	1.64	0.62	1.96	0.63	60.9
1969 - 70	2.81	1.76	0.63	1.63	0.60	57.4
1970 - 71	3.03	1.77	0 58	1.69	0.50	52.0
1971 - 72	3.20	1.83	0.57	1.69	0.60	61.3
1972 - 73	3.28	1.77	0.54	1.97	0 66	68.8
1973 - 74	3.51	1.78	0.51	1.50	0.52	74.4
1974 - 75	3.58	1.66	0.46	1.60	0.65	108.1
1975 - 76	3.69	1.71	0.46	1.37	0.54	96.1
1976 - 77	3.72	1.40	0.38	0.74	0.52	105.9
1977 - 78	3.75	1.43	0.38	0.60	0.40	147.6
1978 - 79	4.16	1.34	0.32	0.20	0.27	80.0
1979 - 80	4.51	1.42	0.31	0.24	0.38	118.0
1980 - 81	4.64	1.85	0.40	0.16	0.32	140.0
1981 - 82	4.81	1.96	0.41	0.16	0.31	181.0
1982 - 83	5.02	2.01	0.40	0.01	0.31	135.0
1983 - 84	5.02	2.11	0.42	0.27	0.37	151.0
1984 - 85	5.09	2.21	0.43	0.33	0.32	180.0
1985 - 86	5.10	2.34	0.46	0.23	0.35	215.0
1986 - 87	5.10	2.45	0.48	0.40	0.42	334.0

CASHEW STATISTICS IN INDIA

1984-85



NO	AREA ('000ha)	PRODUCTION ('000 tonnes)
1	152·6	126·6
2	66·7	24·4
3	66·2	20·0
4	22·7	14·1
5	54·8	11·9
6	94·8	11·6
7	44·1	10·3
8	6·7	2·3