

STATUS OF CASHEW RESEARCH AND DEVELOPMENT IN INDIA: A STATE PERSPECTIVE



Editors

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All India Coordinated Research Project on Cashew,
ICAR- Directorate of Cashew Research, Puttur,
Dakshina Kannada, Karntakata



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Preface

The renewed interest in cashew cultivation throughout the country in recent years is witnessed due to several advantages of the crop. The demand for cashew in India and abroad is ever increasing and the quality of Indian cashew is well known in international markets. It is suitable for cultivation in dry land areas where irrigation facilities are scarce. New bold nut hybrids and ultra high density planting techniques have ushered in new dimensions in cultivation of the crop. Its climate resilience is yet another benefit over other perennial crops. Assured markets and processing facilities in India have instilled new assurance in farmers.

In this context, an attempt to understand the status of cashew research and development in different cashew growing regions of the country assumes paramount importance. This will help in planning and implementation of the activities for further improvement of cashew sector. Keeping this in view, we have compiled this report on current status by obtaining information from AICRP centers functioning in different states of the country.

The information for a state comprises of details such as current scenario of cashew, production statistics, germplasm resources, crop improvement, production and protection efforts, post harvest technologies including recipes and associated traditional knowledge. Initiatives for cashew cultivation among tribal farmers are also included. The theses on cashew and research workers list in respective states also find a place in the report. Further, role of various developmental agencies in cashew development and future prospects of cashew cultivation are discussed.

We take this opportunity to thank all researchers who have contributed write ups for this report. It is hoped that this publication will be valuable for researchers, developmental agencies and students interested in cashew research and development.

-Editors

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STATUS OF CASHEW RESEARCH AND DEVELOPMENT IN ANDHRA PRADESH

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INTRODUCTION

On the recommendations of the Spices Enquiry Committee 1953 the crop has received attention, to aid production and research work on cashew. Laterite soils and heavy rains which typify to the conditions under which cashew is grown on the West coast are not available in the East coast, which is characterized by sandy soils with moderate rainfall. Thus the station came to existence in the year 1955 with an area of 11.36 acres for the scientific and economic development of growing cashew in the East coast. The Cashew Research Station, Bapatla is situated at 54.9 MSL with 14° 54' latitude and 80° 28' longitudes on the East of South India (East Coast).

In Andhra Pradesh Cashew Growing areas fall into following Agro-ecological Sub Regions. Eastern Ghat (South), hot moist-arid/dry sub humid ESR with medium to deep loam to clayey mixed red and black soils, moderate Available Water Holding Capacity (AWC) and Length of Growing Period (LGP) 150-180 days. Utkal plain and East Godavari delta, hot dry sub humid ESR with medium loamy to clayey and deltaic alluvium-derived soils, medium AWC and LGP 180-210 days.

Presently cashew is grown in Srikakulam, Vizianagaram, Visakhapatnam, upland area of East & West Godavari, Krishna, Guntur, Prakasam, Nellore (Kavali), districts of Coastal Zone and Chittoor (Satyavedu) district of Rayalaseema zone in Andhra Pradesh in an area of about 1.26 lakh hectares with a production of one lakh metric tonnes.

GERMPLASM RESOURCES

A total of 127 accessions/genotypes including 32 released varieties have been collected and are being maintained in gene bank for further evaluation.

VARIETIES/HYBRIDS RELEASED FROM CASHEW RESEARCH STATION, BAPATLA

As a result of continuous and systematic evaluation, 4 high yielding selections were identified from local germplasm collection and released as BPP-3 (SM.3/3) BPP-4 (EPM.9/8), BPP-5 (T.No.1) and BPP-6 (T.No.56). Besides, these 4 high yielding hybrids were also developed and released from this station viz., BPP-1 (T.No.1x273), BPP-2 (T.No.1x273), BPP-8 (T.No.1x40) and BPP-9 (T.No.56xM.10/4).

Brief description of Varieties/Hybrids:-

Variety/hybrid	Parentage	% bisexual flowers	Nut Wt.	Shelling %	Yield
BPP-1 (H2/11)	Tree No.1 and 273	15	5g	26	12kg
BPP-2 (H2/12)	Tree No.1 and 273	8	4g	26	15kg
BPP-3 (SCH 3/3)		15	5g	25	25kg
BPP-4 (EPM 9/8)		8			10kg
BPP-5 (TR. No.1)		10	5g	25	42kg at 40 years of age
BPP-6 (TR. No.56)		8	6g	26	57kg at 40 years of age
BPP-8 (H 2/16)	Tree No.1 X Tree No.40		8.2 g	29	21.5 kg / tree
BPP-9 (H 3/28)	Tree no.56 X M 10/4	15	6.7 g	28	24.6 kg

CROP MANAGEMENT**Soils**

In Andhra Pradesh, Cashew is grown in deep loam to clayey mixed red and black soils of Eastern Ghats (South) and medium loamy to clayey and deltaic alluvium-derived soils of Utkal plain and East Godavari delta zone.

Irrigation

Cashew is mostly cultivated under rain fed conditions in many parts of the state. If irrigation facility is available farmers are giving irrigation at an interval of 15 days during flowering to fruit and nut development stages. In flat to medium sloppy lands terraces are made with crescent bund for efficient utilization of the available water during pre and post monsoon periods.

Manures and Fertilizers:

Age of tree	June-July 1 st dose			September-October 2 nd dose		
	Urea (g/tree)	SSP (g/tree)	MOP (g/tree)	Urea (g/tree)	SSP (g/tree)	MOP (g/tree)
First year (Basal)	Farm yard Manure, Neem cake, Single Super Phosphate in Pits.					
Second year	185	185	35	185	185	35
Third year	370	250	70	370	250	70
Fourth year	434	312	100	434	312	100
Fifth year & onwards	543	375	100	543	375	100

- Application of fertilizer in a circular trench of 25cm broad and 15cm deep at 1.5m away from the trunk was found to be more effective.
- Foliar spray with 2% Urea thrice at flushing, flowering and nut formation stage significantly increased the yield.
- For seedling progeny of Cashew fertilizer dose of 500g N, 125g P₂O₅ and 125g K₂O per tree was found to be optimum for sandy soils.
- Top working at 1.0m height during November-December and grafting with scion during January-February was found to be suitable for successful grafting and rejuvenation of old unproductive Cashew trees.
- Among the different seasonal and perennial crops studied as inter crops in cashew the Horse gram, subabul, eucalyptus and Marigold are found to be best respectively in sandy soil situation of Bapatla.
- For clonal progeny of Cashew fertilizer dose of 1000g N, 125g P₂O₅ and 125g K₂O per tree was found to be optimum for sandy soils of Andhra Pradesh.

Pruning

Majority of the cashew plantations are established without proper pruning, training and canopy management. Pruning has to be taken up alternate years by removal of dried and criss crossed branches and branches crawling close to the ground in the month of June to July.

CROP PROTECTION

Cashew is ravaged by many pests out of which five pests are considered as major pests of this region. Tea-mosquito bug is the major problem in North coastal districts (High Altitude areas) of Andhra Pradesh and Cashew Stem and Root Borer is the major problems in all the cashew growing districts. Leaf and blossom Webber, Shoot tip caterpillar and Apple and Nut Borer are the other major pests.

1. Cashew Stem and Root Borer (*Placaederus ferrugineus* L.)

The pest is common in old and neglected plantations. It occurs throughout the year, but more prevalent during the rainy season. The adult lays eggs in crevices and cracks of bark on the trunk and exposed roots. The hatched grubs bore in to the bark. As a result the vascular tissue is damaged, the ascent of the plant sap is arrested, leaves turn yellow and are shed and finally the tree dies. The grubs pupate in a calcareous cocoon in the feeding tunnel.

Management

- Extraction and killing of the grubs & cocoons by chiseling the affected portion of bark of trunk or root followed by spraying the chiseled portion chlorpyrifos 0.2% and earthling up on to the chiseled portion.
- As prophylactic measure the tree trunk up to a height of 1 m and the exposed roots should be sprayed with neem oil 5% thrice during the year at an interval of 4 months starting from June onwards or onset of monsoon.

2. Tea mosquito bug (*Helopeltis antonii*. S)

The tea mosquito bug is one of the serious pests of cashew tree. The nymphs and adults attack the tender shoots, leaves, inflorescence, tender nuts and apples. The following schedule is used for the management of TMB.

Management

I spray	-	Flushing phase (Dec-Jan)	Monocrotophos	1.6ml/liter of water
II spray	-	Flowering phase (Jan-Feb)	Lamada Cyhalothrin	0.6ml/liter of water
III spray	-	Fruit set phase (Feb-Mar)	Profenophos	0.6ml/liter of water

The same schedule spray is used to control other foliage and floral pests viz., Leaf and blossom webber, Shoot tip caterpillar and Apple and nut borer.

POST HARVEST PROCESSING

Cashew processing is a well established activity in Andhra Pradesh. Totally 175 processing units are running at Palasa of Srikakulam district and Vetapalem of Prakasam District with processing capacity of 95 MT it includes small and medium cashew industries.

ROLE OF DEVELOPMENTAL AGENCIES AND OTHER LINE DEPARTMENTS

The developmental agencies like DCCD, NABARD and NHM are playing a very important role in the development of cashew crop. DCCD is providing financial assistance for conducting training programmes to cashew farmers and also providing inputs to some of the farmers under the area expansion programme. NABARD and NHM are also providing subsidies to farmers for purchasing plant material and other inputs.

Strategies for increasing production & productivity of cashew

- 1) Development of compact and dwarf high yielding cashew variety suitable for high density plantation.
- 2) Massive replanting programme to replace senile and unthrifty orchards.
- 3) Development of cost effective cashew production technologies.
- 4) Increasing productivity by adopting improved cashew Production technologies.
- 5) Enhancing the production of raw cashewnut to reduce the imports by expansion of cashew area both in traditional and non-traditional areas
- 6) Development of cashew based integrated farming systems.
- 7) Effective pest control measures for tea mosquito bug (TMB) / cashew stem and root borers (CSRB).
- 8) Promotion of quality planting materials for area expansion. Ninety regional nurseries are established in the country and capable of producing 90 lakh grafts per year. Under National Horticulture Mission, small and mega nurseries are coming up to cover 50,000 ha clonal plantation per annum
- 9) Organization of intensive thematic campaign and farmers' training programmes on cashew production technology.
- 10) Introduction of crop insurance policy for cashew.
- 11) Participation of cashew industry in promotional efforts.
- 12) Conservation of soil, soil moisture and water conservation techniques.
- 13) Development of better packaging and marketing strategies for domestic and international market. Promotion of SHG for marketing of cashew.
- 14) Provision of minimum support price for cashew.
- 15) Post harvest management including value added products and effective utilization of cashew apple.
- 16) Popularization on farm processing technology especially for small and medium size land holders for higher income.
- 17) Promotion of organic cashew cultivation with precision farming development concept.
- 18) Production forecast in relation to climate change.
- 19) Declaration of plantation crop status to cashew by all cashew growing states.
- 20) Conducting awareness programme in every mandal by all the players of cashew sector.
- 21) Caju sevaks may be recruited in every district for intensive publicity for one year.
- 22) Quality planting materials of cashew should be delivered at farm gate.
- 23) Farmers group of common interest should be formed for holistic development.
- 24) All the financial assistance should be transferred directly to the individual beneficiaries account.
- 25) All the panchayath structures of the government at village level need to be involved in the development.
- 26) Contract farming need to be introduced by industries with due support from Government.
- 27) The cooperative collection and marketing centers to be established.

STATUS OF TRIBAL SUB - PLAN PROJECT

AICRP on Cashew, Cashew Research Station, Bapatla was having TSP Programme for the year 15-16. Under area expansion programme for 5 ha and two training programmes were allotted to Bapatla centre under TSP. Regarding area expansion programme 12 tribal farmers were selected and distributed plant material (Cashew grafts – BPP-8) for 12 acres to 12 farmers and also other inputs fertilizers (Urea, SSP and MOP and grafts maintenance charges) about Rs. 90,625/- distributed to Jeelugumilli village farmers of West Godavari District. A training programme was organized at agency area of Gadapapalem, Koyyuru mandal of Visakhapatnam district on 19-12-2016 and another training programme was organized at tribal area of Pathapatnam, Pathapatnam mandal of Srikakulam District on 03-03-2016.

LOCATION SPECIFIC PROBLEMS/ CONSTRAINTS:

- i. Most of the cashew varieties in Andhra Pradesh (East-Coast varieties) are small nut types with cluster bearing habit and not suitable for export market.
- ii. Though cashew is very responsive to irrigation, pruning and nutrition, cashew is predominantly grown in Andhra Pradesh as rain fed crop (majority area) and only a little care is being taken by the farmers.
- iii. Poor establishment of grafts is another major problem in farmers fields due to inadequate care and watering in the initial stages of growth (both sandy and red soils) In red soils the yellowing of leaves, black spots on young leaves (deficiency and toxicity of elements) finally mortality of grafts is another problem.
- iv. Some of the pests like tea-mosquito bug in North coastal districts (High Altitude areas) and cashew stem and root borer in sandy soils were major problems in on cashew plantations.
- v. Non adoption of intercropping techniques and growing of suitable inter crop during initial years of Orchard life.
- vi. Non adoption of recommended fertilizer schedule for cashew orchards raised thorough grafts.
- vii. Package for improving yields of existing seedling progenies of cashew.

EDUCATION IN CASHEW

S. No	Name of the student	M.Sc/ Ph.D	Year of completion	Thesis title	Major recommendations/ findings
1	Barre Prasanna Kumar	Ph.D	2005	Effect of Pruning and plant growth retardants on growth development of Cashew	<ul style="list-style-type: none">▪ From this experiment, it is concluded that soil application of paclobutrazol at 6 g a.i. tree⁻¹ was found to be beneficial under local agro-climatic conditions of Bapatla.▪ The growth retardant paclobutrazol although showed better performance of

				(<i>Anacardium occidentale</i>)	<p>cashew tree with reduction in growth and increased productivity, it is felt necessary to study further the response of cashew to interval of application in years.</p> <ul style="list-style-type: none"> To control the excessive vegetative growth, pruning of leader shoot from mid-July to mid-August was found to be next alternative.
2	Ashok Naidu Pagoti	M.Sc (Hort.)	2012	Utilization of Cashew Apple (<i>Anacardium occidentale</i> L.) for preparing Cashew Apple syrup by using different varieties.	<ul style="list-style-type: none"> Among the varieties studied, significantly highest fruit weight (76.48 g), fruit girth (5.79 cm), fruit length (7.53 cm), fruit volume (58.11cm³) and juice recovery percentage (79.73%) were recorded in the variety Priyanka followed by BPP-8. Highest quantity of syrup was obtained in variety Priyanka (11.04 Kg) followed by BPP-8 (4.56 kg) from 100 fruits on weight basis. Organoleptic evaluation of syrup, the overall acceptability was highest in Priyanka followed by BPP-5, BPP-8 and the lowest in BPP-4 variety.
3.	Anindita Roy	M.Sc (Hort.)	2014	Study on the value addition of Cashew Apple (<i>Anacardium occidentale</i> L.) juice by blending with Mango, Pineapple and Sapota juices for RTS beverage.	<ul style="list-style-type: none"> The density, TSS and TSS/Acid ratio were highest in T₉ (25% Cashew apple juice + 75% Sapota juice) (1.06). The percent reducing sugars was highest in T₂ (50% Cashew apple juice + 50% Mango juice) (7.18). The per cent non-reducing sugars were more in T₇ (75% Cashew apple juice + 25% Sapota juice) (5.13). The highest organoleptic score with respect to colour was high in T₂ (50% Cashew apple juice + 50% Mango juice) (9.16) and for taste and overall acceptability highest score was recorded in T₃ (8.49).

STATUS OF CASHEW RESEARCH AND DEVELOPMENT IN CHATTISGARH

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INTRODUCTION

The All India Coordinated Research Project on Cashew, Jagdalpur was sanctioned during VIII plan period (1993). The mandate of this Coordinated Research Project on Cashew is to develop technologies for increasing production and productivity of cashew nut in Bastar (Chhattisgarh). The S. G. College of Agriculture and Research Station, Jagdalpur, Bastar is a unit of Indira Gandhi Krishi Vishwavidyalaya, Raipur. It is situated at about 300 km from Raipur and 292 km from Vishakhapatnam.

Geographically Bastar is located at 17°45' to 20°34' N and 80°15' to 82°15' E longitude with altitude ranging from 550 m to 850 m above MSL. The climatic conditions as well as the land situation is conducive for cashew plantations therefore area under cashew cultivation is significantly increasing in the state. The cashew plantation was initiated in the state during the early 1960s. The area under cashew nut in the Chhattisgarh is increased from 4268.9 ha during 2004-05 to 28,429 ha during 2015-16. The increased area clearly indicates the adoptability and popularity of the crop in the state. Earlier the cashew nut cultivation was mainly concentrated in Bastar and Raigarh district of the state, but now the cultivation of cashew nut has extended to the Jashpur, Kondagaon, Kanker, Dantewada, Sukma, Korba, Koriya, Narayanpur & Bijapur districts of the state.

Area, Production and Productivity

Year	Area (ha)	Production (mt)	Productivity (mt/ha)
2004-05	4268.9	3071.03	0.719
2005-06	7506.0	12612.0	1.680
2006-07	8372.7	10053.6	1.200
2007-08	17019.0	7166.5	0.421
2008-09	17712.0	7439.0	0.419
2009-10	18362.0	8764.3	0.477
2010-11	19677.5	9182.3	0.466
2011-12	20319.0	11362.4	0.559
2012-13	21603.0	12767.0	0.590
2013-14	27651.0	22601.0	0.817
2014-15	27799.0	23039.0	0.828
2015-16	28429.0	23035.0	0.810

Source: Directorate of Horticulture & Farm Forestry, Government of Chhattisgarh

STATUS OF GERMPLASM

Cashew germplasm accessions maintained at Jagdalpur Centre during the year 2016-17

No. of accessions till 2017		Accessions collected during 2016-17	Total number of accessions
Local germplasm collections	22	-	22
Germplasm obtained from other centres	50	10	60
Total			82

SALIENT RESEARCH FINDING AND TECHNOLOGIES DEVELOPED FOR THE STATE OF CHHATTISGARH

CROP IMPROVEMENT AND CROP MANAGEMENT

Presently our centre having 82 cashew genotypes including 22 promising local germplasm. The promising entry CARS-10 released as "Indira Kaju-1" by State Seed Sub-Committee, Govt. of Chhattisgarh in the year 2010. "Indira Kaju-1" is a high yielding, cold tolerant variety with average nut yield 15.53 kg/tree. Along with Indira Kaju Vengurla-4 is currently recommended for large scale plantation in the Bastar region. Under multilocation trial, genotypes H-68, H-303, H-255 and H-320 have been identified as very promising for the region and hence recommended for Bastar region. Fertilizer dose is standardized for adult tree of cashew @ 1000:250:250 g of N: P: K respectively per tree. In Bastar, flower bud differentiation occurs from October to November. Flowering period varied from mid December to March in the different germplasm evaluated in the station. Blooming usually starts from January and extends till April.

CROP PROTECTION

Cashew stem and root borer, tea mosquito bug, leaf miner and panicle & nut thrips are identified as major insect pests while, leaf folder & leaf caterpillar are identified as minor insect pests of cashew in Bastar, Chhattisgarh. In chemical control trial, profenophos (0.05%) found effective against the major and minor insect pests followed by λ -cyhalothrin (0.003%) when it is sprayed at flushing stage and flowering stages and if needed during fruiting stage. In curative control trial, swabbing of chlorpyrifos 20EC @ 2% was found better against CSRB after removal of grub.

TRANSFER OF TECHNOLOGY

A scion bank (Variety: V-4) of 1 ha is maintained and used for preparation of cashew grafts. Approximately 20,000 cashew grafts are produced per year through university revolving fund. Till date (up to 2017) approximately 3.50 Lakh grafts were sold to the farmer of the region as well as to other parts of the state. Cashew Frontline Technology Demonstration funded by DCCD (Directorate of Cashewnut & Cocoa Development), Kochi, Kerala is also taken up at the Centre. (Table-1).

Panchayat	Area	No. of plants	Year of planting
Rajnagar	04 ha	712	2009-10
Kawdawand	14 ha	2492	2009-10
Bastar	02 ha	356	2009-10

Plantations of recommended cashew variety V-4 and other promising varieties were raised in Bakawand, Jagdalpur, Tokapal and Bastanar blocks with the assistance from different funding agencies like Directorate of Cashew and Cocoa Development, Kochi, Kerala, DPAP Hariyali and Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) as detailed in Table 2.

In Private Lands					
	Karanpur	Chittalur	Upenpal	Turenar	Total
Seedlings (ha)	19.50	13.75	02.50	0.6.00	41.75
Cashew grafts (ha)	0.00	06.00	23.50	170.50	200.00
In Community Land					
Seedlings, (ha)	6.50	10.00	4.50	3.50	24.50
Cashew grafts (ha)	0.00	0.00	0.00	4.50	4.50

Plantation of cashew grafted plant in 10 ha area in village Lamker & Bodanpal of Bastar district is done under cashew FLD programme funded by Directorate of Cashew Research Puttur, Karnataka in the year 2014-15.

Extension Programmes Organised

Year	Title of the Programme	Details
2011	Present status, prospects and problems of cashew plantation in Bastar	<ul style="list-style-type: none"> Two days cashew workshop was organized on wherein more than 150 farmer, extension workers, extension officers and scientists had participated. This programme was sponsored by National Horticulture Mission.
28.03.2006, 08.03.2008 & 10.02.2011	Production Technology of Cashew for Bastar	<ul style="list-style-type: none"> Three 'Cashew days' were organized on 28.03.2006, 08.03.2008 and 10.02.2011 on "production Technology of

		Cashew for Bastar". In exhibition, nuts and grafts of different cashew varieties and machineries for small scale cashew processing were shown to farmer.
--	Management of cashew stem and root borer	<ul style="list-style-type: none"> ▪ Campaigns (four nos) on management of cashew stem and root borer were organized in four villages of block viz., Bakawand, Tokapal and Bastar.
22 nd March 2013	District Level Cashew Seminar	<ul style="list-style-type: none"> ▪ One day District Level Cashew Seminar was organized with the financial support of National Horticulture Mission (Horticulture Department Chattisgarh Government). In this programme, more than 150 cashew farmers, extension workers, extension officers and scientist participated.
2013-14 & 2014-15	Enhancement of tribals income through small scale cashew nut & cashew apple processing in Bastar region of Chhattisgarh	<ul style="list-style-type: none"> ▪ During the year 2013-14 & 2014-15 a total of 03 nos seven days training programme were organized on cashew processing under the project. This programme was organized under TSP (ICAR).
29 th March, 2014	cashew field workshop	<ul style="list-style-type: none"> ▪ One day cashew field workshop was organized on 29th March, 2014 with the financial support of DCR, Puttur, Karnataka. In this programme, more than 100 cashew farmers, extension workers, extension officers and scientist had participated.
22-24 th March, 2014 & on 18-20 th Feb, 2015	Cashew Production, Plant Protection and Processing technologies	<ul style="list-style-type: none"> ▪ Three days training programme on 'Cashew Production, Plant Protection and Processing technologies' were organized on 22-24th March, 2014 & on 18-20th Feb, 2015 with the financial support of Directorate of Cashew nut & Cocoa Development, Kochi, Kerala

11-13 th March, 2015 & on 28-30 th March, 2015	Cashew Production, Plant Protection and Processing technologies	<ul style="list-style-type: none"> Three days training programme on 'Cashew Production, Plant Protection and Processing technologies' were organized with the financial support of Directorate of Cashew Research Puttur, Karnataka
14.10.2015, 13.1.2017, 31.1.2017 and 25.2.2017	Production technologies, Plant Protection and Processing of cashew nut	<ul style="list-style-type: none"> One day training programme was organized on 14.10.2015, 13.1.2017, 31.1.2017 and 25.2.2017 with the financial support of Directorate of Cashew Research Puttur, Karnataka
14.10.2015, 13.1.2017, 31.1.2017 & 25.2.2017	Production technologies, Plant Protection and Processing of cashew nut	<ul style="list-style-type: none"> One day training programme with the financial support of Directorate of Cashew Research Puttur, Karnataka.
4-6 th Feb, 2017, 17-19 th Feb, 2017, 20-22 Feb, 2017 & on 7-9 th March, 2017	'Cashew Production, Plant Protection and Processing technologies'	<ul style="list-style-type: none"> Three days training programme on with the financial support of Directorate of Cashew nut & Cocoa Development, Kochi, Kerala.
15-21 st March, 2017	Exposure visit of Cashew farmers of Chhattisgarh to OUAT, Bhubaneswar, Odisha	<ul style="list-style-type: none"> Exposure visit of 50 Cashew farmers of Chhattisgarh to OUAT, Bhubaneswar, Odisha was organized with the financial support of Directorate of Cashew nut & Cocoa Development, Kochi, Kerala.
24-30 th March, 2017	Enhancement of tribals income through small scale cashew nut & cashew apple processing in Bastar region of Chhattisgarh	<ul style="list-style-type: none"> Seven days training on cashew processing under the project was organized under TSP (ICAR).
29 th March, 2017	Cashew apple utilization	<ul style="list-style-type: none"> One day training programme on cashew apple utilization for unemployed women was organized with the financial support of Directorate of Cashew nut & Cocoa Development, Kochi, Kerala

Role of development agencies and other line departments (DCCD, NABARD, NHM etc) in cashew development in the state

In order to expand the cashew area and quality clonal/ grafted planting material production, Jagdalpur centre has established linkage with State Department of Horticulture including National Horticulture Mission, Forest department, NGOs and with DCCD, Kochi for organizing seminars, field days, training and demonstrations programme

Future Needs of Cashew Research & Extension In Chhattisgarh

(A) Crop Improvement

1. Germplasm collection, conservation, evaluation, characterization and cataloguing.
2. Development of dwarf and compact cashew varieties suitable for high density planting.
3. Development of suitable high yielding varieties for different agro climatic regions of Chhattisgarh.

(B) Crop Management

1. Study of the response of vegetatively propagated material of cashew to different doses of NPK fertilizers at different spacing for a given regional variety.
2. Evaluation of performance of different varieties of cashew under high density planting system.
3. Rejuvenation of old cashew plantations /orchards.
4. Canopy architecture and management to suit the requirement of different plant densities and system of planting.
5. Intercropping in cashew.
6. Organic farming in cashew.
7. Research on value added products of cashew apple.

(C) Crop Protection

1. Development of eco-friendly IPM strategies including Entomo Pathogenic Nematodes (EPN) for control of major insect pests.
2. Evaluation of recent & modern insecticide for control of TMB and other insect pest.
3. Influence of biotic and abiotic factors on incidence of pest complex in cashew.
4. Development of forewarning system of TMB in relation to climate change.
5. Screening of germplasm to locate tolerant / resistant types to Major pests of the region.
6. Investigations on panicle drying (in absence of TMB).
7. Analysis of pesticide residues in cashew produce.

(D) Transfer of Technology

1. Study of impact of cashew production technology on increase in area and productivity of cashew.
2. Analysis of socio-economic impact of cashew cultivation.
3. Production and supply of quality planting material of improved cashew varieties.
4. Organizing demonstration plots and trainers training programmes.

Major constraints in cashew cultivation and processing

1. Lack of policy matter for procurement of cashew grafts from the registered and reliable sources to maintain the quality planting material.
2. Majority of the cashew plantation are seedling originated which reduces the potential yield.
3. In the initial stage of plantation, training and pruning is not adopted by the cashew growers.
4. Lack of high yielding cashew hybrids/ varieties.
5. Fertilizers are not used and plant protection measures are not taken.
6. Lack of cashew nut processing units in the state. The cashew growers are selling raw cashew nuts through middleman at very low price. Establishment and popularization of small scale cashew processing unit through SHGs will enable to increase the socio economic status of the poor & marginal farmers of Bastar region.
7. Cashew apple is not utilized. There is huge scope for popularization of different cashew apple products like jam, jelly, RTS, fenny etc.

Education in cashew

Name of the student	M.Sc./ Ph.D.	Year of completion	Thesis title	Major recommendations/ findings
Khoobi Ram Sahu	Ph.D. (Ag.) Entomology	2009	"Survey of insect pest of cashew (<i>Anacardium occidentale</i> L.) and management of key pest <i>Plocaederus ferrugineus</i> L. (cashew stem and root borer)"	<ul style="list-style-type: none">▪ Total 39 species of different insect pests and their natural enemies were recorded in cashew.▪ Max temp, min temp and wind velocity had significant positive effect & relative humidity had negative effect on CSRB infestation.▪ Out of 10 curative treatment against CSRB, Chlorpyrifos 0.2% was

				most effective with low cost.
Dilip Kumar	M.Sc. (Ag) Entomology	2014	“Population dynamics and management of major insect pests of cashew (<i>Anacardium occidentale</i> L.) with special reference to stem and root borer (<i>Plocaederus ferrugineus</i> L.)”	<ul style="list-style-type: none"> ▪ Total 16 species of different insect pests and their natural enemies were recorded in cashew. ▪ The infestation of CSRB was most serious and its occurrence was noticed through out the year with maximum (16.82%) during February. ▪ DDVP (10 ml) + chlorpyrifos (10 ml) was significantly superior for control of CSRB infestation.
Mangal Singh Paikra	Ph.D. (Ag.) Horticulture	2016	“Studies on genetic divergence in cashew (<i>Anacardium occidentale</i> L.)”	<ul style="list-style-type: none"> ▪ A wide range of GCV was exhibited for number of nuts per panicle, kernel weight, fruit set % and nut yield. ▪ High heritability coupled with high genetic advance observed for number of nuts/ panicle, kernel weight and nut yield, indicating that selection based on these characters may be effective.
				<ul style="list-style-type: none"> ▪ On the basis of D^2 studies, genotypes H-255 and 30/1 could be used for hybridization programme in all possible combination to get maximum heterosis.

Research Workers in cashew

Name and designation	Organization	Present status working/ retired	Major areas of research	Present address with phone/ mobile number
Dr. M.S. Paikra, Sr. Scientist (Hort)	IGKV, Raipur (C.G.)	Working	Crop improvement & Management	S.G. College of Agriculture and Research Station, Jagdalpur, (C.G.) 9424284560 (M)
Dr.O.P. Awasthi Principal Scientist (Hort)	IGKV, Raipur (C.G.)	Transferred	Crop improvement & Management	--
Dr. Anuj Bhatnagar Principal Scientist (Ento.)	IGKV, Raipur (C.G.)	Transferred	Crop protection	--
Dr. T.D. Pandey Professor (Agronomy)	IGKV, Raipur (C.G.)	Transferred	Crop Management	College of Agriculture, Bilaspur, (C.G.) 9926388328 (M)
Dr. Sanjay Sharma Professor (Entomology)	IGKV, Raipur (C.G.)	Transferred	Crop protection	College of Agriculture, Raipur, (C.G.) 9424224206 (M)
Dr. D. Sharma, Sr. Scientist (Hort)	IGKV, Raipur (C.G.)	Transferred	Crop improvement & Management	College of Agriculture, Raipur, (C.G.) 9425213533 (M)
Dr. K.R. Sahu, Sr. Scientist (Ento.)	IGKV, Raipur (C.G.)	Transferred	Crop protection	Krishi Vigyan Kendra, Balrampur, (C.G.) 9424281253 (M)
Dr. A. K. Gupta, Scientist (Ento.)	IGKV, Raipur (C.G.)	Transferred	Crop protection	College of Agriculture, Bemetara (C.G.), 9425213533 (M)

STATUS OF CASHEW RESEARCH AND DEVELOPMENT IN GUJARAT

Shah N.I., Sharma D.K., Makati J.P. and Parmar S.G.

Agricultural Experimental Station, Navsari Agricultural University,
Paria, Pardi Taluk, Valsad district, Gujarat

INTRODUCTION

Cashew cultivation in Gujarat state seems to have started during the early 1990s when it was introduced along with mango through 'Wadi Programme' by BAIF-Dhruva, an NGO working for upliftment of tribal people in Valsad district of South Gujarat. BAIF started the project in 1982 in Vansada village of Navsari district. The cashew was demonstrated on tribal farmer's field after testing its feasibility, as it was not a traditional crop of this region. Initially, the tribal farmers were supplied cashew grafts along with mango grafts under 'Wadi' programme around Vansada taluka. Slowly, the farmers of Dharampur and Kaparada blocks of Valsad district also joined this programme. The main objective was to grow fruit trees which reduce soil erosion as well as generate some extra income with less water requirement, as the tribal people are leaving on undulating area of eastern hills. The NGO supplied planting material along with critical inputs with buy-back arrangement of cashew nuts. It helped in spreading cashews plantation in Kaparada and Dharampur talukas of Valsad district having undulating landscape and high rainfall. The actual production of cashew nut began in the year 2000 onwards. Since then, the crop has become a remunerative crop of the region. It is spread over 7,000 acres in Dharampur and Kaparada taluka in Valsad district as well as in Dang district. About 90 per cent of the plantations are in Dharampur-Kaparada talukas, now slowly spreading in Dang, Narmada and Tapi districts of Gujarat. Sporadic plantation was also observed in Saurashtra region including Junagadh, Rajkot, Bhavnagar, Amreli and Surendranagar districts.

The cashew from South Gujarat is believed to be superior as compared to the cashew from Goa, in terms of taste, whiteness and crunchiness. Research on cashew was started recently at Agriculture Experimental Station, Navsari Agricultural University, during 2009 when AICRP on Cashew scheme was sanctioned by Directorate of Cashew Research, Puttur. The research pertaining to breeding, agronomic, horticulture and entomological aspects is being carried out at Paria.

AREA, PRODUCTION AND PRODUCTIVITY OVER THE YEARS

The area under cashew plantation was 3570 ha during the year 2003-04 which gradually increased to about 8422 ha during the year 2014-15. At present, cashew plantation is increasing steadily in the state while productivity of cashew nut is observed to be at par with national average.

GERMPLASM RESOURCES

A few old cashew plantations are observed at Dharampur, Kaparada and Umergaon talukas where it is planted by forest department. Survey has been done in hilly region of Valsad district, particularly in Kaparada and Dharampur blocks. An accession has been under observation which is likely to have high yielding characteristic along with TMB tolerance. Only one early flowering accession, which flowers in November, is identified from a farmer's field. While collection of about 20 to 25 released varieties from other states is under progress for research purpose at the research station.

Breeding Efforts and varieties released in the state/varieties commercially adopted by farmers

Breeding work in cashew in Gujarat is in very initial stage. There is no variety released from the Gujarat state. According to farmers view, Vengurla-4 (V-4) and Vengurla-7 (V-7) are most suitable for the area. Farmers have commercially adopted V-4 and V-7 varieties of cashew.

CROP MANAGEMENT

Cashew in Gujarat has been observed in various types of soil. It can grow well in hilly red alluvial, loamy clay to sandy type of soils. Generally irrigation is given to developing orchard through flood or drip irrigation. Need based irrigation is being adopted in tribal areas. Almost all cashew growers are using both organic as well as inorganic fertilizers. University is recommending 750: 150: 150g NPK per tree in the state of Gujarat. The old cashew plantation is now facing the problem of low yield due to poor management conditions, which needs to be improved by providing training to the growers.

CROP PROTECTION

Insect pests like tea mosquito bug, thrips, mealybugs, leaf miner, leaf and blossom webber, apple and nut borer and shoot tip caterpillar have been noticed in this crop. Following chemical control measure for the insect pests is recommended by this research centre

1. Spraying of Thiamethoxam 25 WG 0.0084% (3.2 g/lit. of water) at shooting stage, Endosulfan 35 EC 0.07% (20ml/10 lit. of water) at flowering stage and carbosulfan 25 EC 0.1% (40ml/10 lit. of water) at the time of fruiting stage (Year of recommendation is 2011).
2. For the control of tea mosquito bug, spraying of Acetamiprid 20 SP 0.004% (2 g/10 lit. of water).

POST HARVEST PROCESSING

The nuts produced by tribal farmers are being sold in weekly markets where buyers buy the nuts. Some stakeholders also participate in the market and the purchased nut is sold to big stakeholders or processors. The co-operatives and BAIF-Dhruva also purchasing nuts directly from the farmers and process the nuts in their processing plants. Local co-operative societies have set up of 11 cashew processing units in Valsad and Dang districts. Various co-operatives like Sutharpada co-operative, Karjun co-operative, Mandava, Tuterkhed and Pindwad co-operatives are active under the aegis of the Horticulture Co-operative Society of the state.

There are some processors in the state which are mainly used to buy raw cashew nuts from abroad. There are many companies, particularly mainly situated in Ahmedabad viz., Akshar Cashew Industries Pvt. Ltd., Alidhra Cashew Industries, were established and started manufacturing, exporting, supplying, importing, trading a diverse assortment of cashew processing machinery and raw cashew kernels. In south Gujarat, Surat is fast emerging as a processing hub of raw cashew nuts imported mostly from the African countries like Tanzania and Kenya. Over 200 big and small cashew nuts processing units viz., Savalia Industries NP Cashew, Parivartan Kaju House etc. have come up in and around the city in the last couple of years to meet the growing demand of cashews in the Diamond City in particular and Gujarat in general. There are some more cashew processing industries in the state viz., Madhuram Cashew Processing Unit and Panchdev Cashew Industries (Rajkot), Patel Agri Export (Dhoraji), Shreenathji cashew processing unit (Junagadh), Shree Dwarkesh Kaju Factory and SS Cashew Industries (Vadodara), Savaliya Industries, Parivartan Kaju House, Rami International, Suraj Engineering, Om Sai Enterprise etc.

Value added products from cashew apple and kernel

Value addition from cashew is not common in the state yet. The state has potential to use cashew apple for value addition. Increasing area under cashew cultivation will definitely be encouraging to the private sector for value addition to cashew apples as well as cashew kernels.

Recipes

Agriculture Experimental Station, NAU, Paria has prepared recipe for RTS and jam preparation from cashew apples in collaboration with DCR, Puttur after making minor changes and will be recommended very soon.

ROLE OF DEVELOPMENTAL AGENCIES AND OTHER LINE DEPARTMENTS

In Gujarat, National Horticulture Mission is associated with area expansion by providing planting material to marginal farmers while DCCD providing funds for extension works

relating cashew cultivation. Extension activities like farmer scientific interaction, farmers training, farm school, exposure visit etc., are done by Agriculture technology management agency (ATMA) at district level. DCR, Puttur is providing fund under tribal sub plan to Agriculture Experimental Station, NAU, Paria which is used for extension work related to cashew cultivation particularly in Valsad district.

Future prospects of cashew in the state

As cashew cultivation in Gujarat has started recently, much more research is required starting from training entrepreneurs for nursery raising, cultivation practices, IPM, IDM, training and pruning, harvesting, processing of raw nuts and value addition of cashew apples, etc., along with breeding cashew for high yielding, early flowering and TMB resistance.

STATUS OF TRIBAL SUB-PLAN PROJECT

Tribal Sub-plan project has started in the year 2013-14. TSP activities comprises of extension activities along with area expansion under cashew cultivation. The extension activities are being performed in tribal areas of Valsad district under which farmers are mainly informed about benefits of cashew cultivation, plant protection measures and value addition of cashew apples. Some selected farmers are being supplied the planting material along with fertilizers and pesticides for better growth of the crop under area expansion.

MAJOR CONSTRAINTS IN CASHEW CULTIVATION AND PROCESSING

The area under cashew cultivation is mainly confined to hilly areas where tribal farmers are cultivating cashew. There are also some scattered and small areas in the state where cashew cultivation is going on which includes plain soils. But the mindset of the farmers is that cashew cultivation can be done on hilly areas only. In south Gujarat, farmers who are cultivating mango under plains do not want to change the crop. These are some major constraints for area expansion under cashew cultivation.

The cashew processors in the state are mainly having automated machineries but the raw cashew nuts are being imported from abroad. The raw cashew nuts produced from the state is not meeting the needs of entrepreneurs.

EDUCATION IN CASHEW

Name of the student	M.Sc. / Ph.D.	Year of completion	Thesis title
Patel Bhavesh B.	M.Sc.	2011	Influence of different vegetative propagation methods and rootstocks

			for cashew graft cv. Vengurla-4 in south Gujarat.
Solanki Puspraj. D.	M.Sc.	2011	Study on flowering and fruiting behavior of different varieties of cashew in south Gujarat.
Mahida Bijendra.M	M.Sc.	2011	Influence of different media and variety on growth of cashew rootstock.
Gohil Jigar	M.Sc.	2012	Effect of IBA and NAA on air layering of cashew cv. Vengurla-4 under south Gujarat conditions.
Vaghela Dipak. M.	M.Sc.	2014	Effect of season and growing environment on success of softwood grafting in cashew cv. Vengurla - 4.
Gajbhiye R.C.	Ph.D.	2014	Foliar application of nutrients on cashew cv.vengurla-4 with reference to growth, yield and quality.

Main Research workers in cashew

Name and designation	Organization	Present status Working/retired	Major areas of research	Present address with phone/mobile number
Dr. J.P. Makati	Navsari Agricultural University	Working	Horticulture	Agriculture Experimental station, NAU, Paria, Valsad, Gujarat 09724322312
Sh. S.G. Parmar	Navsari Agricultural University	Working	Entomology	Agriculture Experimental station, NAU, Paria, Valsad, Gujarat 09898245830

At present around 11 tribal cashew processing co-operatives are working in Valsad district. These co-operatives provide employment to local tribal farmers especially women. The processing units near big cities generally process the imported raw cashewnuts with engaged labor from local as well as outside Gujarat. The cashew nut produced in Valsad and adjoining districts are being collected by local co-operative societies and later on processed nuts are dispatched to market for sale. The maximum profit goes to the middlemen/ NGO/ Private companies and little is passed on to the workers engaged in processing & farmers engaged in cultivation.

STATUS OF CASHEW RESEARCH AND DEVELOPMENT IN KARNATAKA – COASTAL AND HILL ZONES

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ICAR- Directorate of Cashew Research, Puttur-574 202, Dakshina Kannada, Karnataka

INTRODUCTION

The state of Karnataka comprises of coastal, hill, transition and dry zones and the cashew is predominantly grown in districts of the coastal zone. Recently however, the farmers in different zones of the state are showing interest in cashew cultivation owing to increased price prospects. Hence, the cashew cultivation is extending to districts of hill and transition zones in addition to dry zones of northern and southern parts of Karnataka. The areas which are showing interest in cashew cultivation in recent years include Sagar, Soraba, Shikaripur, Hukkeri, Belagavi, Khanapur, Mandya, Mysore, Gadag, Koppal, Haveri, Bidar, Arasikere, Dharwad etc.

RESEARCH ON CASHEW

Indian Council of Agricultural Research, New Delhi started adhoc research schemes for cashew in many states during the year 1951. Accordingly, this scheme was started in Ullal research station of Karnataka state in 1953. The aim of this scheme is to introduce and evaluate cashew germplasm accessions, production and evaluation of hybrids, propagation studies in addition to flower biology. Cashew was included as one of the mandatory crops of Central Plantation Crops Research Institute (CPCRI), Kasargod which was started during 1970. The All India Coordinated Spices and Cashewnut Improvement (AICS and CIP) was started during 1971 under CPCRI. The research on cashew was initially started in CPCRI regional station, Vittal in Karnataka.

The research on cashew was delinked from CPCRI Regional Station, Vittal and the National Research Center for Cashew was started in Puttur, Karnataka during the year 1986. This was upgraded to the Directorate of Cashew Research (DCR) during the year 2009 with 68 ha of land in Kemminje near Puttur. The Directorate has an experimental station (80ha) at Shantigodu in Puttur Taluk which is at a distance of 13km from the main campus. This Station was started by CPCRI in 1972 as Cashew Seed Farm and was transferred to NRC for Cashew in 1986.

The DCR was given the mandate to conduct mission oriented research on all aspects of cashew for improving productivity and quality with special reference to export. It also serves as a national repository for cashew germplasm and a clearing house for research information on cashew. Further, it gives training in research methodologies and coordinates national research projects. Consultancy in cashew production technology, generation of planting material and collaboration with national and international agencies are also

included in the mandate of the institute. The All India Coordinated Research Project on Cashew (AICRP on Cashew) is also functioning under ICAR-DCR, Puttur. There are two AICRP centers in Karnataka i.e. one at Hogalagere in Kolar taluk and another one at Kanabargi in Belgaum district (as cooperating center) . In addition to these centers, the Agricultural and Horticultural Research Station, Ullal, established in 1953 is functioning currently under University of Agricultural and Horticultural Sciences, Shimoga.

The area, production and productivity of cashew in Karnataka state is given in the Table 1. The productivity in Karnataka is less than that of the national productivity (753 kg/ha). Currently the productivity of the state hovers around 672 kg/ha.

Table 1. Area, production and productivity of cashew in Karnataka state

Year	Area (000 ha)	Production (000MT)	Productivity (Kg/ha)
2008-09	107.00	60.00	561
2009-10	118.00	53.00	461
2010-11	119.00	57.00	491
2011-12	121.00	60.00	517
2012-13	121.88	74.64	640
2013-14	124.11	80.61	750
2014-15	124.71	80.50	645
2015-16	125.86	73.00	572
2016-17	127.86	85.147	672

Source: Directorate of Cashew and Cocoa Development (DCCD), Kochi

GERMPLASM RESOURCES

After the establishment of ICAR- DCR, the germplasm survey and collection were carried out in cashew growing states namely, Karnataka, Kerala, Maharashtra, Goa, Tamil Nadu, Andhra Pradesh, Jharkhand, Orissa and West Bengal. The non-traditional areas such as Garo Hills (Meghalaya), Bastar (Chhattisgarh), Gujarat, Dadra & Nagar Haveli and Andaman & Nicobar Islands were also surveyed for germplasm collection. So far, 542 accessions have been collected and conserved in the National Cashew Field Gene Bank (NCFGB) at the Directorate and five germplasm catalogues have been published.

A robust Decision Support System (DSS) has been recently developed with 478 accessions and 68 characters to manage and better utilize the cashew germplasm resources. The module can be accessed at <https://cashew.icar.gov.in/dcr>. The genetic architecture of cashew germplasm is ascertained with 13 important quantitative characters of 478 accessions. Recently, a core collection of cashew comprising of 49 accessions has been developed deploying advanced M strategy with heuristic approach and the accessions are established in the field. This helps in better management of cashew genetic resources.

The germplasm accessions conserved in the NCFGB at NRCC, Puttur include the diverse types such as high yield, bold nut, semi-tall, compact, Cashew Nut Shell Liquid (CNSL) free, purple pigmented, high shelling percentage, cluster bearing, big apple and early maturity

types. Three wild species namely, *Anacardium pumilum*, *A. othonianum* and *A. microcarpum* are also conserved. The germplasm accessions which are unique and have potential (verified / verifiable) attributes of scientific/commercial value are registered in NBPGR, New Delhi.

Of the germplasm accessions conserved, about 155 accessions have been effectively utilized for crossing programme at the Directorate of Cashew Research (DCR), Puttur and several of these were also supplied to other cashew research centres for hybridization programme and other studies. Presently, the hybridization programme is going on at DCR, Puttur and recently, a program for development of varieties for cashew apple has been initiated in addition to screening of accessions for increased/decreased CNSL content.

BREEDING EFFORTS AND VARIETIES RELEASED FOR CULTIVATION

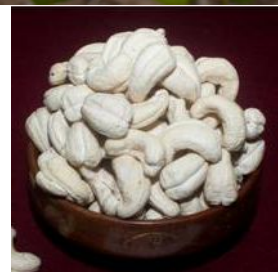
Breeding efforts are being carried out in DCR since 1986 and so far, three varieties have been released. Further, in Ullal center in Dakshina Kannada district, which is presently under University of Horticultural Sciences, Bagalkot has released five varieties. The details of these varieties are given below.

a) Varieties from DCR, Puttur

H-130: A new jumbo nut hybrid H-130 which was superior in yield (3kg/tree in 3 years of planting) with cluster bearing (10-20 nuts/panicle) and bold size (12-13g nut weight) and big apple (>100g) was evaluated and released for cultivation during the year 2018 and performance evaluation in farmers field. The hybrid is highly precocious, early flowering with long fruiting duration. Plant is vigorous but sparse canopy and having large leaves and big inflorescence with strong 8-10 rachis. It has high



number of bisexual flowers and fruit set is as high as more than 30-40 nuts per panicle in the initial stage and subsequently 10-20 nut retention per panicle. The highest initial fruit set per panicle recorded was 72 nuts. The hybrid responds well to pruning and is suitable both for ultra density planting and normal spaced plantations. Hybrid has high shelling (29.9%) with big kernels – 3.5 – 5 g a rare type among released varieties and falls under W-110-150 category kernel grade but most kernels belonging to W-130 category. The kernel protein is 21% and fat is 46%.



NRCC Selection-1: This variety was released in the year 1989. This is a selection from segregating progeny of germplasm 3/8 Simhachalam (VTH 107/3) originally a collection from AP. It is a late flowering type (December - February) with a flowering duration of 82 days. The number of fruits per bunch is 5. The yield, on an average, is 10 kg/tree. The nut weight is 7.6g. The shelling percentage is 28.8% and the kernel grade conforms to export grade of W 210. Apple colour is yellow.

NRCC Selection-2: This is a selection from the segregating seedling progeny of 2/9 Dicharla (VTH 40/1) originally a collection made from Andhra Pradesh. This variety was released in 1989. It has a mid season flowering habit (November - January) with a flowering duration of 74 days. The number of fruits per bunch is 3. The average yield is 9 kg/tree. The nut weight is 9.2g. The shelling percentage is 28.6% and kernel grade conforms to export grade W 210. Colour of apple is orange red.



Bhaskara: This variety was released during March 2006 for coastal region of Karnataka. This is having mid to late season flowering habit (Dec-Mar) with a flowering duration of 60 days and has potential to escape from the attack of the tea mosquito bug (TMB) under low to moderate outbreak situation. But the regular insecticidal spray against TMB is essential under severe outbreak situation. The number of fruits per panicle (bunch) ranged from 4 -13. The average yield on 13th year was 10.7 kg/tree with highest yield of 19 kg/tree. The nut and kernel weight are 7.4 g

and 2.2 g respectively. The shelling percentage is 30.6 and kernel grade conforms to export grade W240. The apple colour is pinkish orange and juice content is 67.5%. This variety is very popular among the farmers of Dakshina Kannada District of Karnataka and also in neighbouring districts of Karnataka and Kerala.

b) Varieties released from ARS, UAS, Ullal

Ullal-1: This is a selection from the germplasm collected from Taliparamba in Kerala (8/46 Taliparamba) and released by ARS, UAS in 1984. The variety has 2-3% of bisexual flowers. The average yield is 16 kg/tree. The duration of harvest is long (about 110 days). The nut weight is 6.7g with shelling percentage of 30.7%. The colour of apple is yellow. Kernel grade is W210.

Ullal-2: This is a selection from germplasm collected from Guntur in Andhra Pradesh (3/67 Guntur). This variety was also released in 1984. The variety is a late flowering type (December to March) with very short duration of harvest (85 days). The yield is about 9 kg/tree. The nut size is medium with 6g nut weight and shelling percentage is 30.5. Colour

of apple is light red. Kernel grade is W 240. This variety is withdrawn from recommendation for cultivation.

Ullal-3: It is a selection from 5/37 Manjeri and released in 1993. It is early in flowering (November - January) and fruiting period is very short (50-60 days). The fruiting is from January to March and sometimes starts from last week of December. It is a high yielding variety with average yield of 14.7 kg/tree. The nut size is medium with nut weight of 7g. The shelling percentage is 30% and the kernel grade conforming to W 210 grade. The colour of apple is red.

Ullal-4: It is a selection from 2/77 Tuni Andhra and released in 1994 for general cultivation. The average yield is 9.5 kg/tree. The nut size is medium with 7.2g nut weight. Shelling percentage is 31%. Export grade of kernels conforms to W 210 counts/lb. The colour of apple is yellow and apple weight is 75g.

UN-50: This is a selection from Nileshtar 2/27 (T.No.25) and released in 1995. This is a medium duration variety. The average nut yield is 10.5 kg/tree. The nut weight is 9g and shelling percentage is 32.8%. The kernels are suitable for export with more than 85% of kernels coming under W 180 export grade. Apple colour is yellow.

CROP MANAGEMENT

Ultra density planting consisting of 1100-1600 plants/ha or more, was pruned to maintain productive canopy was developed and standardized and demonstrated in farmers field (>100 ha) for the first time in cashew for obtaining early benefits and higher yield. This technology was developed during the period from



1999-2018. This technique has shown to improve yield by 3-4 times per unit area over traditional type of planting. When demonstrated in the farmers' field on large area, up to 3 tonnes of nut yield per ha could be harvested in third year of planting at 3m x 3m spacing. The investment on orchard establishment could be realized just in three years. The complete allotted space was covered by canopy in just three years and the full potential yield of the unit land area was achieved through intensive management in the third year of planting. The precocious type of varieties such as VRI-3, NRCC Sel-2, Ullal-1, K-22-1 and H-130 are most suitable for this technique of planting. With this technique cashew yield can be increased in a short span

of time and the dependency for rawnut imported from abroad can be reduced and self sufficiency attained.

The phenological studies were carried out in cashew cultivars, Ullal-3 and Bhaskara using Biologische Bundesantalt Bundessortenamt und Chemische Industrie (BBCH) scale. Hundred shoots were tagged in each cultivar during the month of August, 2017 for recording observations. The observations were recorded weekly twice. The study showed that there are eight important principal growth stages in cashew namely vegetative bud development, leaf development, shoot development, inflorescence development, flowering, nut and apple development, nut and apple maturity and senescence stages. Within each principal growth stages, different secondary stages were identified according to BBCH scale. After identifying the stages, each of the phenological stages were photographed, described and assigned codes according to BBCH scale. In addition, the observations were also recorded for pest incidence.

Growing intercrops like pineapple, amorphophallus, turmeric, brinjal and chillies profitably in cashew orchards has been demonstrated. The trenches made for pineapple planting act as a soil and water conservation measure for cashew orchard. *Glyricidia* grown as green manure crop during initial years contributed 6.75 t/ha of dry matter, equal to 186 kg N, 40.8 kg P and 67.8 kg K / ha. Limb pruning i.e. complete beheading of exhausted cashew trees after the harvest of the crop and redevelopment of canopy with proper Cashew Stem and Root Borer (CSRB) management ensures rejuvenation of old senile cashew orchards. Top working with elite cashew varieties on newly emerging shoots on pruned stumps of old and unthrifty trees with proper CSRB management has been standardized and recommended for homestead gardens to replace the existing old and unthrifty cashew or genetically poor yielders. Further, when Taliparamba -1 was used as rootstock, it reduced the vigour of cashew varieties V-4, VRI-3 and NRCC- Selection -2 up to 10-20%. NRC-492 showed better results and aided in realizing higher nut yield from scion cultivars in the initial years of plantation.

Softwood grafting method was standardized and found ideal for the commercial multiplication of cashew varieties. Application of microbial inoculants i.e. *Azospirillum*, *Pseudomonas*, Phosphate solubilizing bacteria (5 g) and arbuscular mycorrhizal fungi 2.5 g per poly bag containing 2 kg of potting mixture to cashew rootstocks resulted in the production of healthy grafts in the nursery and better establishment in the field. Soil and water conservation techniques like crescent bund and staggered trenches with coconut husk burial conserved soil moisture, lowered annual runoff by 14 per cent and increased cashewnut yield by 30-40 per cent. Terrace with crescent bund for individual cashew tree base is the best SWC measure for cashew grown on slopes. Irrigating cashew at 60-80 L of water / tree once in four days through drip, after flowering till fruit set and development in combination with the application of 750: 187.5: 187.5 g of NPK / tree/annum doubled the yield of cashew under West Coast of Karnataka.

Soil application of Paclobutrazol at pre flushing stage was found to be effective in reducing the plant height, canopy spread, intermodal length and yield increment (51%) per plant over control.

Deficiency symptoms of nutrients such as N,P, K, Fe, S, Ca, B , Zn, Cu, Mo and Mn were ascertained at the Directorate. Optimum fertilizer requirement for normal density planting system (200 trees/ha) is 500 g N and 125 g each of P and K / tree / year through fertigation and castor cake 4 kg / tree through soil application. The optimal rate of drip irrigation is 36 L/day from December to January and 48 L/day from February to March to meet 60 per cent of cumulative pan evaporation. Application of biofertilizer (*Azospirillum* sp.) with compost of recyclable cashew biomass (33 kg / tree / annum) from cashew orchard yielded higher compared to recommended doses of inorganic fertilizers and increased the net profit.

Foliar sprays of major nutrients (3% urea + 0.5% H₃PO₄ + 1% K₂SO₄) and secondary and micronutrients (ZnSO₄ + 0.1% solobor + 0.5% MgSO₄) on nine year old cashew variety 'NRCC Sel-2' had positive significant effects on the number of bisexual flowers/panicle, number of panicles/tree, number of nuts/tree and nut yield/tree over unsprayed plants. Foliar spray of major nutrients results in 16.1% increase in nut yield while, secondary and micronutrients spray had 30.5% higher yield over control in soils deficient in Mg, Zn and B. The productivity is highest in regions with mean annual rainfall distribution of 600 to 1500 mm, mean annual temperature of 22.5 to 27.5° C, minimum temperature ranged from 10 - 22° C and was lower in the regions where the minimum temperature drops below 10° C and it is very low where minimum temperature drops below 8° C.

CROP PROTECTION

In Karnataka state, so far, two major pests have been reported on cashew i.e. Tea Mosquito Bug and Cashew Stem and Root Borer. The work carried out regarding the management of these pests is summarized here. Rearing technique for cashew stem and root borer (CSRB) on host bark has been standardized and phytosanitation (removal of dead trees, trees with yellow canopy and/ or more than 50% bark circumference damage) reduced the percentage of fresh pest incidence and mean number of CSRB grubs / infested tree in a given location. Rearing of the grubs of CSRB on the semi-synthetic diet without cashew bark component has been standardized from which uniform aged adult beetles could be reared for pheromone and kairomone evaluation. The entomopathogenic nematodes (EPN) viz., *Heterorhabditis bacteriophora* and *Steinernema feltiae* were encountered indigenously in the cashew ecosystem. Out of the EPN species tested against CSRB, *Heterorhabditis indica*, *Steinernema abbasi* and *Steinernema bicornutum* survived and maintained their virulence up to 150 days. Further work is under progress.

Survey of natural enemies of tea mosquito bug (TMB) revealed the occurrence of three species of egg parasitoids (*Telenomus* sp., *Chaetostricha* sp. and *Erythmelus helopeltidis*). Activity of *Telenomus* sp. was noticed throughout the year. Reduviids were one of the major insect predators recorded in the cashew eco-system during the year. A total of 17 reduviid species were recorded and the biology of the reduviids *Rhipidius trochantericus* Stal was worked out which can be utilized for biological control of tea mosquito bug (*Helopeltis antonii*). Need based spray of Monocrotophos (0.05%) or L-cyhalothrin (0.003%) at flushing, Carbaryl (0.1 %) or Lcyhalothrin (0.003%) at flowering and carbaryl (0.1 %) at fruiting is recommended for effective management of tea mosquito bug (TMB).

Laboratory rearing technique for tea mosquito bug (TMB) on tender cashew shoots has been standardized. All the released varieties and germplasm accessions screened were found susceptible to TMB. An accession Goa 11/6 (Variety : Bhaskara) was found to escape from the severity of the TMB damage due to mid to late season flowering habit. Besides TMB, shoot tip caterpillars (*Hypatima haligramma* and *Anarsia aporias*) infest cashew inflorescences and cause significant loss in yield. Initial sprays of L - cyhalothrin (0.003%) recommended against TMB during flushing and flowering could effectively manage these pests. Residues of insecticides (lindane, endosulfan, chlorpyrifos, carbaryl and L-cyhalothrin) used for the management of pests of cashew were not detected in the kernels of the raw nuts collected from the treated plots of major cashew growing areas in the country. Further the study on biodiversity of arthropoda fauna in cashew ecosystems revealed the presence of 191 insect pest species and 123 natural enemies. The insects were taxonomically grouped and diversity indices were worked out. The hymenopteran bees (*Pseudapis oxybeloides*, *Lasioglossum* sp., *Braunsapis* sp., and *Homalictus* sp.) are major pollinators in cashew.

POST HARVEST PROCESSING AND VALUE ADDITION

Many equipments related to cashew processing have been developed at the ICAR-Directorate of Cashew Research, Puttur. For instance, radial arm type cashew kernel extractor has been developed for operation in sitting condition which reduces drudgery compared to the existing sheller. It is possible to process 9.3 kgs of raw cashew nuts per hour. Further, a dual mode dryer suitable for rain affected raw cashew nuts is developed to enhance its shelf life. cashew shell cake (CSC) based up draft gasifier, compact type mechanized drum roasting machine, concentric drum type rotary sieve grader for raw cashew nuts were also developed. In addition, hydraulically operated cashew apple juice extractor was developed at the center. As far as processing industries are concerned, there are more than 250 processing units in the state which are spread across Udupi, Dakshina Kannada, Shimoga, Uttara Kannada and Kolar taluks that are utilizing various levels of mechanization.

Many value added forms of cashew kernel are prepared in Karnataka. It is consumed as such after frying or smearing with salt, pepper or chili powders. The kernel is also used in baby foods, chocolates and preparation of sweets such as halva, kheer etc. The cashew apple is consumed raw in many parts of Karnataka (with or without salt) and there have been attempts to develop ready to serve beverage out of cashew apple by some agencies. The astringency due to presence of tannins in cashew apple juice is coming in the way of consuming cashew apple. Towards reducing this, three new low cost food grade materials were identified i.e. defatted Soya meal, dried potato starch, bajra starch at the ICAR-Directorate of Cashew Research, Puttur. Further, cashew apple syrup, cashew apple drink, cashew apple carbonated drink, Jam, jelly, cashew apple cider preparations have been standardized at the Directorate. Further, Madhu Multiples, a home industry in Puttur has developed RTS and different blends of RTS from cashew apple and successfully marketing its products. It is found that farmers in Karnataka are preparing Chocolate, Halva, Ada Appa,

Payasam, Kayirasa and various sweets from cashew apple. These recipes are documented at the Directorate.

Cashew leaves are used for the dish prepared out of rice and jack fruit. The ground rice paste is to be folded in between two cashew leaves and to be cooked. The dish is locally known as “Atte” in Dakshina Kannada, Karnataka. The dish gets a special characteristic odor with a specific taste due to use of cashew leaves.

The tender nuts or green nuts fallen during harvest of nuts are used for culinary purposes. The green nuts are cut and the immature kernel is removed and put in boiling water for easy separation of the kernel from the testa. After separation of the kernel it is cooked and fried with little grated coconut powder. This is most popular and one of the tasty dishes (curry) specially prepared in DK District of Karnataka and adjacent Kasaragode district of Kerala. The tender kernels are also used in preparation of curries (sambar) either with dhal or separately.

TRADITIONAL KNOWLEDGE ASSOCIATED WITH CASHEW CULTIVATION AND USE

In Chintamani region of Karnataka, growing cashew all along the mango garden as wind break and additional source of income is being practiced. Black pepper cultivation on Cashew to ward off cashew stem borer has been practiced by farmers of Dakshina Kannada. Further, the leaves both fresh and dry and twigs were used as raw material for organic manure by the farmers. Farmers believe that spraying water in the morning hours of winter months on the foggy days during early flowering period of cashew helps in preventing flower drying resulting in increased yield. Just before fruiting season or in early fruiting season all the fallen dry leaves are collected from the plantations or from individual plants and stored for rainy season to be put in cowshed as bedding material for cows. The leaves would be later transferred directly to areca gardens to be applied as manure. At times, the cashew dry leaves thus collected are heaped in paddy fields which would be directly incorporated into soil during ploughing and puddling.

The green cashew leaves are used for mulching (green manure) to coconut palms during rainy season. After the base clearing, about 50-60 kg of green leaves are put along with cattle manure and salt and covered with soil. It is believed that this practice helps in preventing button shedding in coconut. The cashew leaves are the second choice if leaves of *Nuxvomica stricta* are not available. Red ant (*Oecocyphylla smaragdina*) colonies which usually appear in old cashew plantations are used by farmers to improve the cashew yield by way of feeding on TMB and other harmful insect pests. Presence of red ants prevents loss by pilferage also as it is difficult to approach and climb such trees for stealing the nuts. Cashew farmers also collect the red ant colonies and allow it to spread in their cashew plantations. Farmers usually collect fallen fruits from the ground. Also, mature fruits are harvested from smaller trees using bamboo sticks.

Porcupines and wild boars damage the cashew grafts at early stages of planting. While the wild boars uproot the plants during rainy season in search of earthworms, the porcupines cut the grafts at collar region and destroy the plants. Farmers’ claim that spreading of small

pieces of cut hair collected from barber's shop around the grafts scares the animals as these hairs get in while breathing causing irritation in nostrils thus forcing the animal to leave the plant. Cashew apple is fed to cows in limited quantities. Further, cashew apples are also added to biogas plant/ biodigesters for getting the increased gas or enriched biodigester liquid.

Ixora flowers, leaf bits of Palmyrah palm and muli grass were used to be tied together and offered to superstitious bodies by manthrikas and later were tied to a visible branch of the cashew tree. People who see this structure (called 'Kodi' in Kannada) would never touch the produce as it was believed that the 'manthra' or such powers to which it was offered will harm the people who touch the produce. This belief was in practice till late seventies and then onwards people gradually did not care for such threats and this practice has almost disappeared. However, even now in some under developed regions of Dakshina Kannada, Karnataka the practice is being followed. The practice is followed to prevent the pilferage of produce as the crop was not systematically cultivated in olden days.

Tender nuts are usually eaten by school children as the cashew trees are grown all along the roads and school premises. Children, rub the ventral side of the tender nuts to the black topped roads or the tree trunk and later it is pressed by foot to remove the kernels. The kernel that comes out is wiped with dry leaves to remove CNSL and eaten as such by school children. The matured and fallen nuts during late season (during May or June), may imbibe water due to rains and germinate in the field itself. Usually, germinating nuts with just emerging cotyledons are collected particularly for the preparation of curry. People believe that preparation (curry) made out of such germinating seeds is very rich in nutrients.

MEDICINAL USAGE

The medicinal uses of leaf, bark, shell, cashew nut shell liquid and testa are well documented. Vast references can be seen in a book known as "Ajji Maddu" authored by well known Ayurvedic doctors "the Panaje Pandiths" near Puttur, Karnataka. The juice of cashew apple is extracted and bottled and kept for a week's time. The liquid is used as a drink after decanting and separation of floating pulp. This is usually practiced by financially weaker sections who cannot always manage to get alcohol. It is also believed that the warmed juice (in sun light for a fortnight) can be preserved for 2-3 years which would have medicinal uses in treating fever and diarrhea of both human beings and domestic animals. It is believed that cashew apple juice induces sleepiness, when given along with medicine to the patients affected by fever. The practice helps in fast recovery from fever.

Green cashew leaves (leaf blades) were being used for brushing and cleaning the teeth by villagers. The leaf blades are folded and used as brush. The mid rib of the leaf after removal of leaf blades was used as tongue cleaner. It is believed that the leaf had medicinal property which reduces tooth decay and toothache and strengthens the teeth. It is also claimed that the powder made out of dry cashew leaves and arecanut used as tooth powder is helpful in overcoming tooth decay and pain.

For treatment of corns, the dry cashew nut is to be cut into two halves. After the removal of the kernel, the shell is to be heated on flame holding with the help of a sharp stick inserted into shell. The corn on the foot is to be cut and exposed. The hot (warm) liquid (CNSL) oozing out of shell when held over the flame should be applied on the corn and may be repeated several times (3 to 4 times in a week). This helps in complete healing of the corn. For treatment for diarrhea, Cashew apple juice is extracted and filtered through cotton cloth and the supernatant liquid is stored in glass bottles. In summer, once in a fortnight or so the bottles are kept in hot sun and seasoning is done. Every time it is filtered and the supernatant liquid is stored. The liquid could be stored for years as claimed by villagers. Liquid thus prepared is used as medicine for treating diarrhea, fever and cough in cattle during rainy seasons.

The animal and human feet (gaps between fingers) get infected with fungus during rainy seasons if they continuously walk bare footed on muddy, slushy soils. For treatment of this fungal infection, in villages the infected part is smeared with a mixture of CNSL and coconut oil mixed (1:1 v/v). Smearing is done during night particularly before going to the bed. For treatment against skin diseases, the live bark of matured cashew tree is removed and the outer scales are scraped off and bark is cut into pieces. The pieces of such scraped bark are cooked with boiled rice. The medicinal rice thus prepared is consumed as breakfast with common salt. It is believed that consumption of such medicinal rice for 3-4 days in the morning would help in curing the skin diseases of human beings. Also, at times the bark is boiled with water and a “Kashaya” (decoction) is prepared. This kashaya is used for bathing and is believed to heal skin diseases.

For treatment for scabies or skin diseases of young calves of cattle, fresh cashew shell is boiled with ganji of rice (rice gruel) and fed on first day. On second day two shells are boiled in the same way and 3rd day again 3 shells are boiled in rice gruel and fed. This treatment helps in curing the skin disease of calf during initial 1-2 years. The wood which are used for construction purposes, particularly the wall plates or rafters, wooden items which touch the soil or walls are smeared with CNSL. Also the reapers which help in holding the roof tiles are smeared with CNSL for seasoning as to prevent from termite damage and fungal decay. Cashew nut shell liquid is also used to smear bamboo baskets and winnows for strengthening and ensuring long life of the material. Cashew tree gives out gummy exudation during injury to its bark or stem. The exudation or oozing of gum is more with larger cuts or wounds. In olden days, this gum was collected and used as adhesive for pasting papers and books, labels etc.

TRANSFER OF TECHNOLOGY

ICAR- DCR is actively involved in dissemination of technologies in addition to supply of planting material. Softwood grafting technique has been standardized at DCR, Puttur and every year about 3.0 lakh grafts of recommended varieties are produced and distributed to farmers and other developmental agencies. The DCR, Puttur nursery has been rated as four star nursery for production of quality planting material by National Horticulture Board, Government of India.

Cashew Field Days / Cashew Days are being conducted at DCR, Puttur along with training programmes on "Cashew Production Technology", "Softwood Grafting Techniques in Cashew" and other need based training programmes every year. Innovative farmers are honoured during cashew day and so far, more than 30 farmers have been honoured for their best performances in cashew cultivation, processing and innovative ideas. Frontline demonstration on improved cashew production technologies in farmers' fields located in Puttur, Belthangady, Buntwal and Sullia taluks of Dakshina Kannada District have been laid out in collaboration with Directorate of Cashewnut and Cocoa Development (DCCD), Kochi. Thematic campaigns are organized to create awareness on the need for soil and water conservation and plant protection measures in collaboration with NGOs and Development Departments.

ROLE OF DEVELOPMENTAL AGENCIES AND OTHER LINE DEPARTMENTS

Directorate of Cashew and Cocoa Development, Cochin is funding projects for various cashew expansion programs, cashew day programs, training programmes for farmers and frontline demonstrations in Karnataka through ICAR- DCR and other organizations. The state department of Horticulture is giving subsidy to farmers under area expansion programs in different districts. National Horticultural Mission and NABARD are also supporting cashew sector in various ways.

Karnataka cashew manufacturers association which is a conglomerate of processors is operating in Mangaluru, Dakshina Kannada district. Further, Karnataka Cashew Development Corporation (KCDC) Limited was established in 1978 with the object of managing the cashew plantations transferred to the Company by the Karnataka Forest Department and to increase the areas of cashew cultivation in the State. The KCDC has 25632.62 hectares of cashew. These plantations are under the control of Divisional Managers stationed at Kumta, Kundapur, Puttur and Moodabidri under the overall direction and administration of the Managing Director at head office in Mangaluru.

STATUS OF TRIBAL SUB-PLAN PROJECT

The tribal sub plan programme aimed at improving the livelihood of tribal farmers was started at the ICAR- Directorate of Cashew Research, Puttur with laying out of 25 cashew demonstration plots in the year 2014-15 in tribal farmer fields of Dakshina Kannada district, Karnataka. The plots were monitored regularly by the team of Scientists of this Directorate during the period and technical advice was given as and when required. In 2015-16, 26 new FLD



plots were established in tribal farmer fields of Dakshina Kannada district of Karnataka and Kasaragode district of Kerala. The plots were visited by TSP team of DCR comprising of Dr. M.G. Nayak and Dr. Sajeev M.V. for identification of farmers, grouping of interested farmers at village level, identifying suitable plots and for provision of assistance during planting and aftercare. Also, 25 FLD plots established under TSP programme during 2014-15 were also monitored regularly and technical advice was provided on aftercare, pest management and manuring.

During 2016-17, 40 new FLD plots were established during 2016-17 in tribal farmer fields of Dakshina Kannada and Madikeri districts of Karnataka. About 51 FLD plots established during 2014-15 and 2015-16 in tribal farmer fields of Dakshina Kannada district of Karnataka and Kasaragode district of Kerala were visited regularly by TSP team of DCR for provision of assistance during planting and aftercare and monitoring and technical advice was provided on aftercare, pest management and manuring. Hence, a total of 91 FLD plots were established over a period of 3 years.

CAMPAIGNS/ TRAININGS IMPARTED TO TSP BENEFICIARIES

The Directorate of Cashew Research, Puttur in association with SKDRDP, Puttur conducted training on pest management in cashew for tribal farmers at Perlampady village, Kolthige, Puttur on 23-02-2014. More than 100 farmers participated enthusiastically in the programme in which officials of SKDRDP also shared their views and experiences along with scientists of DCR Puttur. After inauguration of the programme, Dr. M.G. Nayak, Principal Scientist (Hort.), DCR handled session on advances in cashew cultivation. He advocated that the adoption of scientific management practices along with high yielding cashew the need of the hour for realizing the quantum jump in production and productivity varieties is of cashew nut. Dr. P.S. Bhat, Principal Scientist (Ento.), DCR handled session on pest management in cashew. Field visit to demonstration plot of DCR was arranged in the post lunch session. Farmers were taken to Irde, Papanadka where ultra high density planting by Sri. Deranna Rai was demonstrated to them. The various aspects of ultra high density planting was shown and explained to farmers in detail during this field visit. The training and field visit created huge interest among tribal farmers and more than 25 farmers expressed their interest to go for cashew cultivation immediately after the training programme.

This Directorate in association with SKDRDP, Puttur conducted training on cashew production technology for tribal farmers at Bettampady village, Irde, Puttur on 25-02-2014. After inauguration of the programme, Dr. M.G. Nayak, Principal Scientist (Hort.), DCR handled session on advances in cashew cultivation. Dr. T.N. Raviprasad, Principal Scientist (Ento.), DCR handled session on pest management in cashew. Field visit to demonstration plot of DCR was arranged in the post lunch session. Farmers were taken to ultra high density orchard of Sri. Deranna Rai, a frontline demonstration farmer of DCR and the technology was demonstrated to them. The various aspects of ultra high density planting was shown and explained to farmers in detail during this field visit.

The Directorate of Cashew Research, Puttur (DCR) in association with SKDRDP, Puttur conducted training on 'Cashew Apple Utilisation' for tribal women at DCR campus on 28-03-2014. Mr. M.N. Venkata Krishna, progressive cashew farmer and entrepreneur shared his experiences in cashew processing and marketing with the gathering. He also shared some of his cashew based recipes for the benefit of tribal women. Later, Dr. D. Balasubramanian, Principal Scientist (AS&PE), DCR conducted practical demonstration and shared the various cashew apple recipes for preparation of juice, squash, jam and pickle. Later the tribal women were divided into groups and hands-on training was provided on juice extraction, pickle and jam preparation in the post harvest technology laboratory.

Orientation training on 'Establishment of Cashew Orchard under Tribal Sub Plan' for 30 selected tribal farmers at DCR campus was conducted on 05-09-2014. Smt. Thulasi Maddineni, IAS, Chief Executive Officer, Zilla Panchayat, D.K. District, Karnataka inaugurated the training programme. She addressed the trainees and spoke about the various phases through which cashew cultivation passed in the district. Field visit to demonstration plot of DCR was also arranged in the post lunch session. Farmers were taken to Kadamajalu village where an orchard demonstrating normal density, high density and ultra high density planting of cashew laid out by Sri. Subhash Rai. The various aspects of establishment of a cashew orchard were explained to farmers in detail during this field visit.

The training programme on cashew cultivation to tribal farmers of Chembu village, Madikeri Taluk was conducted on 27th February 2018 at Sri Vishnumurthy temple, Kudrepaya. Lecture on various aspects of cashew production technology like varieties, site selection, planting, maintenance of plants with proper pruning and training, fertilizer application, soil and water conservation, pest management, harvesting and value addition was delivered. Later, the trainees were taken to the field where the aspects of managing cashew plants, identification of pests like CSRB and TMB followed by their management were explained.

EDUCATION TOUR

Eight TSP farmers were taken on agricultural education tour to Kerala during 12-14th March 2018. The farmers visited Indian Institute of Spices Research, Calicut and came to know about different pepper propagation techniques, nutmeg and turmeric varieties. They were exposed to different cashew varieties, cultivation practices and value addition aspects of cashew apple at Cashew Research Station, Madakkathara, Kerala. A visit was made to Agricultural Research Station, Munnuthi where the concept of Food Security Army was explained and different machineries for paddy cultivation were shown. They also visited a farmer's cashew plantation to learn about the practice of eco-friendly ways of controlling Tea Mosquito Bug. Further, the farmers visited Regional Research Station, Pilicode to know about different value addition possibilities in coconut and cashew.

MAJOR CONSTRAINTS IN CASHEW CULTIVATION AND PROCESSING

The presence of old and senile plantations are lowering the productivity of cashew in the state. Further, yield levels are low in seedling originated plantations. In the farmer's fields, menace of cashew pests such as Tea Mosquito Bug, Cashew Stem and Root Borer is the major reason for lesser production. Further flower drying, poor soils, management

constraints, monkey menace, price fluctuations, lack of cashew farmer associations and no value addition of cashew apple are the problems that reduce the productivity from cashew. Farm level processing of cashew nut and apple is very less. There is an immense scope for this activity which will help in increasing the economic returns for farmers.

FUTURE PROSPECTS

Under area expansion program, non-traditional areas such as hill zone, southern and northern dry land areas have to be given priority. Quality planting material supply is one of the major areas which can considerably boost the production and productivity of cashew in the state. For this, cashew nurseries have to be encouraged in many districts. Further, consultancy services at various stages of the crop in the farmers' field are required. Formation of farmer producer companies for kernel and apple processing and promotion of marketing is the need of the hour. In addition, formation of cashew growers association is required to combat price fluctuations, to facilitate exchange of ideas in cashew cultivation, to promote farm level processing of cashew. The value addition possibility for cashew apple utilization also needs to be tapped.

EDUCATION IN CASHEW

1. **Name of the Student** Thimmappaiah
M.Sc. / Ph.D. Ph.D
University Department of Biosciences
Mangalore University
Mangalagangothri – 574 199

Year of Completion 1998
Thesis Title Invitro studies on cashew (*Anacardium occidentale* L.)”
Major recommendations / findings
 - A complete regeneration protocol using seedling explants was standardized.
 - Induction of somatic embryogenesis from both immature cotyledon and nucellar tissue was shown.
 - However, germination of somatic embryos was found to be pre-cocious.
 - Protoplast isolation was made from cotyledon., leaf and hypocotyls segments of seedlings.
 - In histological sections of ovules fixed at different periods nucellus tissue was found to degenerate by 3weeks of fruit development.
 - Nucellus callus showed formation of embryos in various stages of development.

2. **Name of the Student** N. Yadukumar
M.Sc. / Ph.D. Ph.D. in Biosciences (Agronomy & Plant Physiology)
University Department of Biosciences
Mangalore University
Mangalagangothri – 574 199

Year of Completion 2001
Thesis Title Efficacy of drip irrigation and graded nitrogen, phosphorus and potassium on the productivity of cashew (*Anacardium occidentale* L.)

Major recommendations / findings
 - Irrigating 80 L/tree once in four days from the second fortnight of December to end of March significantly increased the total number and weight of nuts produced/tree over lower irrigation levels (20, 40 and 60 L/tree).
 - The crop yield both in terms of number of nuts and weight of nuts increased significantly to the

highest levels of NPK nutrients (750 g N: 187.5 g each of P₂O₅ and K₂O/tree/year compared to the lower levels of nutrients and no-nutrient applications.

- Increased production of flushing laterals/leader shoot/year resulted in increased flushing and flowering laterals/tree when irrigated and also when applied with fertilizers.
- Strong positive correlation was observed between light interception by the crop canopy and the yield.
- Irrigation at 20 to 60 L/tree had considerably increased protein content of cashew kernel.
- Cashew yield can be significantly and profitably increased in the initial eight years period with drip irrigation combined with fertilizer applications.

3. Name of the Student
M.Sc. / Ph.D.
University

Shobha, D.
Ph.D.
Department of Applied Botany
Mangalore University
Mangalagangothri – 574 199

Year of Completion

2014

Thesis Title

Development of molecular markers linked to economic characters in Cashew (*Anacardium Occidentale* L.)

Major recommendations / findings

- Four markers were identified which are polymorphic not only between the bulks and but also between the individuals constituting the bulk.
- Out of the four RAPD markers identified in germplasm, three markers namely OPN 14775, UBC 185275 and UBC 184475, were found to be polymorphic between the bulks of nut weight and one marker UBC 185275 was polymorphic between the bulks of plant stature.
- Association analysis carried out with RAPD (40) and ISSR (56) markers on 14 phenotypic traits in 146 diverse accessions of cashew. Stepwise multiple regression analysis revealed several markers (QTL's) associating with a single trait and a single marker associating with several traits (pleiotropy).

4. Name of the Student
M.Sc. / Ph.D.
University
Year of Completion

S. Vigneswaran
M.Sc. (Biotechnology)
Bharathidasan University, Tiruchirappalli – 620 024
2005

Thesis Title Molecular characterization of cashew based on RAPD and isozyme markers.

Major recommendations / findings

- Vengurla-1 and Madakkathara-1 are considered to be most diverse varieties with least similarity coefficient of 0.78.
- Ullal-4 and H-32-4 were considered most similar varieties with similarity coefficient of 0.97.
- Based on 33 isozyme markers, Vengurla-1 and Ullal-1 were considered most diverse varieties.

5. **Name of the Student** N. Pradeep Kumar

M.Sc. / Ph.D. M.Sc. (Biotechnology)

University Bharathidasan University, Tiruchirappalli – 620 024

Year of Completion 2006

Thesis Title Micropropagation in Cashew (*Anacardium occidentale* L.)

Major recommendations / findings

- Reported the production of somatic embryos through nucellar tissue of bisected ovule.
- Shoot bud proliferation give rise to multiple shoots.
- Embryo culture gave rise to root and shoot formation.

6. **Name of the Student** Arulananthu G

M.Sc. / Ph.D. M.Sc. (Biotechnology)

University Department of Biotechnology
St. Joseph's College
Tiruchirappalli – 620 002

Year of Completion 2007

Thesis Title Somatic embryogenesis and RAPD analysis in cashew

Major recommendations / findings

- Somatic embryo induction was higher rate in reproductive tissue such as nucellar, styles and pollen.
- The 10-12 month old callus initiated the somatic embryos.
- The cultivars VRI-2, VTH-52, VTH-578/1, BPP-4, VTH 134/1, BPP-6, BPP-8, Kunthur-24, Udupi-8, Karkala-5, Godavari-2 were had maximum similarity.

7. **Name of the Student** M. Robert John

M.Sc. / Ph.D. M.Sc. (Biotechnology)

University Bharathidasan University, Tiruchirappalli – 620 024

Year of Completion 2008

Thesis Title Regeneration and finger printing of cashew with SSR markers.

Major recommendations / findings

- Among the primers used, CS-8 (2.736), CS-14 (1.588) and CS-18 (1.221) were found to be highly informative.
- Jaccard's similarity co-efficient bared from 0.17 to 0.93 indicating wide diversity among the varieties studied.
- Highest similarity (0.97) was observed between V-7 and V-1 and the lowest similarity (0.17) was observed between V-6, Chintamani and V-2.

8. **Name of the Student** Ananthalakshmi, M.
M.Sc. / Ph.D. M.Sc. (Biotechnology)
University Department of Biotechnology
 J.J. College of Arts and Science
 Pudukkottai – 622 404

Year of Completion 2008

Thesis Title RAPD profiling of 43 germplasm accessions in cashew

Major recommendations / findings

- NRC-158 and NRC-432 are considered as most similar varieties with similarity co-efficient of 0.54.
- Among the 43 accessions studied NRC-432 and NRC-375 were found to be most divergent.
- No strong relationship was observed between diversity and place of their origin.

9. **Name of the Student** Jeena, P.M.
M.Sc. / Ph.D. M.Sc. (Biotechnology)
University Department of Biotechnology
 J.J. College of Arts and Science,
 Pudukkottai – 622 404

Year of Completion 2008

Thesis Title Genetic diversity in 43 accessions of cashew based on ISSR markers.

Major recommendations / findings

- The most divergent accession based on cluster analysis was NRC-432, it was having the lowest similarity coefficient.
- Among the accessions studied NRC-280 and NRC-283, NRC-413 and NRC-428 were found to be genetically similar.
- It is revealed that no significant correlation between their geographical and genetic diversity.

- | | | |
|-----|--|---|
| 10. | Name of the Student
M.Sc. / Ph.D.
University

Year of Completion
Thesis Title
Major recommendations / findings | S. Vinoth Kumar
M.Sc. (Biotechnology)
Department of Biochemistry and Biotechnology
Annamali University, Annamalai Nagar
2009
Genetic diversity of 67 accessions of cashew based on RAPD markers.
<ul style="list-style-type: none"> ▪ Genetic similarity varied from lowest of 0.53 (between NRC 335 and NRC 388; NRC 362 and NRC 388) to highest of 0.94 (between NRC 338 and NRC 321). ▪ At 64% similarity two groups were formed using cluster analysis. |
| 11. | Name of the Student
M.Sc. / Ph.D.
University

Year of Completion
Thesis Title
Major recommendations / findings | Prajna, P.S.
M.Sc. (Biotechnology)
Department of Biosciences
Mangalore University
Mangalagangothri – 574 199
2009
Genetic diversity in 44 accessions of cashew based on microsatellite markers.
<ul style="list-style-type: none"> ▪ The similarity co-efficient varied from 0.26 to 1.0 with average of 0.556 indicating moderate diversity existing among the accessions. ▪ Five pairs of accessions viz., NRC-59 and NRC-101, NRC-111 and NRC-9, NRC-112 and NRC-9, NRC-126 and NRC-110, NRC 126 and NRC-112 showed low genetic similarity (SC 0.26). ▪ Three pairs of accessions viz., NRC-126 and NRC-9, NRC -112 and NRC-111 , NRC-71 and NRC-121 showed highest genetic similarity of 1.0. |
| 12. | Name of the Student
M.Sc. / Ph.D.
University

Year of Completion
Thesis Title | Rakshatha, P.C. and Prajna, P.
M.Sc. (Biotechnology)
Department of Biotechnology
St. Aloysius College
Mangalore – 676 003
2010
Molecular analysis of 35 accessions of cashew based on RAPD markers. |

Major recommendations / findings

- High polymorphism of 65.1% was observed which indicated high genetic variation existing among the accessions.
- Among the primers OPO-02 was highly informative.
- The average similarity of 0.71 indicated low diversity existing among the 35 accessions.
- Cluster analysis using UPGMA method distinguished 35 accessions into 12 clusters.
- There is need for use of robust marker like SSR.

13. Name of the Student
M.Sc. / Ph.D.
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Sumana, G.R.
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Department of Biosciences
Mangalore University
Mangalagangothri – 574 199

Year of Completion

2010

Thesis Title

Diversity analysis in 67 accessions of cashew based on ISSR markers.

Major recommendations / findings

- Among the primers UBC 856 and UBC 857 were highly informative.
- Low similarity of 0.38 observed between NRC-369 and NRC-372 indicated that these two accessions as highly divergent.
- This also showed that NRC-368 and NRC-364 are closely related.
- The study indicated that ISSR markers could be employed for characterization.

14. Name of the Student
M.Sc. / Ph.D.
University

Shilpa, B.
M.Sc. (Biotechnology)
Department of P.G. Studies and Research in Biochemistry
Kuvempu University, Shimoga

Year of Completion

2011

Thesis Title

Molecular analysis of 25 accessions of cashew based on ISSR markers

Major recommendations / findings

- A high polymorphism of 61.7% indicated using 6 ISSR primers in 25 accessions revealed the existence of moderate genetic variation.
- UBC-8567 and UBC-817 were found to be highly informative.
- Similarity coefficient of 0.302 to 0.93 with an average similarity of 0.746 indicated low diversity existing among the accessions.

		<ul style="list-style-type: none"> ▪ The low similarity observed among these accessions indicated that the accessions are having the origin from same region.
15.	Name of the Student M.Sc. / Ph.D. University Year of Completion Thesis Title Major recommendations / findings	Reema, K.C. M.Sc. (Biotechnology) Department of Biosceinces Mangalore University Mangalagangothri – 574 199 2011 Molecular characterization of 35 accessions of cashew using RAPD markers. <ul style="list-style-type: none"> ▪ Among the primers used UBC 353 and UBC 352 were highly informative. ▪ Similarity coefficient of 0.54-0.89 with an average similarity of 0.84 indicated low diversity among the accessions. ▪ NRC-453 and NRC-452 are considered as most similar varieties with the highest similarity coefficient of 0.89. ▪ Among 35 accessions studied, NRC-455 and NRC-461 were found to be most divergent.
16.	Name of the Student M.Sc. / Ph.D. University Year of Completion Thesis Title Major recommendations / findings	Akshatha, C. M.Sc. (Biotechnology) Post Graduate Department of Biotechnology Alva's College, Moodbidri – 574 221 2012 Molecular analysis of 22 accessions of cashew based on RAPD markers. <ul style="list-style-type: none"> ▪ The genetic similarity varied from lowest of 0.47 (between NRC 469 and NRC 446) to highest of 0.98 (between NRC 477 and NRC 474, NRC 447 and NRC 477, NRC 447 and NRC 475, NRC 478 and NRC 475, NRC 471 and NRC 478 and NRC 472 and NRC 447). ▪ This study would be highly useful in identification of the accessions, screening the most similar accessions and designing further breeding strategy and crop improvement.
17.	Name of the Student M.Sc. / Ph.D. University	Kavya, B. M.Sc. (Biotechnology) Department of Biosceinces

		Mangalore University Mangalagangothri – 574 199 2012 Genetic diversity in 23 accessions of cashew based on RAPD markers
	Year of Completion	
	Thesis Title	
	Major recommendations / findings	<ul style="list-style-type: none"> ▪ Among the primers used OPN 14 was highly informative. ▪ The average similarity of 0.83 indicated low diversity existing among the 23 accessions. ▪ There was no correlation between the clustering and place of origin.
18.	Name of the Student	Shruthi, K.V.
	M.Sc. / Ph.D.	M.Sc. (Biotechnology)
	University	Department of Biosceinces Mangalore University Mangalagangothri – 574 199
	Year of Completion	2013
	Thesis Title	Diversity of 23 accessions accessions of cashew using RAPD markers
	Major recommendations / findings	<ul style="list-style-type: none"> ▪ Using 9 random primers of RAPD a high polymorphism of 96.75% was observed which indicated high genetic variation existing among species. ▪ Among the primers used UBC 303, UBC 307, UBC 346, UBC 352, UBC 353, UBC 363, UBC 372 was highly informative. ▪ The average similarity of 0.54 indicated low diversity existing among the 23 accessions. ▪ There was no correlation between clustering and place of origin.
19.	Name of the Student	Pooja, S. and Priya
	M.Sc. / Ph.D.	M.Sc. (Biotechnology)
	University	Department of Biotechnology St. Aloysius College Mangalore – 676 003
	Year of Completion	2013
	Thesis Title	Molecular analysis of 48 germplasm accessions of cashew based on SSR markers from other species.
	Major recommendations / findings	<ul style="list-style-type: none"> ▪ NRC 447 and NRC 493 showed the lowest similarity of 0.10 suggesting that they are highly divergent whereas NRC 482 and NRC 495 showed highest similarity of 0.92 indicating that they are less divergent and are genetically similar.

		<ul style="list-style-type: none"> ▪ The study revealed that high divergence was observed between NRC 493 and NRC 447, while NRC 482 and NRC 495 showed 92% genetic similarity. ▪ The percentage transferability obtained was 40% for Pistachio markers and 12% for Alfalfa markers.
20.	Name of the Student M.Sc. / Ph.D. University Year of Completion Thesis Title Major recommendations / findings	Pavithra, M. M.Sc. (Biotechnology) Department of Biosciences Mangalore University Mangalagangothri – 574 199 2013 Molecular characterization of 23 accessions of cashew using RAPD markers. <ul style="list-style-type: none"> ▪ Meghalaya and Devarakolli-1 accessions were highly divergent and accession H-66/81 and H-68/57 and V-4 (Vengurla) and V-3 (Vengurla) were genetically similar. ▪ The average similarity of 0.59 indicated low diversity existing among the 23 accessions. ▪ Cluster analysis using UPGMA method distinguished 23 accessions into five clusters. There was no correlation between the clusters and place of origin.
21.	Name of the Student M.Sc. / Ph.D. University Year of Completion Thesis Title Major recommendations / findings	Anusha, K. M.Sc. (Biotechnology) Department of Biosciences Mangalore University Mangalagangothri – 574 199 2014 Molecular characterization of 19 accessions of cashew based on ISSR markers. <ul style="list-style-type: none"> ▪ The lowest similarity coefficient of 0.37 (between Bhutanata and Kodippadi) indicated that these accessions are highly divergent and the highest similarity of 0.90 (between Vengurla-2 and Thaliparamba) indicated that these accessions are highly similar (less divergent). ▪ Grouping made indicated that among Vengurla varieties V-4 and V-8 are closely related as they clustered together in the same group. ▪ The prerelease hybrids of DCR H-66/81, H-68/57 and H-126/83 were found clustering together indicating their common lineage or ancestry.

		<ul style="list-style-type: none"> ▪ The study indicated that the ISSR markers could be employed for characterization, varietal description and varietal selection for breeding.
22.	Name of the Student M.Sc. / Ph.D. University Year of Completion Thesis Title Major recommendations / findings	Madhuri M.Sc. (Biotechnology) Department of Biosceinces Mangalore University Mangalagangothri – 574 199 2014 Diversity of 22 accessions of cashew based on ISSR markers. <ul style="list-style-type: none"> ▪ High percentage of polymorphism (79.07%) showed the high genetic variation among the accessions. ▪ Among the primers UBC 817, UBC 820 and UBC 857 were highly informative. ▪ The lowest similarity coefficient of 0.38 (between V-7 and Bhedasi) indicated that these accessions are highly divergent and the highest similarity of 0.95 (between H-68/57 and H-66/81; H-126/83 and H-68/57) indicated that these accessions are highly similar (less divergent). ▪ Bhedasi was most divergent. ▪ Groupings indicated that among Vengurla varieties V-3, V-4 and V-1 are closely related as they clustered together in the same group and where as V-7 clustered separately.
23.	Name of the Student M.Sc. / Ph.D. University Year of Completion Thesis Title Major recommendations / findings	Lakshmi pathi Ph.D. in Biosciences (Seed Technology & Horticulture) Department of Biosceinces Mangalore University Mangalagangothri – 574 199 2015 Effect of growth regulators and certain micronutrients on vegetative and reproductive growth of cashew. <ul style="list-style-type: none"> ▪ The rawnuts of cashew can be pretreated with GA₃ at 577.42 µM for enhancing seed germination and seedling growth.

- Foliar application of Ethrel at 346.02 μM during flushing, flowering and fruiting can enhance nut yield in cashew through enhancement in number of perfect flowers per panicle as well as fruit set and fruit retention.
 - Foliar application of ZnSO_4 (0.5%) + borax (0.1%) can enhance nut yield in cashew by increasing yield attributing parameters.
- 24. Name of the Student** Anitha, P. and Srivatsa Prabhu
M.Sc. / Ph.D. M.Sc. (Biotechnology)
University Department of Post Graduate studies and Research in Biotechnology
SDM College, Ujire – 574 240
Year of Completion 2018
Thesis Title Developing of core collection through advanced maximization strategy with heuristic approach in cashew using morphological and molecular data.
Major recommendations / findings
 - With the aid of PowerCore, morphological core was developed based on morphological data. The parameters of PowerCore shown that the core has high efficiency.
 - Molecular core was also developed with the aid of PowerCore. By plotting the dendrograms for cores, we get to know about the genetic relation among them.
 - The core developed by PowerCore has small size and less number of duplicates, can be used as working collection for cashew germplasm conservation and crop improvement programs. These accessions can be evaluated in different environment condition to identify widely or specially adapted stable accessions, which further can be utilized in cashew programme.
- 25. Name of the Student** Chandana Kumari, V.B. and Athira Manohar
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University Department of Post Graduate studies and Research in Biotechnology
SDM College, Ujire – 574 240
Year of Completion 2018
Thesis Title Depicting genetic relationship among some popular varieties of cashew (*Anacardium occidentale* L.) using SSR markers.
Major recommendations / findings
 - Cashew SSR primer for CS-1 to CS-21 about 21 pairs of primers were used for screening over the 8 sample varieties. CS-1, CS-4, CS-9, CS-12, CS-13, CS-14, CS-15, CS-16, CS-17, CS-18 and CS-20 all

these primers expressed non-polymorphic levels.

- CS-2, CS-3, CS-5, CS-7, CS-8, CS-10, CS-11 and CS-19 expressed polymorphic levels. CS-6 and CS-21 did not express any bands.
- The percentage of polymorphic level was found to be 67.64%.
- Depicting genetic relationship among some popular varieties of cashew using SSR markers.
- H-125 and H-126 were almost similar compared to H-130 and the hybrids were closely related to Bhedasi.
- Lowest genetic relationship was seen in between V-4 and Selection-2, which can be further used for the hybrid development and improvement.

CURRENT RESEARCH WORKERS IN CASHEW AT THE ICAR-DCR, PUTTUR:

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Karnataka Cashew Manufacturers Association <http://growcashew.in/>

Karnataka Cashew Development Corporation: <http://kcdccashew.com/>

STATUS OF CASHEW RESEARCH AND DEVELOPMENT IN SOUTHERN PLAINS OF KARNATAKA

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INTRODUCTION

Cashew (*Anacardium occidentale* L.) is an upcoming commercial plantation crop suited to southern plains of Karnataka as it is known to exhibit drought tolerance. The All India Coordinated Research Project on Cashew was started at Agricultural Research Station, Chintamani, under Region III, Zone-5 (Eastern Dry Zone) of Karnataka during the VI plan period. AICRP on Cashew at Chintamani is dedicated for research on cashew in maidan parts of Karnataka and has released high yielding cultivars suitable for plain regions. After the formation of University of Horticultural Sciences, Bagalkot, the AICRP on Cashew has been transferred from ARS, Chintamani (UAS, Bangalore) to Horticulture Research & Extension Centre, Hogalagere (UHS, Bagalkot) during April 2012.

Maidan part of Karnataka has dry weather with low average rainfall and with limited ground water resource along with prolonged dry spell in a year. Planting of cashew plants in marginal and waste lands in this region is a traditional practice. Excess use of below ground water, changing weather conditions and uneven rainfall patterns, followed by higher susceptibility of cultivated crops for pests and diseases have lead farmers to think of an alternative crop suitable for this region. Cashew has been identified as one of the best trees which can be cultivated with low water requirement. Availability of improved cashew varieties and cultivation practices has lead farmers to grow cashew in this region. Now it has assumed the status of one of the prominent plantation crops for maidan parts of Karnataka with many different varieties of cashew, marketing links and processing industries.

However, reasons for lower yields in Karnataka include old and senile orchards, seedling originated farms, grown on waste and degraded soils and adoption of poor production practices in most parts of the state. Karnataka has an area of 4.15 lakh ha of marginal and waste lands. The state government has taken significant steps to grow cashew nut in the districts of Kolar and Mysore. There are several instances wherein farmers have received more than Rs. 8,000/- per quintal. Most of the farmers in sidlaghatta taluk have cultivated cashew nuts in H Cross, Kumbiganahalli, Haradi, Cheemangala, Chikkadasarahalli, Koththanur, Anur, Thippenahalli and Kundalagurki villages. According to Horticulture Officer Mahadevu, farmers have cultivated cashew nut in 2,855 acres in sidlaghatta taluk alone in Kolar district. Among the cashew nut breeds, Chintamani-1, Ullal-1 and 2 and Maharashtra Vengurle -1, 2, 3 are of good quality suited for maidan parts.

CROP IMPROVEMENT

Resources of Cashew germplasm

Collection of germplasm resources from maidan parts of karnataka was initiated as a part of AICRP activity during 1986 and since then 128 accessions have been collected and are maintained. Further, in order to identify suitable cashew cultivars for maidan parts, 14 cultivars/hybrids released from different centres were field planted at the Agricultural Research Station, Chintamani during 1992. Among 14 entries, the highest nut yield of 12.76 kg/tree was recorded by 'H-320' followed by 'NRCC-2' (10.82 kg/tree). The cumulative yield over a period of 16 harvests, 'H-320' recorded highest cumulative yield of 144.85 kg/tree followed by 'NRCC-2' (127.34 kg/tree). On perusal of the data, it was observed that among cultivars/hybrids tried 'H-320' recorded higher nut weight (8.8 g), shelling percentage (31%) and consistent nut yield over years in maidan parts of Karnataka (Reddy *et. al.*, 2015).

Breeding work

Hybridization and selection of cashew accessions has been taken up at ARS, Chintamani since 1994-95. Apart from this, evaluation of cashew varieties released in different parts of the state for their suitability has been taken up and accordingly varieties for maidan parts have been recommended and adopted by the farmers. The varieties are listed below.

Varieties suited for maidan parts of Karnataka:

- Chintamani -1
- Chintamani-2
- Chintamani-3
- Ullal-1
- Ullal-3
- Ullal-4
- NRCC-2
- Vengurla-4

CROP MANAGEMENT

Irrigation

Irrigation is important during establishment of young trees in a dry season in maidan parts. Due to the deep root system the trees can survive few months without irrigation after 3rd year. Mature trees should receive 1800 litres of water per tree every 2 weeks. Yield can be doubled through providing protective irrigation of 200 litres of water per tree once in 15 days from January to March, during summer. Drip Irrigation of 80litres/tree once in four days through from December to March (total irrigation of 2,400 litres / tree/ season) can also increase yield substantially.

Manures, Fertilizers and Fertigation

In maidan parts, potential yields could be realised by application of 25 kg farmyard manure and 60:60:60g of NPK during 1st year, 125:125:125g of NPK during 2nd year, 250:125:125g of NPK during 3rd year, 500:125:125g of NPK during 4th year. During 5th and subsequent years 500:250:250 gm of NPK. Cashew trees subjected to zinc deficiency can be treated using 200g of zinc oxide/100 l of water applied as a leaf spray. Water-soluble fertilizers like Urea, Diammonium phosphate, and Muriate of potash are used for fertigation through drip lines from December to March. Fertigation interval suggested is once a week from December to March. Application of 2 kg castor cake to soil during August is recommended. The quantity of nutrients to be applied through fertigation can be reduced to half of the quantity recommended for general application.

Training & Pruning

After planting the grafts, sprouts coming from root stock portion of the graft have to be removed frequently during the initial stages of graft establishment. Sprouts of root stocks take away valuable plant nutrients, suppressing the growth and proliferation of scion portion. Training and pruning of cashew plants during initial 3-4 years is important to maintain proper shape of the trees. Plants should be allowed to maintain a single stem up to 1 metre height from ground level. Weak and crisscross branches have to be chopped off to avoid lodging of plants by heavy winds and proper staking of plants is very essential. Little pruning is necessary for maintenance of the plants further.

High-Density Planting

The recommended spacing for cashew is 7.5m x 7.5m or 8m x 8m. High-density planting with 4m x 4m spacing (625 plant density/ha) was shown to be better than normal spacing resulting in a yield increase by 2.5 times over normal spacing in the initial ten years. Regular pruning is essential to manage the canopy spread. After 11th year of planting, removal of alternate plants has to be done to reduce the plant population to 50%, thus ensuring canopy overlapping. Overall cashew yield could be increased by 2 to 3 folds by high density planting system as compared to the normal density planting.

CROP PROTECTION

Pests

It is observed that there are about 30 species of insects infesting cashew. Out of these tea mosquito bug, flower thrips, stem and root borer and fruit and nut borer are the major pests, which are reported to cause around 30% loss to the yield in maidan parts of Karnataka.

Tea Mosquito Bug

The nymphs and the adults of tea mosquito bug (*Helopeltis* spp.) sucks sap on the tender leaves, shoots and inflorescence and even young nuts and apples. The saliva of this insect is

very toxic, which causes blistering at the site of infestation. Severe attack on the young shoots causes dieback. Attacked inflorescence usually can be recognized from a distance by their scorched appearance. Tea mosquito bug population builds up during the beginning of rainy season, when the cashew tree is full of new flush.

Tea mosquito can be controlled by spraying Carbaryl 75WP @ 0.1% or Phosalone 35EC @ 0.07% or Endosulfan 35EC @ 0.05% or Dimethoate 30EC @ 0.05% or Lambda Cyhalothrin 5 EC @ 0.6ml/l. Spraying should be done thrice, first at the time of flushing, second at early flowering and third at the time of fruit set.

Thrips

Both nymphs and adults suck and scrape at underside of the leaves, mainly along main veins, causing yellowish patches, latter turning grey, giving the leaves a silvery appearance. These thrips are more active during dry season. Monocrotophos 36SL @ 0.05% or Carbaryl 75WP @ 0.1% or Dimethoate 30EC @ 0.05% is very effective for controlling thrips.

Stem and Root Borers

The young white grubs bore into the fresh tissues of bark of the trunk and roots and feed on subsequent sub epidermal tissues and make tunnels in irregular directions. Due to severe damage to vascular tissues the sap flow is arrested and stem gets weakened. The characteristic symptoms of damage include the presence of small holes in the collar region, gummosis, yellowing and shedding of leaves and drying of the twigs.

Complete control of this pest after infestation is very difficult. However, prophylactic measures for its control can be adopted with BHC 0.1% swabbing twice a year, once in April-May and the second application during November.

Fruit and nut Borers

The young caterpillar bores through the apple and nut causing deformity and /or loss of kernel weight. Spraying of Monocrotophos 36SL @ 0.05% concentration at flowering and fruit setting is recommended.

Diseases

Fortunately cashew crop does not have any serious disease problem. However, powdery mildew affects the young twigs and inflorescences resulting in whitening. This disease generally appears when the weather becomes cloudy. Control can be obtained by dusting with Sulphur WP @ 2%.

POST HARVEST PROCESSING

Processing of cashew apple is not commercially exploited in this part of Karnataka. Cashew apple is marketed as a dessert fruit in and around the cities. The processing of cashew nuts

also gives a by product which is cashew nut shell liquid (CNSL) and augments to the income of processing unit.

Table 1 : Cashew fruit varieties colour and proportion of juice

Sl. No.	Varieties	Apple colour	Juice in apple (%)
1	Chintamani -1	Yellowish red	65
2	Chintamani-2	yellow	63
3	Ullal-1	Yellow	64
4	Ullal-3	Dark red	66
5	Ullal-4	Yellow	65
6	NRCC-2	Rose red	-
7	Vengurla-4	Red	76

(Ref : Cashew cultivation and processing published by KVK, Kolar)

Table 2: Nutrient content in 100g of ripened cashew apple

Sl. No.	Nutrients	Quantity
1	Moisture	87.8 g
2	Organic carbon	0.2 g
3	Sugars	11.6 g
4	Fat	0.1 g
5	Iron	0.2 mg
6	Calcium	10 mg
7	Vitamin "C"	261 mg
8	Beta carotene	9 mg

(Ref : Cashew cultivation and processing published by KVK, Kolar)

VALUE ADDED PRODUCTS FROM CASHEW APPLE AND KERNEL

Cashew crop is mainly cultivated for its nuts, however, utilisation of cashew apple and cashew nut shell is also more common in cashew growing areas. Many products are prepared from cashew apple and nuts for their value addition and marketing. Listed below are some of the products prepared from cashew apple and nuts predominantly in maidan parts of Karnataka.

Table 3 : Products prepared from cashew apple and nuts

Sl. No.	Products from cashew apple	Products from cashew nuts
1	Cashew fruit jam	Cashew nut Holige
2	Cashew fruit Juice	Cashew nut Burfi
3	Cashew fruit Toffee/Burfi	Cashew fried nuts
4	Cashew fruit Pickle	
5	Cashew fruit Chutney	
6	Cashew fruit Jelly	
7	Cashew fruit cheese	
8	Cashew fruit preserve	
9	Golden Syrup	

10	Cashew fruit Candy
11	Canned product of cashew fruit
12	Cashew fruit vinegar

(Ref. Cashew cultivation and processing published by KVK, Kolar)

RECIPES OF CASHEW PROCESSING

Procedure for preparation of cashew products using their apple and nuts have been standardised by the research centre of the region, a few commonly prepared products have been mentioned below. Soaking of cashew apples in 2% salt solution and cleaning them has to be taken up in general before processing cashew apples

Table 4 : Recipes of cashew apple and nuts processing

Sl. No.	Product	Materials required	procedure
Products from cashew apple			
1	Cashew fruit Jam	Cashew fruit – 1 Kg Sugar – 1 Kg Citric Acid – 6 g Vinegar – 5 ml	Homogenisation, mixing of the ingredients, boiling and jam setting with the addition of citric acid and vinegar
2	Cashew fruit juice	Cashew fruit – 1 Kg Lime fruit juice – 60g Water – 500ml Citric Acid – 10 g Sugar – 700g Sodium Benzoate – 1.2 g	Extraction of juice from apple, mixing and boiling of other ingredients and after cooling add filtered cashew juice, store in pasteurised bottles with the addition of sodium benzoate. Use after suitable dilution with water instantly.
3	Cashew fruit Toffee/Burfi	Cashew fruit pulp – 250 g Sugar – 140 g Glucose – 25 g Milk powder – 40 g Ghee – 25 g	The pulp of cashew fruit has to be boiled in low flame till it reaches 1/3 rd of its original proportion. Then except milk powder, all other materials have to be boiled till they start solidifying. Little milk powder after mixing with water has to be added to the above mixture and boiled for a while. This has to be poured on to a plate already smeared with ghee and after cooling has to be cut into desired shapes.
4	Cashew fruit Pickle	Cashew apple- 1 Kg Salt – 200 g Dry chilli powder – 100 g Mustard – 40 g Fenu greek – 10 g Turmeric powder – 5g Oil – 300 ml	After selecting good fruits and washing them and steaming them for five minutes they have to be cut. After sprinkling salt and covering with light cloth, they have to be kept in sun light. Repeating this after for 4-5 days and water collected should be discarded. For the above the finely powdered mustard, fenu greek has to be mixed along with salt and turmeric powder and transferred to storage jars and capped air tight and stored for a week after which the pickle is ready for use.
5	Cashew	Cashew apple – 2.5 Kg	After boiling the fruit in pressure cooker for 10-

	fruit Chutney	Sugar – 2.75 Kg Salt – 30 g Citric acid – 10 g Cut onion – 15 g Raw Ginger – 2.5 g Black pepper – 2.5 g Coriander seeds – 5 g	12 min, mix with salt and sugar uniformly. Boil by stirring slowly and continuously. Finally by mixing powder of all other ingredients, product has to be collected and stored in glass bottles.
6	Cashew fruit Jelly	Cashew apple (Partially ripened) – 1 Kg Sugar – 500 g Citric Acid – 3 g	The selected fruits have to be sliced, mixed with salt and boiled on low flame for an hour till they get smoothened then using muslin cloth decant supernatant liquid and to that add 75% sugar then repeat boiling till it gets proper consistency.
7	Cashew fruit cheese	Cashew apple – 1 Kg Sugar – 1.5 Kg Citric acid – 2 g Salt – 1 tea spoon Red food grade colour – 1 Pinch	Cleaning, boiling with low quantity of water, decanting supernatant liquid, adding sugar and repeating the boiling till it solidifies and finally addition of salt and citric acid then transferring the mixture to a container for cooling and slicing.
8	Cashew fruit preserve	Cashew apple – 1 Kg Sugar – 1 Kg Salt – 20 g Citric acid – 20 g	The cleaned fruits have to be sliced. Sugar solution with 40 brix sugar content and 2 per cent salt content has to be prepared and boiled. The boiling solution has to be poured on to the sliced pieces of cashew apple in containers, leaving 1.25 cm of space in the bottles. The bottles have to be kept in boiling water and then capped.
9	Golden Syrup	Cashew apple juice – 1 litre Sugar – 1 Kg Calcium oxide – 1 tea spoon Citric acid – 2 g	The fruit juice has to be boiled by adjusting the pH to 7.4 using calcium oxide. Meanwhile the solids will settle down. The supernatant has to be collected and the pH has to be adjusted to 6. Then it has to be bottled in sterilised conditions and stored before use.
10	Cashew fruit Candy	Cashew apple – 1 Kg Sugar – 1 Kg Citric acid – 1 g Potassium meta bisulphate – 4 g Salt – 8 tea spoons /litre	Storage of fruits in salt solution at concentrations increasing at the rate of 2% has to be continued for 5 days. Then mix potassium meta-bisulphate and again store in salt solution for 3 days and wash in sweet water. The fruits have to be boiled at 2.4Kgs pressure for 10-15 minutes and soaked in concentrated sugar syrup with increasing concentrations of sugar. This product can be stored for a long period.
11	Canned product of cashew fruit	Cashew apple – 1 Kg Sugar – 750 g Calcium oxide – 2 g Sulphur oxide – 5ml/l	The cleaned fruits have to be boiled in salt water for 5 minutes and then in 0.3N sulphur solution. Then fruits have to be preserved in pasteurised bottles. Fruits have to be soaked with 40 brix sugar syrup and transferred to boiling water and capped and stored after cooling.
12	Cashew fruit vinegar	Cashew apple juice – 1 litre Sugar – 140 g Yeast – 10 g	Prepare fruit syrup of 150 brix by adding sugar and after cooling inoculate with yeast and incubate for 15 days. The pasteurized products pH has to be adjusted between 5-6.

Products from cashew nuts			
1	Cashew nut Burfi	Cashew nuts – 100g Sugar – 150g Ghee – 7-9 Tea spoons Maida – 4 Tea spoons Pista Essence – ½ Tea spoons	Prepare concentrated sugar syrup and mix it with cashew nut powder, when the syrup starts to solidify add with maida and ghee and stir properly. Required essence can be added later and brought into desired shapes.
2	Cashew fried nuts	Cashew nuts – 100g Salt – 1 tea spoon Dried chilly powder – 1 tea spoon Oil – little quantity	Fry the cashew nuts at 120-125°C and at 65°C smear with oil and salt. And at 43°C smear with ghee and after cooling completely store them in butter paper covers.

(Ref : Cashew cultivation and processing published by KVK, Kolar)

ROLE OF DEVELOPMENTAL AGENCIES AND OTHER LINE DEPARTMENTS IN CASHEW DEVELOPMENT

DCCD has sponsored for the establishment of nurseries for cashew propagation. NHM and NABARD have been providing financial assistance for taking up cultivation of horticultural crops in general among which cashew is a component suited for the maidan parts of Karnataka and is considered as a substitute in old and unmanaged mango plantations.

FUTURE PROSPECTS

Areas that need emphasis in future research programmes in Maidan areas are:

- Development of compact and dwarf varieties suitable for high-density planting.
- Evolving varieties with high-yield, resistance to biotic and abiotic stresses, better flowering behaviour/ characters (synchronized and staggered), and, better kernel quality for domestic consumption and export.
- Integrated Plant Nutrient Management (IPNM) including nutrient budgeting, orchard management, weed management, irrigation management, micronutrient deficiency management and, soil and water conservation techniques, for achieving high yield.
- Canopy management and rejuvenation of old cashew plantations/orchards; Canopy architecture and management to suit requirement for different plant densities and system of planting.
- Development of eco-friendly IPM strategies, including entomo-pathogenic nematodes for control of major insect pests.
- Investigation on panicle-drying in the absence of tea mosquito bug.
- Development of value-added products from low grade kernels.
- Exploring the possibility of cashew apple utilization for production of industrial alcohol/bio-fuel/syrup on commercial scale.

MAJOR CONSTRAINTS IN CASHEW CULTIVATION AND PROCESSING

- Cashew is usually taken up in waste lands and maintenance of cashew plots is negligent.
- Cashew plots are old and are most of them are established by local seed source.
- Lack of awareness regarding the cost economics and profitability of cashew production.
- Lack of promotional activities to motivate and to initially support planting of cashew plants with systematic cultivation practices.
- Lack of assessment with respect to the suitability of land and varieties among farmers.
- Limited availability of good varieties of cashew at an affordable price locally.
- Limited availability of cashew nuts for processing.
- Initial establishment cost of processing unit at commercial scale is higher.

MAIN RESEARCH WORKERS IN CASHEW

Table 5: List of workers contributed to research and development in cashew at ARS, Chintamani & HRES, Hogalagere

Name and designation	Organization	Present status Working/retired	Major areas of research	Present address with phone/mobile number
Dr. T. R. Guruprasad	Regional Horticultural Research & Extension Centre, Bengaluru, UHS, Bagalkot	Retired	Crop management	--
Dr. K. M. Rajanna	College of Agriculture, Chintamani, UAS, Bangalore	Working	Crop Improvement	COA, Kurubur Farm, Chintamani-563125. Chikkaballapur Dt.
Dr. H. B. Lingaiah	College of Horticulture, UHS, Bagalkot	Working	Crop Improvement	Dean, College of Horticulture, GKVK, Bengaluru – 65.
Dr. Vishnuvardhan	Horticultural Research & Experiment Station, Hassan, UHS, Bagalkot	Working	Crop management	Head, Horticultural Research & Experiment Station, Somanahalli Kavalu, Hassan.
Dr. Venkataravanappa	ARS, Chintamani, UAS, Bangalore	Working	Crop Improvement	SFS, ARS, Kurubur Farm, Chintamani-563125. Chikkaballapur Dt.
Dr. Maruthi Prasad	College of Horticulture, Bengaluru, UHS, Bagalkot	Working	Crop management	Asst. Professor, College of Horticulture, GKVK, Bengaluru – 65.
Dr. R. T. Patil	Horticultural Research & Experiment Station,	Working	Crop management	Asst. Professor, Horticultural

	Kanbargi, UHS, Bagalkot			Research & Experiment Station, Kanbargi, Belgaum.
Dr. Srinivas	College of Horticulture, Bidar, UHS, Bagalkot	Working	Crop management	Asst. Professor, College of Horticulture, Alanda Road, Bidar.
Dr. M. K. Honnabyraiah	College of Horticulture, Bengaluru, UHS, Bagalkot	Working	Crop management	Professor, College of Horticulture, GKVK, Bengaluru – 65.
Dr. K. R. Vasudeva	Horticultural Research & Extension Centre, Hogalagere, UHS, Bagalkot	Working	Crop Improvement	Associate Professor, Horticultural Research & Extension Centre, Hogalagere, Srinivasapura Tq., Kolar Dt.
Dr. N. Aswathanarayana Reddy	Horticultural Research & Extension Centre	Working	Crop Protection	Asst. Professor, Horticultural Research & Extension Centre,, Hogalagere, Srinivasapura Tq., Kolar Dt.
Dr. V. A. Ramachandra	Horticultural Research & Extension Centre	Working	Crop management	Asst. Professor, Horticultural Research & Extension Centre, Hogalagere, Srinivasapura Tq., Kolar Dt.
Dr. Vidya Mulimani	College of Agriculture, Chintamani, UAS, Bangalore	Working	Crop Protection	Asst. Professor, College of Agriculture, Kurubur Farm, Chintamani- 563125. Chikkaballapur Dt.
Dr. G. T. Tirumala Raju	Agricultural Research Station, Chintamani, UAS, Bangalore	Working	Crop Protection	Professor, National Seed Project, GKVK, Bengaluru- 65.
Dr. C. Manja Naik	Agricultural Research Station, Chintamani, UAS, Bangalore	Working	Crop Protection	Associate Professor, AICRP-Soybean, GKVK, Bengaluru-65.
Dr. Vijaya Mohana Reddy	Agricultural Research Station, Chintamani,	Retired	Crop Protection	-

	UAS, Bangalore			
Dr. Shivanandam	Agricultural Research Station, Chintamani, UAS, Bangalore	Retired	Crop management	-
Dr. M. Narasimha Reddy	Agricultural Research Station, Chintamani, UAS, Bangalore	Retired	Crop management	-
Mr. B. N. Rajendra	Horticultural Research & Extension Centre, Hogalagere, UHS, Bagalkot	Working	Crop management	Asst. Professor, Horticultural Research & Extension Centre, Hogalagere, Srinivasapura Tq., Kolar Dt.

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STATUS OF CASHEW RESEARCH AND DEVELOPMENT IN KERALA

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INTRODUCTION

Cashew is an important crop in the agricultural, industrial and commercial economy of Kerala, where cashew processing industry is concentrated, employing above a lakh peoples. Even though Brazil is the center of origin of cashew, due to more than four centuries of growing, cashew has well acclimatized to Kerala conditions. Due to intensive out crossing in seed-raised plantations, wide genetic variability exists in this crop. In Kerala, cashew is grown in mostly poor soils, where no other crop can be profitably grown. A major part of the cashew plantations in the state are located in hill-slopes, where the soil is largely lateritic. Eventhough cashew is grown in almost all districts; the major districts include Kannur, Kasargod, Thrissur, Kozhikkode and Palakkad. Cashew production is relatively high in Kannur and Kasaragod districts, where prolonged dry spell is noticed from November to March coinciding with the reproductive phase of the crop. In central part of Kerala, high wind speed during November-December and maximum surface air temperature beyond 35⁰C during summer may limit better yields. Lack of mild winter and occasional wet spells towards south of Kerala may also hinder cashew production.

Cashew Research in Kerala

Cashew research in Kerala was started in 1952 with the setting up of a research station at Kottarakkara, under an ICAR adhoc project. Subsequently, the Government of Kerala has started a full-fledged Cashew Research Station at Anakkayam in 1963 under a scheme included in the third five year plan. Cashew Research Station, Anakkayam, was one of the four centers of the All India Co-ordinated Spices and Cashew nut Improvement Project of the ICAR, when the later was started in 1971 and was brought under the Kerala Agricultural University, in 1972. Cashew Research Station, Madakkathara was started under KAU on 1.5.1973. Subsequently the centre of the AICRP on Spices and Cashew nut shifted to Madakkathara.

In addition to the research programmes conducted at the Cashew Research Stations of Anakkayam and Madakkathara, several research projects on cashew were carried out under the Kerala Agricultural Development Project (KADP), Vellanikkara during 1978-79. The World Bank aided Multi State Cashew Research Programme was implemented at Madakkathara during 15.2.82 -3.9.86 in 8th five year plan. The AICRP on Spices and Cashew nut was bifurcated in 1986 and an independent AICRP on Cashew started in 1986 with its head quarters at NRC for cashew, Puttur, Karnataka,now renamed as Directorate of Cashew Research. During 1989 cashew research started at RARS, Pilicode(Kasargode) under NARP and in February 1993, RARS,Pilicode has been recognized as a sub-centre of the AICRP on Cashew.

Area, Production and Productivity

Earlier, Kerala stood first in the extent of area under cashew. However, the area under cashew has declined over the years and at present Kerala Stands 5th in area under cashew. Data indicates that there has been a continuous and considerable decline in both area under cultivation as well as production of cashew in Kerala. The decline in acreage and production can be attributed to several reasons as outlined below.

Table 1. Year wise area, production and productivity of cashew over the years

Year	Area (Hectares) (ha)	Production (Tonnes) (Ton.)	Productivity(Kg /ha)
1993-94	156000	140000	925
1994-95	156000	119000	781
1995-96	118000	140000	1000
1996-97	119000	134000	1140
1997-98	120000	100000	850
1998-99	122000	130000	1100
1999-2000	122000	100000	850
2000-2001	100000	76000	765
2001-2002	100000	87000	870
2002-03	88548	66087	746
2003-04	86376	65658	760
2004-05	81547	60584	743
2005-06	78285	68262	872
2006-07	70463	61680	875
2007-08	58381	52402	898
2008-09	53007	42334	799
2009-10	48972	35818	731
2010-11	43848	34752	793
2011-12	54052	36743	680
2012-13	52086	37910	730
2013-14	49105	33400	680
2014-15	45436	29715	654

- Nature of the crop -The crop yields only once in a year; with a local variety yielding only less than 10 kg per year realizing only Rs 700 to 800 per tree per annum. Harvesting and collection of nuts is labour intensive.
- Occupies large area-Large patch of land is occupied by the crop and no crop grows beneath it. Hence income per unit area also becomes low.
- Old and senile plantations- Most of the existing plants are of poor genetic make-up, old and senile and hence poor yielders.
- No scientific care and management of the crop - Cashew is generally a neglected crop planted in wasteland and receives little care and management. Pest and disease incidence is more when left unattended.

- Area expansion in rubber- Cashew plants were cut and removed even from homesteads for planting natural rubber (*Hevea brasiliensis*).
- Dwindling size of operational holdings and other uses for land- The size of individual operational holdings is coming down day by day with increasing rate of subdivision of family property among children and also use for other purposes.
- No or minimum domestic use for the raw nuts and cashew apple, which are by nature cumbersome to handle.

Presently cultivated area and areas available for cashew expansion in Kerala

Table 2 : District wise area and production of cashew nut in Kerala

	District	Area (ha)	Production (Tonnes)
1.	Thiruvananthapuram	1278ha	306
2.	Kollam	2679 ha	772
3.	Pathanamthitta	455ha	121
4.	Alappuzha	1921 ha	318
5.	Kottayam	399 ha	103
6.	Idukki	1375 ha	410
7.	Ernakulam	430 ha	122
8.	Thrissur	1697 ha	426
9.	Palakkad	2353ha	609
10.	Malappuram	2582 ha	671
11.	Kozhikode	2015 ha	740
12.	Wayanad	718 ha	224
13.	Kannur	20350 ha	18570
14.	Kasaragode	7182 ha	6323
	Total	45436	29715

Kannur district contributes about 63% production, and Kasaragod district about 19%. Kerala accounts for 15 % of cashew production in the country. Kannur and Kasargod districts account for nearly 60 per cent of the total area under cashew cultivation. About 28 per cent of the total production came from homestead gardens of less than 2 ha, mostly marginal land belonging to the rural poor.

GERMPLASM RESOURCES

Survey and collection of novel types to enrich the germplasm was the initial research programme in Kottarakkara (Kollam district,Kerala). These accessions were later taken to research stations at Anakkayam and Madakkathara. At Cashew Research Station Anakkayam, 84 accessions (few seedling progenies and other air layers of germplasm) from Kottarakkara and at Madakkathara, 93 seedling accessions and 68 clonal accessions are being maintained. In addition, seeds of 18 accessions from the republic of Panama were introduced and sown during July 1988 and seedlings of 14 accessions were planted during September 1988 for

evaluation. Now cashew germplasm in Kerala Agricultural University is maintained at three research stations, Anakkayam with 85, CRS Madakathara with 167 and RARS Pilicode with 64 accessions (John *et al.*, 2003). This germplasm includes indigenous, from other states and exotic collections from Brazil, Indonesia, Tanzania and Republic of Panama.

This germplasm is enriched with many novel varieties like the precocious dwarf accessions from Brazil, cashew nut shell liquid free accession Pattannur 1-1 (Nalini *et al.*, 1994) which can be used raw for culinary purposes, purple cashew (ornamental- NRCC, Thaliparamba dwarf suitable for high density planting from Pilicode (TPB1) etc.

TPB-1 (Dwarf) - It is a natural dwarf selected from Kurumathur near Taliparamba (Kannur Dt.) during 1995. It grows very short (2m height) with very short internodes, small leaves, dense foliage, and short and dense inflorescences. It has 7.8 per cent bisexual flowers. It starts flowering very early in October, fruit set is very low (4.5%) and has single nut per panicle with nut weight 3g and apple is small and red in colour.

KGN 1-A precocious type started bearing at seven months of age of seedlings at CRS Madakkathara in 1998. Introduced from Brazil and bears bold nuts, gives very good yield from the first year onwards and the kernel is also bold and of export quality.

Mridula (PTR 1)-A selection from the Pattannur area in Kannur district is a late season and the shell lacks shell liquid. The nuts are very small (3.55g) and kernel weight is 1.38g only. Nut yield is only 3.31kg/tree

BREEDING EFFORTS

Early bearing and higher yield were the primary criteria for releasing a variety for cultivation in earlier days. However, in view of the demand for better kernel size and higher shelling percentage, later efforts were intensified to release high yielding varieties with bold nut size. Due to research efforts, sixteen varieties were released by the Kerala Agricultural University, six are selections and ten are hybrids. The released varieties can be grouped mainly into three groups viz., early, mid and late season types based on their time of flowering. The early types flower during Oct-Nov, the mid season in Dec- Jan and the late types during the Feb-March. They may again be classified based on the nut size viz., small nut types (nut weight <6g), medium nut types (weight 6 -8g) and bold nut types (nut weight >8g).

Anakkayam 1-A selection from the tree number 139 from CRS, Bapatla and released from CRS, Anakkayam in 1982, semi-tall with dense and compact canopy. A very early type with average nut weight of 5.95g and kernel weight 1.67g and with the shelling percentage of 27.99; export grade is W280. The average yield per tree is 12kg.

Madakkathara- 1 A selection from the tree no. 39/A from CRS, Bapatla and released from CRS, Madakkathara in 1990. It is tall with dense and compact canopy. An early type, average annual yield is 13.8kg per tree, nut weight is 6.2g and the kernel weight is 1.62g, shelling percentage 26.4. Export grade is W 280.

K-22-1 (Kottarakkara 22-1)-This was released as a selection of Tree no. 22 from the erstwhile CRS, Kottarakkara in 1987. It is tall with dense and compact canopy. A mid-season type, annual yield is 13.2kg per tree and the nut weight is 6.2g. Kernel weight is 1.6g; shelling percentage is 26.5 with the export grade of W 280.

Madakkathara- 2-A selection from the tree no 2 in the Neduvallur estate of Kannur district, Kerala, released in 1990 from CRS, Madakkathara. A late season variety, a high yielder with 17 kg per tree and nut size is medium (7.2g per nut). The kernel weight is 1.88g with shelling percentage of 26 and export grade of W240.

Sulabha (K- 10-2) - A bold nut variety with an average yield of 21.9 kg/tree and released in 1996 byKAU. It is a selection from tree no. 10 Kottarakara, Kerala, tall with compact and dense canopy. A late season variety, nut weight and kernel weight are 9.8g and 2.88 g respectively. Export grade is W210 and shelling percentage is 29.4. Highly suitable to the coastal and midlands of the west coast.





CASHEW VARIETIES RELEASED FROM KERALA AGRICULTURAL UNIVERSITY

Kanaka (H 1598) - It is a hybrid between BLA 139-1 and H3-13, released by CRS, Madakkathara in 1993. The tree is tall with open canopy and intensive branching and fruiting season is Dec- March. Annual yield is 12.8 kg per tree with medium nut size (6.8g) and high shelling percentage, kernel weight is 2.08, export grade W280.

Dhana (H 1608) - It is a hybrid between the high setting exotic type from Brazil and a bold nut type (ALGD -I x K 30-1) and released in 1993. The tree is tall with dense canopy and is a midseason type. Nut yield is 10.66 kg/tree and the nuts are bold with 8.2 g, shelling percentage 29.8% and kernel weight 2.44g, export grade W 210. Released for cultivation at national level.

Priyanka (H 1591) - A hybrid between BLA 139-1, and K 30-1, very bold nut type. Released in 1995 from CRS, Madakkathara and recommended for cultivation in all the cashew growing tracts in India. A mid-season type, with an average yield of 17.03 kg/year/annum. The nuts and kernel are very bold (10.8g and 2.87g respectively). Shelling percentage is 26.57 and export grade W180. The tree is having open canopy and dense branching habit. A very popular variety in Kerala.

Dharashree (H 3-17) - This was released in 1996 from CRS, Anakkayarn, a hybrid between Tree no. T-30 and Brazil-18, a bold nut type from Brazil. The tree is having sprawling branching habit and compact canopy. Mid- season type, yield is 15.02 kg/year, nut weight 7.8g, kernel weight 2.4g, export grade W240, shelling percentage 30.5.

Amrutha (H 1597) - It is a mid-season hybrid (BLA 139-1xH 3-13) released in 1998 from CRS, Madakkathara. The tree is sprawling type with low branches and starts flowering during Dec -Jan. Annual nut yield is 18.35 kg/ tree. Nuts are medium sized (7. 18g) and kernel weight is 2.24g with a shelling percentage of 31.58 and export grade W210.

Anagha (H 8-1) - A hybrid (Tree no. 20xK 30-1) with very bold nut and kernel, released from the CRS, Anakkayam in 1998. The tree has compact canopy and dense branches and flowering in Jan-Feb. Annual nut yield is 13.73kg per tree and nut weight is 10g. The kernel is bold (2.9g) with a shelling percentage of 29 and export grade W180.

Akshaya (H 7-6) - A hybrid between 114- 7 and K 30-1, released from the CRS, Anakkayam, with compact canopy, dense branching, and a mid-season flowering type. Average nut yield

is 11.78 kg per tree per annum. The nuts are very bold (11g) and the kernel weight is 3.12g. The shelling percentage is 28.36 and export grade W180.

Raghav (H 1610) - It is a hybrid between ALOD - 1-1 and K 30-1 released from CRS, Madakkathara in 2002. A tree with tall, compact canopy and flowering in Jan- Feb. Annual nut yield is 14.7 kg/ tree, nut weight 9.2g and kernel weight 2.27g with export grade of W 210. Shelling percentage is 26.6.

Damodar (H 1600)-The hybrid (Anakkayam x H' 3-13), released in 2002 from CRS, Madakkathara, is a mid season flowering type. The tree is tall with profuse branching and dense canopy, trunk is smooth and slightly tolerant to stem borer. Annual yield is 13.4 kg/ tree with nut weight 8.2g and kernel weight 2g (export grade 210). Shelling percentage is 27.3 and apple is red. It is highly suitable to northern Kerala.

Poornima (H 1593) - This is released from CRS, Madakkathara during 2006 and is a cross between BLA 139-1 and K-30-1 and with upright, compact tree habit with intensive branching. It has mid- season flowering behaviour. Annual yield is 14.08 kg/tree. It has the desirable nut characters like good nut weight (7.8 g) high kernel weight (2.6g), high shelling percentage (31%) and good export grade (W 210). It is moderately susceptible to tea mosquito bug.

Sree (Selection 990)-A selection from CRS, Anakkayam

Varieties commercially adopted by farmers : Dhana, Priyanka, Poornima, Raghav, Anagha, Akshaya, Kanaka, Damodar, Sulabha, Vridhachalam 3 (VRI-3), Dharasree, K22-1, Amrutha, Madakkathara-2, Madakkathara-1, K-22-1. Vridhachalam-3 is a selection from the Tamil Nadu Agricultural University and performing comparatively well in agro-climatic situations of Kerala.

CROP MANAGEMENT

Cashew grows and yields best in well-drained red sandy barns and light coastal sands. Since cashew is grown mainly without applying fertilizers, the potentialities of biofertilizers as well as other management practices including efficient recycling of litter can be utilized best for improving the productivity.

Climate & Soil

Variation in heat unit requirement is observed among different genotypes. Early varieties like Anakkayam-I require lesser amount of heat units (1953 day°C), while late varieties like Madakkathara-2 require more (2483 day°C). The mid season varieties had a value in between them (2245 day °C). It is found that branches on southern, SW and SE quadrant flower early compared to northern quadrant. The kernel weight was influenced by total heat units received and also by the available soil moisture. The best soil types are brown forest soils or deep well

drained laterite soils with a high water holding capacity and rich in organic matter. Eroded laterites and coastal sandy soils are unsuitable and less productive. Saline or alkaline soils are not favourable for the crop. Soil characteristics in natural forests, teak and cashew plantations in Kerala were studied to characterize the soils of natural forests and plantations of different species in the Malayattoor Forest Division of Kerala. Soils in the cashew plantations were found to be sandy loam and moderately acidic. Soils in the plantations were found to be deteriorated when compared to those in natural forests. The red and laterite soils support tree crops in high as well as less rainfall areas.

Planting

Seedlings or softwood grafts are planted in pits of size 50cm x 50cm x 50cm during June-July. Planting may be done at a spacing of 7.5 m for poor and 10 m for rich and deep soils and sandy coastal areas. On very sloppy lands, the rows may be spaced 10-15 m apart with spacing of 6-8 m between trees in a row. In high density planting instead of the normal planting density of 100-177 plants/ha, 312-625 or more grafts/ha are planted. The population is regulated in later years by selective felling. The success of high density planting depends on the initial spacing (planting density) and the time of thinning at later stages. Per hectare yield will be more from high-density plantations in the initial years, later the productivity of both the plantations would be more or less the same. The cumulative percentage yield was 3.8 times high under high density system (Annual Research Report, 2008). Jose Mathew and Mini (2008) conducted the economic analysis of the high density system and found significant increase in net income and benefit cost ratio.

Irrigation & Weed Management

Drip irrigation @ 80 litres/tree once in 4 days from 2nd fortnight of December to end of March coinciding with the flowering season resulted in significantly higher yield compared to lower levels of irrigation or without irrigation. In a study conducted during 1995-97 to evaluate the effect of N at 0, 750 and 1500 g/tree, applied under different levels of drip irrigation (at 0, 40 and 80 litres of water/tree per day), on 3-year-old cashew grafts cv.H-3-17, the highest yield was obtained with the application of 1500 g N/tree at a drip irrigation regime of 80 litres/tree per day. Depending upon the weed growth, weeding operation may be done during August-September. The plant base is mulched with dry leaves to reduce sun-scorch to tender plants. Sickie weeding is the most common practice of weeding. Three sprays of paraquat (0.4kg/ha) or single application of Glyphosate (0.8kg/ha) were equally effective. 2, 4-D controlled broad leaved weeds whereas Dalapon was effective against grasses. The yield reduction due to weed competition is estimated to be 60-70%.

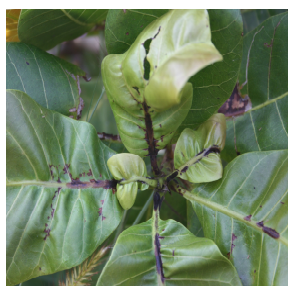
Pruning, Intercropping & Manuring

Initial training and pruning of young cashew plants during the first 3-4 years is essential for providing proper shape. Thereafter, little or no pruning is necessary. The plants should be allowed to grow by maintaining a single stem up to 0.75-1.00 m from ground level. This can be achieved by removing the side shoots or side branches gradually as the plants start growing from the second year of planting. Weak and crisscross branches can also be removed. During the first year, about 90% of the area is available for intercropping which

reduces to 80 and 70 % during the second and third years. Short duration crops like pineapple, papaya, cowpea, banana, ginger, groundnut, pulses, vegetables and tapioca are suitable for intercropping. Pineapple is the most profitable intercrop in cashew plantation in the early stages of growth. A fertilizer dose of 750g N, 325g P₂O₅ and 750 g K₂O per plant is recommended for cashew (KAU, 2002). Apply 1/5th dose after the completion of first year, 2/5th dose during second year and thus reaching full dose from 5th year onwards. Broadcast the fertilizer within an area of 0.5 to 3.0 m and 15 cm deep around the tree and incorporate by light raking. The organic materials available in the plantation can be subjected to vermi composting. Cashew apple residue and leaf litter could be composted in ninety five days which served as an ideal ameliorant for acid soils of Kerala (Mini *et al.*, 2004).

CROP PROTECTION

Key insect pests are tea mosquito bug (TMB) and cashew stem and root borers (CSRB), though multitude of insect-pests inclusive of other arthropod pests are recorded. TMB (*H. antontii*) is distributed in most of cashew growing regions of Kerala.



TMB attack in nursery



TMB attack on panicle



Shoot die back and inflorescence blight due to tea mosquito-fungal complexity



The bug and fungi complex-A perusal of available literature depicts that TMB and certain fungi are often associated with blossom blight and shoot dieback (Nambiar *et al.*, 1973). Kerala recommendation (KAU, 2002) was 3 - round schedule found to be the most effective and profitable schedule for managing the tea mosquito bug-fungal complex.

Crop stage	Insecticide and fungicide
Flushing	Lambda cyhalothrin (0.6ml/l) + copper oxychloride (2g/l)
Flowering	Quinalphos (2 ml/l) + Mancozeb (2 g/l)
Nut set stage	Thiamethoxam (0.2g/l)

The application strategy must agree to the crop-age. When the farmer has mixed varieties (early, mid and late) in his orchard, he should resort to spraying according to the right phenophase rather than going by month-wise application strategy. Spray before 9am or after 4pm is recommended in order to save non-target pollinators. According to canopy-size, use 5-10 litres of spray fluid for grown up trees with high volume spray. Use rocker sprayer with Hi-tree lance or power sprayer for fully covering the canopy (KAU, 2002).

Role of red ants-Trees harbouring ant-colonies (particularly red ants; *Oecophylla smaragdina*) are to be spared of spraying. Ants help in increased pollination and minimize the infestation of some of the insect pests including TMB. However, appropriate care should be taken as ants help spreading mealy bugs and scales.

CASHEW STEM & ROOT BORERS (CSRB)

Three main species of beetles were recorded to infest cashew viz. *Plocoederus ferrugineus*, *Plocoederus obesus* and *Batocera rufomaculata*. The *Plocoederus* spp. are encountered as primary pests while *B. rufomaculata* occurs as a secondary pest of cashew.



Eggs



Grubs



Pupa



Female and male

Curative method

Mechanical extraction of the grub and swabbing the tree with 2% carbaryl solution minimises the damage. Pouring 2% carbaryl solution in the soil at tree basin also helps to minimise the incidence of stem borer. Application of neem oil 5 per cent on collar portion up to 1m height and on exposed roots keep the insects away for a period of 3-months. Soil application of 75g of sevidol in tree basin also minimizes the attack of the stem and root borer (KAU, 2002). The present recommendation is drenching with chlorpyrifos @10ml/l as post extraction prophylaxis in the form of removal of grubs from the infested tree. Swabbing with 5% neem oil is also recommended. The treatments have to be repeated at least twice or thrice a year (KAU POP, 2016) in order to get good results and to reduce the chance of re infestation. Certain precautions are to be taken in curative management of stem borer. The dead and those trees beyond recovery are to be removed in order to prevent the spread of pest. At most care should be taken to avoid injuries to bark of the trees during management practices to prevent the egg laying by the adult female on injured bark.

POST HARVEST PROCESSING & VALUE ADDITION

Cashew apple, which is highly nutritious, can be used for preparing various products. The Kerala Agriculture University has done pioneering work in the utilization of cashew apple. An FPO licensed cashew apple processing unit (now converted to FSSAI) has been established at Cashew Research Station, Madakkathara, Thrissur under Kerala Agricultural University during 1997 for the preparation of unfermented cashew apple products. It is the first ever unit established in India for cashew apple processing. It undertakes commercial production of eight cashew apple products viz., syrup, drink, cashew apple – mango mixed

jam, pickle, candy, soda, chocolate and vinegar. Several trainings are being conducted at CRS, Madakkathara on cashew apple utilization including off campus trainings. The constant transfer of technology initiatives by the Madakkathara Centre has resulted in the establishment of several units by private entrepreneurs and Self Help Groups. The first ever cashew apple processing unit in private sector using Madakkathara technology has been established at Iritty, Kannur, Kerala under the trade name “TOMCO PRODUCTS” and they are marketing cashew apple syrup and candy. CRS, Madakkathara is participating in many exhibitions for the dissemination of the novel technologies in cashew production and processing.



Training on cashew apple utilization organized by CRS, Madakkathara, Thrissur, Kerala

Technologies developed at Cashew Research Station, Madakkathara, KAU, Thrissur, Kerala

The presence of astringent principles producing an unpleasant and biting sensation on the tongue and throat and poor storability are the two major constraints in the economic utilization of cashew apple. Cashew Research Station, Madakkathara has developed techniques for overcoming these constraints. Removal of tannin (clarification/de-tanning) done by adding cooked sago @ 5g/litre of juice and potassium meta bisulphite (KMS) 2.5 g and citric acid 5g are added for extended storage of cashew apple and juice. The apples are detanned by immersing in 5% salt solution for three consecutive days, daily changing water.

Recipes of cashew apple products (Mini and José Mathew, 2008)

1. **Cashew apple syrup** - Sugar @ 2.0 kg/litre is added into the clarified cashew juice and then heat moderately, till the sugar completely dissolves. Then add citric acid @ 15 g / litre (dissolved in little quantity of syrup) and stir well. Remove the solution from the stove, cool, strain. Now syrup is ready.
2. **Ready - To - Serve beverage (RTS beverage)** - Required quantity of sugar and citric acid are taken in water and boil. Towards the end, clarified cashew apple juice is added immediately in hot condition itself by stirring. Cool and bottle it. Pasteurize the bottles by keeping in boiled water for 20 minutes for a storage life of three months.
3. **Cashew apple – Mango mixed fruit jam** - Fresh ripe mango fruits are washed, peeled, sliced and made into pulp using a mixer or pulper. Add KMS @ 2.5 g and citric acid @ 5

g /kg of pulp for storage. Mix the pulps in the ratio of 1:1. Add 1.0 kg sugar per kg of mixed pulp and citric acid (quantity adjusted as per acidity) and cook it with continuous stirring till it reaches the appropriate stage for jam, transfer hot into sterilized glass bottles.

4. **Cashew apple pickle** - Pickle is made as in the case of all pickles using gingelly oil, asafoetida powder, turmeric powder, fenugreek powder, chili powder, mustard powder, sliced raw green fruit, garlic, green chilli, ginger, required quantity of water, vinegar and salt.

5. **Cashew apple candy** – Ingredients :- cashew apple-1kg, sugar-1kg, water-1 litre

Preparation of cashew apple - Keep detanned cashew apple in a solution of Potassium meta bisulphite (of two pinches) for 2-3 days. Thoroughly wash the apple in water. Remove black spots and parts of pedicel. Keep in perforated crates of stainless steel and steam for 10-20 minutes in pressure cooker without overcooking (making too soft). Make deep holes in the apple using bamboo sticks or steel forks to facilitate entry of sugar syrup in the next stage.

Preparation of sugar syrup - Dissolve 250 g sugar in one litre of water and heat well. Dissolve citric acid (1.0 g) and potassium metabisulphite (2 pinches) in this solution.

Preparation of candy - Drop the pre-prepared apple into the boiling sugar syrup so that the apples are completely immersed. Cover the container with lid and keep it as such for one day. Take out the fruits on the 2nd day, add 125 g sugar, and drop the apple while heating. Repeat it for 7 days. On 8th day, volume of sugar syrup will be reduced to one-third. Keep the apples as such for 8-10 days. Remove the apples from the syrup solution, drain for 30 minutes and dry it slowly in open area by spreading in a polythene sheet. Keep it in clean, dry, screw capped glass jars in a cool, dry place.

6. **Cashew apple vinegar** – *Ingredients* : Unclarified cashew apple juice - 1.0 litre, Sugar-158g, powdered sago-5g, mother vinegar-3 times the alcoholic ferment, starter solution - 2g yeast + 20 ml coconut water (kept overnight). Vinegar preparation consists of two stages : alcoholic and acetic fermentations.

Alcoholic fermentation - Take one litre of cashew apple juice, add 158 g sugar and yeast (2 g in 20 ml coconut water). Keep for 7 days in narrow mouthed plastic bottle with cotton plugging.

Acetic fermentation - After 7days, add mother vinegar (3 times the alcoholic ferment). Again keep for 2 weeks for acetic fermentation, check acidity, pasteurize.

7. **Cashew apple chocolate** - Ingredients-cashew apple powder - 200g, milk powder-400g, sugar-400g, cashew kernel - 50g, butter - 50. Mix well the cashew apple powder and

milk powder. Put the mixture to the sugar syrup and add cashew nut pieces and butter. Pour the mixture to trays smeared with butter. Make chocolate pieces in the required size after cooling.

8. **Cashew apple carbonated drink** - *Ingredients*- cashew apple syrup-40ml. Add 160 ml chilled carbonated (100psi) water to 40 ml syrup and seal to get 200ml carbonated drink.

Osmodehydrated cashew apple making use of honey instead of sugar, cashew apple halva, cookies, wine and cashew apple chutney have also been developed at Kerala Agricultural University.

9. **Cashew nut products** - **The Kerala State Cashew Development Corporation Ltd.** based at Kollam is preparing plain, roasted and salted kernels under the name “CDC Cashews”. They also developed cashew nut products - Cashew Vita, Cashew Powder, Cashew Soup, Choco-Kaju, Milky Kaju and Cashew Bits and are being sold. Their new developed products ready for launch are pepper coated cashew and garlic coated cashew. A study conducted at CRS, Kerala Agricultural University Madakkathara, Thrissur, for finding out utilization of immature nuts revealed highest kernel recovery when the nuts were harvested at 55 days after flowering. The kernels could be used for the preparation of highly relished curries and products like spiced and salted kernels.

ROLE OF DEVELOPMENTAL AGENCIES AND OTHER LINE DEPARTMENTS

1. **DCCD, Kochi, Kerala** - The Directorate of Cashew and Cocoa Development is giving financial assistance for conducting trainings and seminars on cashew production and processing technologies. Apart from trainings, DCCD also assist in organic farming, Demonstration, Cashew Day, Horti Fair and Exhibition programmes in the state and exposure visit to other cashew growing states through which farmers get exposure on latest technologies and products and also the development in other leading states. Yield production models were developed in cashew with assistance from this directorate.
2. **KSCDC, Kollam, Kerala** - The Kerala State Cashew Development Corporation Ltd. based at Kollam is involved in the development of cashew in the state. KSCDC was incorporated in July 1969 and started commercial activities in the year 1971. They are having nut processing factories in different places of Kerala and also distributing planting material to the farmers there by promoting cashew cultivation.
3. **CEPCI, Kollam, Kerala** - The Cashew Export Promotion Council of India, Kollam is mainly involved in the export of cashew from our country. They also have a Laboratory and Research Institute with activities like analytical services, testing facilities, research projects, market research activities, etc.

4. **KSACC, Kollam, Kerala** - Kerala State Agency for Expansion of Cashew Cultivation is a government agency involved in cashew area expansion and cultivation in the state. The agency is conducting several trainings and giving assistance for new plantings as a part of area expansion programme.
5. **NHM** – National Horticultural Mission has funded for the establishment of a Model Cashew Nursery for the production and distribution of quality cashew grafts of high yielding varieties to farmers and for a state level model cashew apple processing unit at CRS, Madakkathara.
6. **CAPEX, Kollam** - Kerala State Cashew Workers Apex Industrial Co-operative Society Limited is involved in cashew nut processing and marketing.

Other organizations involved in cashew cultivation are Aaralam Farm, Kannur; Farming Corporation, Punalur; Forest Development Corporation, Punalur etc.

TRADITIONAL KNOWLEDGE ASSOCIATED WITH CASHEW CULTIVATION AND USE

- Cashew apple juice with salt is being used for improving the digestion.
- Cashew apple juice mixed with ginger extract and salt kept in glass bottle for one year is considered as a remedy for stomach pain, indigestion, vomiting and other connected diseases.
- Cashew apple juice blended with turmeric is considered good for poultry diseases.
- Cashew apple is one of the ingredients in traditional dishes of Kerala like *aviyal chutney* and *bajji*
- Cashew apple juice added with jaggery, boiled to get toffee and cashew apple juice along with dried ginger and pepper is used to prepare *Arishtam*, an ayurvedic product.
- Green cashew apple used for the preparation of pickles. Cashew apple made to long pieces, mixed with rice powder, chilli, pepper and salt and dried to get *kondattam* which can be *fried* in oil and eaten. Cashew apple is a good feed for cattle to increase milk production.
- Liquor prepared from cashew apple juice is good for sound sleep.
- Immature as well as mature cashew nuts are used for making many curry preparations. Cashew nut shell liquid along with turmeric powder and coconut oil is used as a medicine for cracks in legs. Cashew nut is good for bone strength and heart muscles. Cashew apples are used for making wine, tonic etc. CNSL is used against termite attack and for treating leg infection in cattle.

- Cashew nut is used in roast, sweet ball, *peda*, fish curry, meat curry, egg curry, crab curry.
- Cashew flowers are used to prepare curry, preparations with cashew bark used against urinary infections, medicine for cattle, stomach pain, rheumatic complaints, etc.
- Immature leaf of cashew is used for stomach pain and kidney stones.
- Immature leaf of cashew and fenugreek paste is used for treating diarrhea in cattle

FUTURE PROSPECTS OF CASHEW IN THE STATE

Replacing the plantations of seedling origin with grafts of high yielders is necessary to enhance productivity and total production. Rejuvenation of senile cashew orchards is a better option for getting high productivity. As far as Kerala is concerned, there is little scope for expansion of area under cashew because of less per capita land availability. High density planting is a good option for land utilization. Strategies for high density planting and ultra high density planting under Kerala conditions are to be worked out in different cashew varieties, in different areas and with good management practices. The economics of cultivation and BC ratio are to be calculated, which needs further research. Intercropping is to be intensified with more economical and high value crops to get maximum returns from unit area. Crops like pepper can be tried in the later stages of cashew with shade loving pepper varieties.

Potential areas for increasing the production of cashew

Kannur, Kasaragod, Palakkad and Malappuram area are having potential for increasing the production of cashew in Kerala. Usually cashew gives high yield where prolonged dry spells for three to five months were seen during reproductive phase. Cashew production is relatively high in Kannur and Kasaragod districts, where prolonged dry spell is noticed from November to March coinciding with the reproductive phase of the crop.

Measures for Area Expansion

KSACC was able to bring 3108 ha of land under new plantation of cashew and rejuvenate 760 ha of old and senile plantations. These efforts have to be further strengthened.

- Fallow and Waste Land Utilization: Cashew can be planted in the fallow and waste lands
- Replanting and Rejuvenation: Old and senile plantations are to be replanted with HYV.
- Awareness on Scientific Crop Management Techniques:.
- Organic Cashews Can Fetch a Premium Price.
- By Product Utilization: Value added products, vermicompost, biogas, biofuel from cashew apple.

- Cashew nut processing: Supply of raw materials and support of incentives.
- Cashew based commercial enterprises: Cashew based commercial enterprises - graft production and nursery management as well as cashew apple utilization for increased income.
- Crop insurance and minimum support price for farmers are to be assured

RESEARCH NEEDS

- The research programme on varietal improvement has to be intensified.
- Feasibility studies on high density as well as ultra high density planting.
- Integrated pest management giving emphasis to biological methods.
- Regularization of flowering in cashew has to be explored for getting increased yield.
- Strategies for intercropping with high value crops and organic cultivation are to be worked.
- Cashew apple processing is to be intensified and refined.
- Exploring the possibility of biogas and biofuel production from cashew apple.
- Exploring the possibility of nutraceuticals from cashew apple.
- Utilization of cashew apple for cattle feed, poultry feed etc to be explored.
- Production of dwarf genotypes for planting in the homesteads of Kerala.
- More value added products from cashew nut to be developed.
- Emphasis to be given for finding the medicinal uses of cashew apple.
- Explore the possibility of using root stocks of other members of *Anacardiaceae* family for successful grafting so as to find the possibility of resistance to CSRB and the research on allelopathic interactions in cashew based multistoried cropping systems is highly essential.

STATUS OF TRIBAL SUB-PLAN PROJECT

The tribal sub plan was implemented at tribal colonies of Thrissur under the leadership of Cashew Research Station, Madakkathara, Kerala Agricultural University.

1. **Awareness programme**-Awareness programmes on cashew cultivation were conducted at different tribal colonies in Thrissur and Palakkad districts. Orientation was given on cashew production technology and booklets delineating all these aspects were supplied to the beneficiaries.



Training cum awareness programme on cashew –Tribal Sub Plan

2. **Training on cashew apple utilization**-Hands on training on cashew apple processing and value addition was given for duration of 7-21 days, to the selected tribal women of Thrissur district utilizing the facility at CRS, Madakkathara.
3. **Training on cashew nursery production technology**-Practical oriented training on cashew nursery production technology was given to tribal people of Thrissur district with 7-15 days duration.



Grafting-hands on training at CRS, Madakkathara

4. **Establishment of small scale nursery**-Two cashew graft production units were established
5. **Demonstration of plant protection measures** -Demonstration programme was conducted for 27 tribal people regarding the pests and diseases of cashew with hands on training.



TMB and CSRB control - Practicals



Leaflets on cashew cultivation, in local language, distributed to the trainees of TSP

MAJOR CONSTRAINTS IN CASHEW CULTIVATION AND PROCESSING

The sustainability of the crop in Kerala is in real threat on account of the surging pressure of replacement with rubber. The cashew processing units in Kerala together constitute a capacity of 8 lakh tonnes per annum but the production is far below the processing capacity and the potential for export. In order to ensure a steady supply of raw cashew nuts domestically, a minimum production level has to be achieved. The cashew farmers are not getting crop insurance, when they face problem of crop damage by devastating pests, weather calamities, etc. At present there is no minimum support price for cashew farmers, which is a major concern in the present scenario of fluctuating prices.

EDUCATION IN CASHEW

Sl. No.	Name of the student	M.Sc./ Ph.D.	Year of completion	Thesis title	Major recommendations/findings in bullet points
1.	Sreeja K.C	M.Sc	1976	Qualitative changes in cashew apple products in storage with special reference to vitamin C	There was a significant difference in vitamin C content of different cashew apple products like clarified juice, squash, wine, jam and candy between the time of preparation and in storage period.
2.	Vilasachandran	M.Sc	1978	Quality evaluation of cashew apple high yielding varieties	Variety K 10-2 ranked first in respect of the mean weight, length, diameter, length/diameter ratio and juice content of apples. Variety M 6/1 recorded the maximum T.S.S. Specific gravity and sugar.
3.	Parameswaran N.K.	M.Sc	1979	Factors affecting yield in cashew (<i>Anacardium occidentale</i> L.)	Percentage of flowered shoots/unit area of tree canopy was found as most important factor contributing to yield. A positive correlation was found between yield and % of bisexual flowers.
4.	Thomas K.M.	M.Sc	1981	Relative susceptibility of cashew types to Infestation by the tea mosquito <i>Helopeltis antonii</i>	Accessions 22, 1112, 1430 and 1097 were least susceptible in vegetative shoots infestation. Acc. 22, 1112, 1352, 1469 and 1097 were significantly less susceptible with respect to

				Signoret (Hemiptera:Miridae)	floral branches infestation.
5.	Remesh B Nair	M.Sc	1981	Determination of the size and shape of plots for trials on cashew	Single tree plots were found to be the most efficient for conducting field experiments; shape of plot did not have consistent effect on variability.
6.	Shylaja M.R.	M.Sc	1984	Standardisation of the technique of stone grafting in cashew and management practices for field establishment	August – September was found most suitable for stone grafting, cleft method found better than splice method using scion sticks defoliated 10 days ahead. Stocks and scions of girth 2.1-2.4 cm gave better success.
7.	Elsy C.R.	M.Sc	1985	Pollination studies In cashew	Flower opening period in male and bisexual flowers was same, starting after 23 hr and up to 15 hr next day. The peak flower opening for male flowers between 7 and 9 hr and bisexual flowers was between 9 -11 hrs.
8.	Rajasekharan P	M.Sc	1987	Study on marketing margins and market structure of cashew nut in Kerala	Various market functionaries involved in cashew nut marketing were the village merchants, petty traders, itinerant traders, semi-wholesalers, wholesalers and processors.
9.	Manoj P.S	M. Sc	1992	Biometrical studies in Cashew (<i>Anacardium occidentale</i> L.) Hybrids	Wide variability existed in the hybrids and parents with highest degree of variation for nut yield.
10.	Joby Bastin	M.Tech	1993	Design fabrication and testing of a cashew nut decorticator	A manually operated cashew nut decorticator with a capacity of 900 nuts/h and with 88 per cent efficiency was designed, developed and evaluated.
11.	Mini Abraham	M.Sc	1994	Foliar Absorption of Nitrogen and Phosphorus by cashew	A sequential leaf washing technique was developed involving four washings each with 50 ml of 2 per cent teepol and was found to be reasonable to quantify the foliar absorption of ^{14}C -urea and ^{32}P .

12.	Angaiah K	M.Sc	1995	Evaluation of Neem Triterpenes as Ovipositional and Feeding Deterrents to the Tea Mosquito Bug, <i>Helopeltis antonii</i> Sign. on cashew	Commercially available neem products showed a high degree of effectiveness in reducing the feeding and oviposition by <i>H. antonii</i> .
13.	Mini K.G.	M.Sc	1996	Time series modelling and forecasting of the yield of cashew <i>Anacardium occidentale</i> L) in Kerala	Univariate ARIMA models offered a good technique for predicting the magnitude of all the variables for the forecast of production of cashew crop in Kerala.
14.	Bindhu N	M.Sc	1996	Die- back in cashew incited by the Tea Mosquito Bug, <i>Helopeltis antonii</i> Signoret as influenced by wound pathogens and plant biochemicals	Predominantly occurring fungus isolated from the necrotic lesions was identified as <i>Colletotrichum gloeosporioides</i> and its role in aggravating the seedling die-back has been established.
15.	Nalini P.V	PhD	1997	Productivity in relation to branching pattern and pruning in cashew (<i>Anacardium occidentale</i>)	Canopy of a seedling was massive and like a hemisphere placed above a solid cylinder. Grafts were found to be much superior to seedlings and layers. Pruning schedule of removal of 25 per cent of the n5 order of branches at 3 yr interval increased yield.
16.	Latha A.	Ph.D	1998	Varietal reaction to nutrient and moisture stress in cashew (<i>Anacardium occidentale</i> L.)	Varieties H-1591, M-26/2, V-5 and M-44/3 are drought tolerant and K-22-1 is drought sensitive. N application @ 1500 g/tree/ year with irrigation @ 80 litre/tree/day (through drip) is essential for obtaining best results.
17.	Rekha S.	M.Sc	1999	Improvement of <i>in vitro</i> somatic embryogenesis in cashew (<i>Anacardium occidentale</i> L.)	Nucellus responded better than embryo mass in initiating somatic embryoids. Maximum somatic embryogenesis from nucellus occurred in culture in dark, on ½ MS, 2,4-D 1.0 mg/l, BA 1.0 mg/l, NAA 1.0 mg/l, sucrose 30.0 g/l.
18.	Pushpalatha	PhD	2000	Morphophysiological	Variability in 18 morphological

	P.B.			al analysis of growth and yield in cashew (<i>Anacardium occidentale</i> L.)	characters among 27 genotypes showed high variability for flush length, number of leaves/ flush, % of bisexual flowers, no.of nuts/ panicle, nut weight and yield. Yield is positively correlated with number of panicles (m-2), bisexual flowers (%), panicle length and number of nuts per panicle and negatively correlated with flush length.
19.	Jagadeesh Kumar T.N.	PhD	2000	Nutritional characteristic in relation to growth and productivity of cashew (<i>Anacardium occidentale</i> L.)	Potting media containing 1:1 soil : FYM supplemented with 200 g N, 100 g P ₂ O ₅ , 200 g K ₂ O/ 100 kg potting media was best for cashew seedlings. Flower and yield characters were significantly influenced up to a level of 750:325:750g NPK tree ⁻¹ /year.
20.	Narayanan Kutty M.C	PhD	2000	Development pattern, storage behaviour and variability in processing characters of cashew apple	Volume of cashew apple showed a marked increase from 35-40 DAFS stage onwards. Nuts attained maximum size and fresh weight at 30 to 40 DAFS stage. Kernel formation commenced from 20 DAFS stage.
21.	Maria Glenda Rose Carvalho	M.Sc	2001	Standardisation of techniques for cashew apple wine production and development of wine based products	Yeast strain MICC 180 was superior for wine production and produced wine of high alcohol content and low acidity.
22.	Vandhana V	M.Sc	2001	Quality evaluation of kernels of different cashew varieties	The highest weight, length, breadth and thickness were observed in H-1600, M-33/3, Priyanka and H 2/15 respectively.
23.	Shibu Sebastian	M.Sc	2001	Economic analysis of production and marketing of cashew nut in Kerala	Significant increase in area by 5.97 per cent per annum in the first period (1952-53-1999-2000) followed by a decline by 1.82 per cent in the second period (1976-77 to 1999-2000).
24.	Divya Raman N	M.Sc	2001	Processing qualities of cashew nut in relation to	Variation in agro ecological factors modifies the processing qualities of cashew nuts. Nuts from southern region were

				agroecological and phenological factors	observed to possess high shelling percentage, kernel size and kernel grade.
25.	Usha K.E	PhD	2001	Integrated nutrient management in cashew in relation to yield and quality	Annual litter fall in ten year old cashew plantation was 5014 kg ha ⁻¹ . Litter contribution varied with the season and variety. Dry months contributed to the major share of annual litter production. Combined inoculation of AMF and <i>Azospirillum</i> was found best among the different combinations tried in the nursery.
26.	Nair Rajiv R.K	M.Sc	2002	Effect of major nutrients on the yield and quality of nuts in graft-raised cashew (<i>Anacardium occidentale</i> Linn)	Yield of cashew nuts and apples were significantly increased in highest level of nitrogen. Application of potassium at the highest level increased the apple yield/tree.
27.	Usha Vani D.	M.Sc	2003	Morphological, biochemical and molecular markers for the genetic analysis of cashew	No. of perfect flowers, no. of nuts, apple wt., nut wt. and kernel wt. provide clear separation of the genotypes. H-1593 was the most divergent genotype.
28.	Sinish M.S.	MSc	2003	Nutrient management in cashew nursery	The-bulk density and particle density were found to be decreased by application of organic manure in the potting mixture and the lowest was found with coirpith compost.
29.	Deepthy K.B.	M.Sc	2003	Evaluation and management of pest complex in cashew grafts	Genotype 11-1600 was observed promising as it is comparatively tolerant to both TMB and TMB- <i>Colletotrichum</i> complex. Varieties Madakkathara-2, H-1610 and Kanaka also recorded lesser TMB damage.
30.	Suman K.T.	Ph.D	2006	Physico-chemical and nutritional attributes of cashew apple and its products	Amrutha had the highest juice yield and juice residue ratio. Kanaka had highest tannin and lowest was in Amrutha and Anakkayam-1.

31.	Remyamol K.K.	M.Sc	2006	Standardisation of blended cashew apple RTS beverages	RTS with 75% cashew apple and 25% lime was acceptable up to one month of storage under ambient condition and up to three months of storage under refrigeration.
32.	Jusna Mariya L	M.Sc	2009	Management of recalcitrancy in <i>in vitro</i> cultures of cashew (<i>Anacardium occidentale</i> L.)	One endophytic bacterium named as KAU-EC1 and two covert bacteria named as KAU-CC1 and KAU-CC2 were isolated from <i>in vitro</i> cultures.
33.	Jeethu M. Gopalan	M.Sc	2012	Export and price behaviour of cashew nut in India	The Compound Growth Rate (CGR) and the trend indices for the post liberalization period (1993-2011) indicated that area under cashew had been steadily increasing but production and productivity showed wide fluctuations.
34.	Purushottam Meena	M.Sc	2014	Molecular characterization and DNA fingerprinting of selected cashew (<i>Anacardium occidentale</i> L.) varieties of KAU	Priyanka, Dhana were found closer with 98 % similarity but a field grown graft of Poornima was the most distinct one from other cashew genotypes. Separate fingerprints were developed for five varieties Priyanka, Dhana, Poornima, Sulabha and Madakkathara-1
35.	Deepak S Poojary	M.Sc	2014	Entomopathogenic nematodes for the management of cashew stem and root borer, <i>Plocaederus ferrugineus</i> L.(Coleoptera; Cerambycidae)	<i>Steinernema carpocapsae</i> showed significant difference from other treatments at 1000 IJs/ ml and it was followed by <i>H. bacteriophora</i> . Under field evaluation, drenching the soil with EPN suspension, placing EPN impregnated sponges in bore holes and placing EPN infected wax moth cadavers in the bore holes in comparison with chemical treatment using chlorpyrifos 0.2%, chlorpyrifos has performed better.
36.	Mir Faizan Anwar	M.Sc	2015	Performance of selected medicinal herbs under rubber and cashew plantations	Plant height and pseudo stem length of turmeric was high in cashew.
37.	Indu V. K.	M.Sc	2016	Recycling of Cashew	By employing the epigeic earthworms <i>Eisenia foetida</i> ,

				(<i>Anacardium occidentale</i> L.) leaf litter and Cashew apple through vermi technology	untreated lingocellulotic solid organic resource, cashew leaf litter and cashew apple could be effectively converted to nutrient rich vermin fertilizer.
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MAIN RESEARCH WORKERS IN CASHEW IN KERALA AGRICULTURAL UNIVERSITY

Dr. Veeraraghavan, Professor	Dr. P.V. Nalini, Professor	Dr. P. A. Valsala, Professor
Dr. V.K. Dhamaodaran, Professor	Dr. Usha, K.E. Professor	Dr. Jayaprakash Naik, Professor
Dr. A. Abdul Salam, Professor	Dr. Ancy Joseph, Professor	Dr. Jose Mathew, Professor
Dr. P. Rajendran, Professor	Dr. C. Mini, Professor	Dr. B. Suma, Professor
Dr. P.S. John, Professor	Dr. A. Sobhana, Professor	Dr. A.Suma,Professor
Dr. Mareen Abraham, Professor	Smt. Meagle Joseph, Associate Professor	M.S. Smitha, Assistant Professor
Dr. Susannama Kurian, Professor	V.G. Jayalekshmi, Professor	
Dr. S. Pathummal Beevi, Professor	Dr. G.K. Mahapatro, Assistant Professor	Dr. Meera Manjusha, Assistant Professor
Dr. P.B. Pushpalatha, Professor	Dr. Gavas Ragesh, Assistant Professor	Sri. Gregory Zachariah, Associate Professor

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STATUS OF CASHEW RESEARCH AND DEVELOPMENT IN MAHARASHTRA

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AICRP-Cashew, Regional Fruit Research Station, Vengurle, Dist, Sindhudurg

INTRODUCTION

The Konkan region of Maharashtra is characterized by the modest temperature (17 °C to 35 °C), high humidity (more than 80%), high annual rainfall (3000 to 3500 mm/year) and well-drained lateritic soils along the 750 Km coastal belt with undulating topography. Such kind of soil and climatic situation is considered as most the favorable for cashew plantation. Cashew needs a climate with at least 4-5 months well defined dry season during the period of October- May to achieve the best results. This might be one of the reasons for better cashew quality and higher production in the Konkan region of Maharashtra under rainfed conditions.

In the 16th century, the introduction of the spices by the Portuguese adventures was first to Goa and to the Malabar Coast in Kerala by the Spaniards and to other centres in India (De Costa, 1578). It was planted particularly along the sea shore and has become naturalized throughout the West Coast (Goa, Sindhudurg and Ratnagiri tracts of Maharashtra, Kerala and Karnataka). It was introduced in India as a crop of soil conservation but now it has gained momentum in economy of the Konkan, state as well as country. Cashew research in Maharashtra dates back to 1950's, when Indian Council of Agricultural Research sanctioned ad-hoc schemes in the Bombay State. Thus, Vengurle (Maharashtra) in 1957 came into being as pioneering cashew centres in the country. The research station started during the early 1950s, as an ad-hoc scheme at Vengurle in Maharashtra, to undertake the programme of collection of locally available elite plants for evaluation and further selection. As a result of germplasm collection, evaluation, first cashew variety through selection under the name Vengurla-1 was released at Vengurle centre (Dr. B. S. Konkan Krishi Vidyapeeth, Dapoli) in the year 1974 and Maharashtra is the first state to release first the cashew variety in India.

Further the ad-hoc-scheme on cashew has been reestablished as Regional Cashew Research Station, at Vengurle in the year 1957. The station was under the control of State Government of Maharashtra and later on it was transferred to Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli Maharashtra in 1972. AICRP on Cashew was sanctioned by the ICAR New Delhi in the year 1970. In the initial stage survey and germplasm collection work was initiated with the main objective of collection of promising high yielding genotypes. Presently cashew research station has an area of about 21.79 ha.

Considering the suitability of cashew in Konkan region, the Maharashtra State Government has encouraged its plantation on maximum area by providing cent per cent subsidy for cultivation. As a result, the area of 8,000 hectare under cashew in the year 1970 in Maharashtra has been increased to 1.86 lakh hectare by the year 2014-15 through the horticulture plantation under Employment Guarantee Scheme sponsored by Government of Maharashtra since the year 1990.

Due to development and adoption of high yielding varieties, production has increased from 0.5 kg to 15 kg/tree. The productivity of cashew is the highest in Maharashtra in the country. This is because plantations have been established with high yielding varieties having the potential yields of 15-30 kg/tree. The maximum cashew plantation of Maharashtra state is in Sindhudurg, Ratnagiri, Palghar, Raigad and Thane districts and still there is good scope for area expansion in these districts to the tune of 1.5 lakh ha. Besides this, there is also great scope for cashew area expansion in other non-traditional areas like Kolhapur (Chandgad, Aajra, Gadhinglaj, Bhudargad, Radhanagari and Gargoti Talukas), Nashik (Igatpuri) and Gadchiroli districts of Maharashtra.

Cashew grows well in marginal land of Sindhudurg and Ratnagiri districts of Maharashtra, where other crops fail to establish. It grows in lateritic as well as in forest loams soils. The growth rate, flowering and productivity are quite high as in such soils. It is also found growing in semi-hard lateritic rock to some extent in Ratnagiri and Sindhudurg districts.

MAHARASHTRA STATE CASHEW SCENARIO

Maharashtra is leading in production and productivity of cashew mainly development due to of high yielding cashew varieties and production technologies developed by the Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri (M.S.). Although Maharashtra only accounts for about 28 per cent of the total area under cashew, yields in this state are relatively higher when compared with other cashew producing states. Estimated cashew productivity in Maharashtra is 1367 kg of raw nuts per hectare, which is almost, double than that of rest of the India.

Before 1970, the area under cashew in Maharashtra was around 8,000 ha, and it increased to 1.86 lakh ha i.e. 28% of total area (10.27 lakh ha) in India. At present, Maharashtra rank first in cashew area (1.86 lakh ha), production (2.48 lakh tones) and productivity (1367kg/ha) in the country and contributing 28% area and 31.49 per cent total cashewnut production in the country. Year-wise area, production and productivity in Maharashtra are given in Table 1. Contribution of Maharashtra in cashewnut production is presented in Fig. 1, while different cashew growing districts of Maharashtra is given in Fig. 2.

Table 1 : Year-wise area, production and productivity in Maharashtra

Sr. No.	Year	Area (ha)	Production (MT)	Productivity (kg/ha)
1	1990-91	23,000	30000	-
2	1991-92	-	29500	-
3	1992-93	-	30050	-
4	1993-94	51022	46086	1246
5	1994-95	58020	37006	1100
6	1995-96	66007	69000	1440
7	1996-97	80000	80000	1570
8	1997-98	104000	60,000	1500
9	1998-99	119000	85,000	1500
10	1999-2000	121000	125000	1470
11	2000-01	121000	98000	1050

12	2001-02	143000	103,000	880
13	2002-03	148000	110000	1000
14	2003-04	148000	120000	1100
15	2004-05	160000	174000	1200
16	2005-06	160000	183000	1300
17	2006-07	164000	197000	1500
18	2007-08	167000	210000	1500
19	2008-09	170000	225000	1500
20	2009-10	175000	198000	1186
21	2010-11	181000	208000	1231
22	2011-12	181000	208000	1500
23	2012-13	148200	110000	1000
24	2013-14	184020	224640	1282
25	2014-15	186020	248001	1367

Source: 1993-94 to 2000-01 DCCD Kochi Kerala (Anon., 2012) and 2001 to 2014-15 NHB database (Anon., 2014)

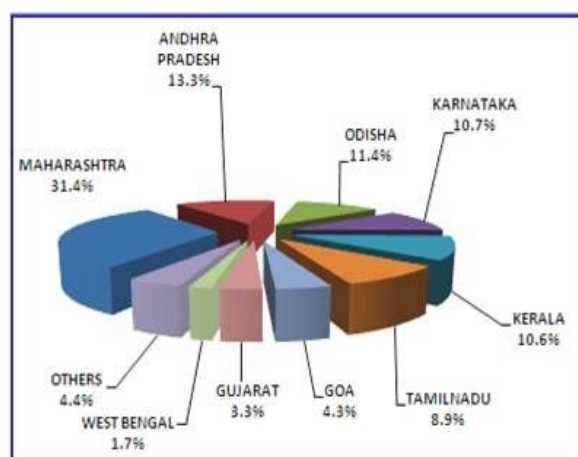


Fig.1: Leading Cashewnut Producing States in India (2014-15)

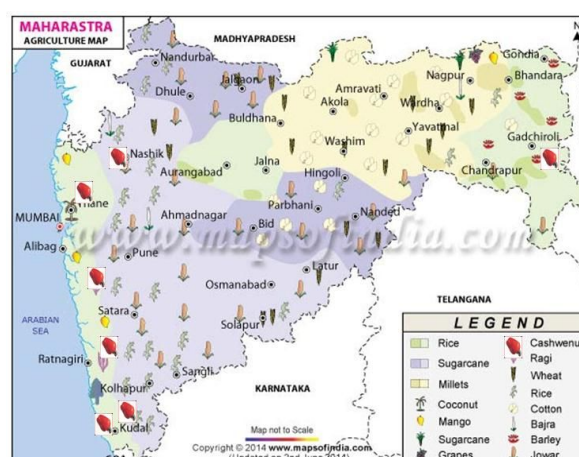


Fig.2: Different Cashew growing districts in Maharashtra

CROP IMPROVEMENT

Germplasm resources

Many research centres which were established subsequently to Vengurle Centre have collected the seeds of germplasm from Vengurle centre. While making the initial collections of germplasm, these centres had confined their survey mainly to the respective states and hence they represent the local germplasm available in the states. Since the inception of All India Coordinated Spices and Cashewnut Improvement Project (AICS and CIP) in 1971, Central Plantation Crops Research Institute (CPCRI) Regional Station, Vittal, also took up the programme of cashew germplasm accession which mainly consisted of the seedling progenies of collections available at Vengurle and a few other states. Subsequent to the establishment of National Research Centre for Cashew (NRCC) at Puttur (Karnataka) in 1986, the germplasm collection through seeds has been discontinued and only the vegetatively propagated material is being collected and conserved in gene bank. A co-ordinated approach was brought in the cashew germplasm collection by organizing joint survey teams consisting

of scientists of NRCC and All India Coordinated Research Project on Cashew (AICRP on Cashew) centres of respective states. In year 2000-2001, a joint survey was undertaken in Maharashtra and 14 types were collected from four different districts viz., Sindhudurg, Ratnagiri, Raigad and Thane. The main criteria adopted for collection of germplasm were the superior economic characters such as high yield, bold nut, cluster bearing, apple qualities, canopy types and dwarfness of the plant or any other unique characters observed during the survey.

Presently total 307 accessions are in the gene bank at Vengurle. Out of these, 170 types have been evaluated and planted in conservation block at the spacing of 4m x 4m and 7m x 7m. Out of 307 cashew germplasm, 161 elite types and 74 bold types have already been registered with NBPGR, New Delhi and these types have also got the IC numbers. AICRP-Cashew Vengurle centre has 74 very bold types collection of which BT1, BT6, BT10, BT22 and BT65 types have been extensively used in cashew hybridization programme at Vengurle centre.

Table 2 : Cashew Germplasm at Vengurle Centre

1)	Old germplasm	:	161
2)	Bold nut germplasm	:	74
3)	Bold nut germplasm from ICAR Complex Goa 1994	:	08
4)	Germplasm Collected during year 2001-2002	:	
	Sindhudurg, Ratnagiri, Raigad, Thane, Kolhapur	:	16
5)	Germplasm collection during the year 2002-2003	:	06
6)	Germplasm collection during the year 2003-2004 under ATMA Ratnagiri, Sindhudurg	:	15
7)	Germplasm collection during the year 2004-2005	:	12
8)	Germplasm collection during the year 2005-2006	:	05
9)	Germplasm identified during the year 2008-2009 & planted during the year 2010-11	:	03
10)	Germplasm collected during the year 2011-2012	:	03
11)	Germplasm identified during the year 2013-2014	:	01
12)	Germplasm identified during the year 2014-2015	:	03
	Total	:	307

The collection of local germplasm has been undertaken since inception of centre in 1957. The first cashew variety Vengurla-1 released in the year 1974 from Ansur early whereas Vengurla-2 released in 1978 from WBDC-VI (West Bengal Deepal Collection-VI). However, cashew hybridization programme initiated at Vengurle centre in 1970 and large number of cashew progenies has been developed and planted at Vengurle for screening cashew varieties viz., 'Vengurla-3', 'Vengurla-4', 'Vengurla-5', 'Vengurla-6', 'Vengurla-7', 'Vengurla-8' and 'Vengurla-9' are recently released through hybridization programme for commercial cultivation. Though with very high yield potential but due to small nut size particularly in cashew varieties Vengurla-2, Vengurla-5 and low shelling percentage in Vengurla-3, these varieties are not presently recommended by university for commercial plantation. However, these varieties are being used in hybridization programme. Presently 'Vengurla-1' 'Vengurla-4', 'Vengurla-6', 'Vengurla-7', 'Vengurla-8' and 'Vengurla-9' (recently released) are recommended for commercial cultivation. Out of which, Vengurla-4 and Vengurla-7 are most

popular and widely adopted by the cashew growers. Among the cashew varieties released, Vengurla-4 has wider adoptability and hence has more demand in almost all the cashew growing states of India. These varieties have achieved the place of pride and privilege in India. The variety Vengurla-8 demanded mostly from farmers of Goa state for making *fenny* because of big size apple (100g) and 86% juice recovery.

Vengurle-9 (H-303) has medium tree with compact canopy, bold size nut, bunch bearing habit, high yield, more shelling percentage and export grade kernel.

SALIENT FEATURE OF VARIETY VENGURLE-9

Salient features

1. Branching pattern – Intensive
2. Season of flowering – Mid late
3. Flowering duration – 111 days
4. Hermaphrodite flower (%) – 21%
5. Apple colour – Reddish yellow
6. Apple weight – 69.71 g
7. T.S.S.– 13.0⁰ Brix
8. Titrable acidity – 0.21(%)
9. Av. juice content – 76 (%)
10. Nut wt. – 8.9 g
11. Shelling– 29.35 per cent
12. Average kernel weight – 2.2 g
13. Omega fatty acid
 - a) Omega 3 fatty acid – 0.1g/100g)
 - b) Omega 6 fatty acid – 19.4 /100g)
 - c) Omega 9 fatty acid – 29.8 /100g)
14. Average yield – 7.24 (kg/tree)
15. Reaction to insect pest – Medium



Similarly, H-662 and H-675 of Vengurle centre has been included in MLT-III because of their high yield potential with bold size nut. The details of cashew varieties released by AICRP-Cashew Vengurle centre is given in Table 3.

Table 3 : Comparative performance of cashew varieties developed at RFRS, Vengurle

Sr. No	Characters	V-1	V-2	V-3	V-4	V-5	V-6	V-7	V-8	V-9
1.	Pedigree	Selection (Ansur-1)	Selection (WBDC-VI)	Vengurla-1 x Vetore-56	Midnapur Red x Vetore-56	Ansur Early x Maisur Kotekar	Vetore-56 x Vengurla-1	Vengurla-3 x VRI-1	Vengurla-4 x VRI-1	Vengurla- 4 x M-10/4
2.	Year of released	1974	1979	1982	1984	1984	1992	1997	2001	Released in 2015
3.	Average yield (kg/tree)	15.74	23.10	16.66	19.08	25.6	17.00	14.94	16.50	7.59
4.	No. of nuts/kg	160	230	115	140	220	125	100	86	112
5.	Average weight of nut (g)	6.25	4.35	9.09	7.69	4.54	7.90	10.00	11.50	8.9
6.	Shelling (%)	31.00	32.00	27.00	31.00	30.00	28.00	30.50	28.00	29.35
7.	Apple Colour	Yellow	Reddish	Yellow	Reddish	Yellow	Yellow	Yellow	Yellowish red	Reddish yellow
8.	Average cashew apple weight (g)	60.00	37.00	78.00	46.00	30.00	70.00	65.00	100.00	72.9
9.	Cashew apple juice (%)	65.00	45.00	77.00	76.00	86.00	75.00	85.00	85.00	76.0
10.	Hermaphrodite flower (%)	8.00	21.00	25.00	26.00	50.00	7.50	26.5	38.5	21.0
11.	Kernel count grade (W. K. per pound lb)	320	400	210	240	400	210	180	180	210
12.	Important features	Early variety with medium size nut	Small size nut, synchronized flowering	Bold size nut but low shelling %	All purpose variety	High yield and Compact canopy	Bold size nut with less spreading habit	Vigorous growth and Bold size nut	Very big size nut and apple	Compact canopy, Cluster bearing habit, bold size nut and high yield

The ICAR Network Programme on Cashew hybridization was conducted at AICRP-Cashew Vengurle centre during the year 2000-2002. The main objective allotted to this centre was nut size improvement. Total 300 different cross combinations were made @ 100 cross combinations per year. As the result of this programme, large number of F_1 cashew progenies were developed and planted at Vengurle and other research stations of university.

Similarly, ICAR Ad-hoc Project on '*Evaluation of F_1 cashew progenies in Konkan region of Maharashtra*' was carried out during 2005-2007. Through this project, more than 2000 F_1 cashew progenies (planted during 1999-2004) were initially evaluated, similarly large number of F_1 cashew progenies developed and planted at Vengurle for further evaluation.

Since 1999, more than 4000 F_1 cashew progenies were developed and planted at AICRP-Cashew Vengurle centre and other research station at 5m x 5m. Generally, for cashew pollination, other centers use butter paper bags. However, at Vengurle centre, complete flowering panicle is inserted in aluminum cage covered with cotton cloth with one end completely closed, while other end open and closed after emasculation and pollination. Simple pollination technique has many advantages. Higher production of hybrid nuts with maximum retention, and no chance for TMB, thrips and other pest infestation. It also helps to protect the pollinated flowering shoot from unseasonal rain and high speed winds. It has also light weight which makes the cage easy to handle.

Total 2756 F_1 cashew progenies planted during 1999 to 2004 were evaluated during 2014. Out of these F_1 cashew progenies, top performing F_1 cashew progenies were screened from respective year of plantation and finally 56 best performing hybrids were selected as promising hybrids. Among the evaluated F_1 , 56 hybrids are high yielding, bold and jumbo nuts weighing ranged about 8 to 15 g and high shelling percentage with export grade kernels. The grafts of these promising hybrids are prepared at this centre during 2016 for their further evaluation under field conditions at normal 7m x 7m spacing along with local check in replicated trial at Vengurle. While, poor performing 1623 hybrid progenies were removed.

TECHNOLOGIES DEVELOPED/ ACHIEVEMENT AT AICRP-CASHEW, RFRS, VENGURLE

CROP IMPROVEMENT

1. First centre in the country to develop & released the first cashew variety 'Vengurla-1' from local collection Ansur-1 during the year 1974. The special features of this variety are; Early type, medium size nut (6.0 g), high shelling percentage and high yield. While, cashew variety Vengurla-2 released in 1984. The important feature of this variety are, small nut size (4.5 g) with high yield potential (20-25 kg/tree), and synchronized flowering habit (short harvesting period i.e. within 45 days).

The long term yield performance of Vengurla-1 is being tested at Vengurle and it recorded average yield of 10.87 kg (1.98 t/ha). This shows that this variety has potential to perform well for long term.

2. Total nine cashew varieties released (Vengurla-1 to Vengurla-9) for commercial cultivation, out of which Vengurla-1 and Vengurla-2 by selection method and Vengurla-3 to Vengurla-9 (six varieties) by hybridization method. The detail information on released cashew varieties is presented in Table 3.
3. Multi-Locational Trial-II was initiated in 1998 at Vengurle centre and among the 12 types/hybrids, the best performing hybrid H-303 (developed by Vengurle centre) at this centre as well as other AICRP-cashew centers of the country, recently released as Vengurla-9 i.e. H-303 (V-4 x M-10-4) during 2015. This is having characters like compact canopy, intensive branching, bunch bearing habit, bold size nut and high yield.
4. Since 1999, more than 4022 F₁ cashew progenies have been developed and planted at Cashew farm, RFRS, Vengurle and other research station of university for further evaluation. Out of which, 2796 cashew progenies planted during 1999 to 2003 were evaluated during 2014-15 and top best performing 58 hybrids were selected as promising hybrids and grafts of these promising hybrid are prepared and will be planted in replicated trial for further evaluation. While the evaluation of other F₁ cashew progenies are in progress.
5. Total 310 cashew local germplasm are collected by this centre. Out of which, 183 elite types and 74 bold types have been evaluated. Similarly, 161 types have been registered with NBPGR, New Delhi and these types have got the IC numbers. The evaluation of rest of cashew types is in progress. Evaluation of different types/hybrids under MLT-III is in progress. The catalogue of germplasm planted during 1998 and 2001 is prepared.

CROP MANAGEMENT

Soft wood grafting, coppice grafting and flush grafting techniques have been standardized and recommended for cashew propagation.

The development in cashew production in Maharashtra was mainly due to

1. Evolving and release of high yielding cashew varieties for different agro-climate.
2. Development of easy, simple, cheap and commercially acceptable soft wood grafting technique.
 - a. Demonstration of massive soft wood grafts production by RFRS, Vengurla
 - b. Extensive short term training to village workers in grafting.
3. Massive demand for grafts for EGS linked Horticultural Development Programme.
4. Active support by Central Government for cashew development.

Large number of cashew nurseries are established in the Konkan region of Maharashtra, which help substantially to the unemployed rural poor for generation of income. Due to

effective dissemination of this technology; cashew grafts from Konkan region are supplied in all cashew growing states in the country. Large number of genuine quality grafts of cashew varieties Vengurla-4 and Vengurla-7 produced at AICRP-Cashew, RFRS, Vengurle centre and supplied to the cashew growers of Konkan and adjoining region of Maharashtra as well as other state like Goa, Karnataka, Orissa, Andhra Pradesh, Gujarat, etc. Total 2,58,7013 numbers of cashew grafts were supplied through Vengurle centre since 1992-2015 to cashew growers.

Soil and Water conservation techniques: Use of staggered trenches is recommended for cashew plantation in high rainfall and more sloppy land of Southern Konkan for soil and water conservation. There should be 230 trenches per hectare. Terrace with crescent bund and opening of catch-pits treatment is the best soil and water conservation technique for cashew garden grown in flat to medium slopes and serves the purpose in undulating soils. It has been recommended to do plastic (500 gauge) lining at the bottom and sides of a trench of 5 m long, 30 cm wide 25 cm deep for cashew nursery under Southern Konkan region.

The spacing of 7m x 7m and 8m x 8m is recommended for normal planting whereas, 5 m x 5 m spacing is recommended for high density planting (Removal of alternate rows at 10th year). Wider spacing 7m x 7m and 8m x 8m is mostly adopted by cashew growers and they are getting very good yield at this recommended spacing. However, the high density planting of 5m x 5m is adopted by farmers to some extent and it is found that HDP adopted farmers are mentally not ready to remove the alternate row (Horizontal & vertical) after 10th year. Recommendation of fertilizer dose: for proper growth and to improve the yield 4 pots of FYM, 1000 g N, 250 g P₂O₅ and 250 g K₂O for the 4-year-old plants is recommended. In the first year 1/4th dose, 2nd year 1/2 dose, 3rd year 3/4th doses and 4th year full dose is recommended.

The recommended fertilizer schedule for different age group is as given below:

Age	FYM (pot/tree)	Nutrients (g/tree/year)			Fertilizer (g/tree/year)		
		N	P ₂ O ₅	K ₂ O	Urea	SSP	MOP
1 st year	1	250	62.5	62.5	500	375	100
2 nd year	2	500	125	125	1000	750	200
3 rd year	3	750	187.5	187.5	1500	1125	300
4 th year and onwards	4	1000	250	250	2000	1500	400

During 2014-15, this station has implemented IVLP programme on 50ha area at farmer field in Taluk Dodamarg of Sindhudurg district and through this programme, necessary inputs such as recommended dose of fertilizers and insecticides were supplied to Cashew growers. Selected farmers have the high yielding varieties like Vengurla-4 and Vengurla-7. The total yield of each cashew grower plot recorded and they obtained average yield of about 2.9

t/ha. Further, canopy management and rejuvenation of senile cashew plantation have been standardized at the centre.

Intercropping of cucurbitaceous vegetables viz., bitter melon, bitter melon and ridge melon in the initial growth stage of orchard during kharif season is recommended. Tuber crops like lesser yam, greater yam, elephant foot yam, aerial yam are also good as intercrops which increase total returns from the older cashew plantations during rainy season.

CROP PROTECTION

Three sprays of insecticides are recommended for control of tea mosquito bug. ant protection schedule is as follow

- i. First spray at flushing – Monochrotophos (0.05%)
- ii. Second spray at flowering – Profenophos (0.05%)
- iii. Third spray at fruit set – Lambda cyhalothrin (0.003%)

CASHEW STEM AND ROOT BORER

For the control of cashew and root borer sanitation and regular supervision of the orchard, maintaining cleanliness at the collar region of the tree is essential. Swabbing tree trunk up to 1m height with Carbaryl (0.2%) or painting of the tree trunk up to 1m ht. with Coal tar + Kerosene (1:4) as preventive measures. Removal of grubs from infested trees. Swabbing of affected plant part and tree trunk up to height of 1mt. from ground level with 0.2% Carbaryl (50% WP) is recommended. The swabbing and drenching of Chlorpyrifos 20 EC @ 10 ml/lit (5 lit/tree suspension) is recommended as curative treatment for the management of Cashew Stem and Root Borer (CSRB) after following phytosanitary measures i.e. removal of CSRB grubs with the help of 15 mm chisels from the infested tree during early stage of infestation.

Pouring DDVP 76 EC (10ml + 50 ml) kerosene solution in to the entry hole of larva and plugging the hole with mud or pour Chlorpyrifos 20 EC (10 ml + 50) ml kerosene in to the entry hole of larva and plugging the hole with mud is also advocated.

OTHER TECHNOLOGIES

The productivity of cashew gardens with lower soil pH levels (4.5-5.5) is very poor due to inadequate uptake of required micro-macro nutrients. In such gardens, trees of high yielding varieties at age of 10 years are severely affected. It is recommended to undertake three sprays of 0.25% (Urea, Single super phosphate, sulphate of potash each) + 0.01% (Sodium molybdate). First spray be given one month before flowering, second at flowering and third at nuts setting time along with recommended dose of fertilizer in lateritic soil of Konkan to obtain maximum yield and to control yellow leaf spot.

Low productivity in cashewnut is very closely associated with nutrient management. The integrated nutrient management of cashew has been recommended. The foliar application of *Amrashakti* (Multi Nutrient Spray) is advised for obtaining higher yield in cashewnut. For increasing the yield, spraying of 2 per cent urea is recommended along with insecticide solution at the time of emergence of vegetative flush (before flowering), flowering and fruit set.

Foliar spray as well as drenching 8 days cattle urine at the concentration of 25% (i.e. 5 and 10 lit. solution through foliar spray and drenching respectively for every grown up tree). To increase the fruit set in cashew nut the spray of low cost dry fish extract @ 500g/10 lit of water first at flowering and second 15 days after first spray is recommended. For increasing the yield of cashew nut, two sprays of 10 ppm Ethrel are recommended, first at flushing and second at flowering stage. For fully grown cashew tree, application 1.0 kg N in 13 equal splits at weekly interval through 50 lit of water through diffuser. Similarly as per recommendation, 4 basket of FYM, 250g P₂O₅ and 250g K₂O per tree should be applied during rainy season that increased the nut yield in cashew.

The available water during monsoon season can be efficiently harvested and utilized for higher yields using proper soil and water conservation techniques. Use of staggered trenches of field length 2m long, 4.5 cm top width, 30 cm bottom width and 50 cm depth are recommended for in situ moisture and soil conservation measures in between the two plants.

POST HARVEST PROCESSING

Two Indian business families Dajisaheb Torney and Mahadev Zantye family of Vengurle known for important contribution and pioneering work in the development of cashew processing industry and promotion the processed cashew kernels in the foreign market. They sent their first consignment of cashew kernel to New York in 1924 (Joshi, 1982).

At present there are 419 cashew processing units in Maharashtra with total processing capacity of 1.08 lakh tones. However, actually processing is about 68,845 MT of raw nuts (Shingate 2014). Area, production and processing of cashewnut in Maharashtra during 2014 as reported by Shingate (2014) is presented in Table 7.

Table 7: Area, production and processing of cashewnut in Maharashtra (2014)

Sr. No.	District	Area (ha)	Production (MT)	Total processing units	Capacity of Processing Units (MT)	Processing at Present (MT)
1	Ratnagiri	91350	67179	141	40000	24000
2	Sindhudurg	56225	66003	111	36000	22700
3	Raigad	21351	20733	11	3000	1500
4	Kolhapur	19864	45728	119	22450	17395
5	Others	6972	19721	37	6460	3250
Total		195762	225000	419	108110	68845

Source: Kranti, Shingate (2014).

Machinery/Equipments for cashew apple nut processing



“Vipul” Cashew apple Juice Extractor

Useful to extract cashew apple juice from ripe cashew apples for preparation of ready to serve, sharbats, nectar etc.



Cashewnut Desheller

Manually operated useful for deshelling of steam roasted cashew nuts, arrangement for adjusting the distance between two cutting jaws.



Green Cashewnut Sheller

Suitable for shelling green cashewnut

Recovery is good if cashewnuts are shelled one day after harvest

Shelling capacity 120-140 nuts/hr (2 to 2.25 kg)

Shelling Efficiency 98%, full kernel recovery 95%



CAET” Cashew Cutter

Useful to cut dry cashew nuts

VALUE ADDED PRODUCTS

The cashew apple is almost wasted and only a trace amount is used for processing in Maharashtra. Cashew apple is highly nutritious and comparable with many other tropical fruits. Various technologies have been developed by Dr. B.S. Konkan Krishi Vidyapeeth, Dapoli for the economic utilization of fresh cashew apple by processing it in to various value added products such as cashew nectar (RTS), squash, syrup, jam and vine. While fallen fermented/ waste apple can be efficiently used to convert it into compost, vermi-compost and animal feed etc. Processing of cashew apple is an economically viable enterprise in cashew growing tracts. Women Self Help Groups can very well take up this enterprise, thereby contributing to the cause of women empowerment. If legal permission is available

for production of fermented products like liquor and wine, it can substantially enhance the income from cashew apple processing many folds.

IMPACT OF CASHEW APPLE AND NUT PROCESSING TRAINING

The list of processors who took training on cashew nut and apple processing at RFRS, Vengurle and they have successfully started their own business are as follows.

Sr. No.	Name	Address	Annual capacity of processing
1.	Sau. Shivani Shivram Aarolkar	At & post Matt, Tal. Vengurle, Dist. Sindhudurg	Cashew and Mango processing; 50-60 lakhs turn over.
2.	Shri. Prabhakar Mahadev Nivjekar	At & post Vadkhol, Tal. Vengurle, Dist. Sindhudurg	Prepares 15-20 tones cashew processed products annually
3.	Shri. Pandurang Krushna Morajkar	At & post Bhedshi, Tal. Dodamarg, Dist. Sindhudurg	Prepares 10-12 tones of cashew and mango processed products annually
4.	Shri. Jayant Shivaji Nalawade	At & post Belwadi, Tal. Deogad, Dist. Sindhudurg	Prepares 5-6 tones of cashew and mango processed products annually
5.	Sau. Vrushali Bhalchandra Tamankar	At & post Nadwade, Tal. Vaibhavwadi, Dist. Sindhudurg	Prepare 25 tones of cashew processed products annually
6.	Shri. Arjun Gawade	At & post Vajrat, Tal. Vangurla, Dist. Sindhudurg	Prepares 5-8 tones of cashew processed products annually

TRADITIONAL KNOWLEDGE ASSOCIATED WITH CASHEW CULTIVATION AND USE

In Ratnagiri district, cashew kernels coated with mud and put in pit. Cashew apple liquor is used for ailments such as worm, sickness, cold, body ache, fever or flue, tooth ache, fresh wounds and cuts, cramps due to chilly weather, muscular pain, irregular movement of bowel, low blood pressure, loss of sleep for aged people, diarrhea, cholera and fresh juice keep eye sight in good condition. The kernel oil can be used in the treatment of leprosy, warts, worms; ulcer, etc.

Cashew Nut Shell Liquid (CNSL) is traditionally used for coating of boats and fishing nets other than the industrial use i.e. acid-resistant paints, foundry resins, varnishes, enamels and black lacquers for decorating vases and as insecticide and fungicide. CNSL has been used in treating leprosy, elephantiasis, psoriasis, ringworm, warts and corns.

ROLE OF DEVELOPMENTAL AGENCIES AND OTHER LINE DEPARTMENTS

Cashew Growers and Scientists Forum Meetings are organized regularly either on farmer's field or at the research station itself. The cashew scientists, officers from state department of agriculture as well as extension officers are the participants. Through these meetings immediate solution to problems of the farmer is provided. Similarly various DCCD sponsored

training programme on cashew production and processing technology viz., State level cashew workshop, District level cashew workshop, Three days training on cashew, Cashew apple utilization training for unemployed woman's, Cashew field day are being organized every year by Vengurle centre since last two decades. Cashew nut processing training (3 days) programme sponsored by state agriculture department is also regularly organized at this centre. This has enhanced the cashew area and production of the state as well as farmer know how of the technologies and further adoption.

FUTURE PROSPECTS OF CASHEW IN MAHARASHTRA

Major constraints in cashew production in Maharashtra which limits the productivity of cashew per unit area and processing of nuts are as follows.

- Large area under cashew in the Maharashtra is covered by high yielding varieties however; growers are not applying any inputs to cashew hence not getting the expected yield levels.
- Cashew is a neglected plantation crop among the farmers.
- The land which is not suitable for other fruit/plantation crops only is available to cashew crop. Hence, the land is usually eroded and degraded with poor soil fertility.
- Farmers are not fully aware of the latest cashew production technologies due to inadequate transfer of technology.
- Even if farmers are aware of the latest cashew production technologies, non adoption of recommended package of practices to the extent required.
- Absence of compact and dwarf high yielding varieties, because of which high density planting cannot be adopted to realize the full potential.
- Maharashtra produces 50-60 % of raw nuts required by processing industries and the remaining quantity is imported from African and other countries. In future raw nut availability from importing countries may gradually decline or may all together stop if those countries start the processing. So, there is an urgent need to enhance cashew nuts production of Maharashtra. Maharashtra has developed large number of cashew production technologies but there is a need of concerted effort for transferring these technologies to farmers* field. There is great scope to expand area under cashew in both traditional and non-traditional areas of Maharashtra.

FUTURE STRATEGIES

Area expansion and transfer of technologies are important in increasing productivity and production of raw cashew nut in the Maharashtra. The following possible solutions and strategies to overcome cashew production constraints are:

1. The cashew scenario of Maharashtra completely changed after 1990 mainly due to grafts of high yielding varieties supplied to the cashew growers through Employment Guarantee Scheme (EGS) Programme on large scale. At present the EGS programme is not working in Konkan region. Therefore, for expansion of area and production of cashew in Konkan region in future, there is urgent need to carry on the EGS programme through the funding from DCCD/Central Government.
2. Massive replanting programme to replace senile and unthrifty orchards.
3. Increasing productivity by adopting improved cashew production technologies.
4. Enhancing the production of raw cashew nuts to reduce the imports by expansion of cashew area both in traditional and non-traditional areas.
5. Development of cashew based integrated farming systems.
6. Organization of intensive thematic campaign and farmers' training programmes on cashew production technology.
7. Participation of cashew industry in promotional efforts.
8. Development of better packaging and marketing strategies for domestic and international market. Promotion of SHG (Self Help Group) for marketing of cashew.
9. Provision of minimum support price for cashew.
10. Post harvest management including value added products and effective utilization of cashew apple.
11. Popularization on farm processing technology especially for small and medium size land holders for higher income.
12. Promotion of organic cashew cultivation with precision farming development concept. Organic certification and marketing through support prices
13. Development of varieties having dwarf and compact canopy, high yielding, pests and disease resistance, bold nut size, high shelling percentage with export kernel grade.
14. Identification of promising accessions which are suitable for different locations viz., coastal areas, high and low rainfall zone.
15. Development of technology for canopy management for high-density plantation.
16. Establishment of co-operative marketing system.
17. Identification of suitable rootstock for canopy management.

18. Development of variety having longer shelf life of cashew apple.
19. Utilization of cashew apple in cattle and poultry feed.
20. Integrated pest management programme and development of low cost, farmers friendly package for controlling Cashew Stem and Root Borer as well as Tea Mosquito Bug and Thrips.
21. Development of suitable protocol for prevention of CSRB incidence in cashew gardens.

There is great demand for cashew kernel in the domestic market as well as in foreign market. In Maharashtra, out of total 2200 processing units, 700 small scale cashew processing units are operating under cottage industry. To achieve the target, the technologies developed at Research stations need to be extended to the farmers' field. Under National Horticulture Mission, there is target to extend 50,000 ha cashew area with clonal materials with suitable horticultural packages. Within 5 year, 2.5 lakh ha clonal cashew area will be available in the country. The concentrated and coordinated efforts of developmental agencies and researchers will revolutionize the cashew industry in the state.

IMPACT OF CASHEW DEVELOPMENT IN KONKAN REGION

The systematic efforts have lead to establishment cashewnut on 3,00,000 ha in Konkan region. From the old and newly established plantation, the yield of 4.66 lakh tones can be expected in 2020, which will further increase to 5.46-lakh t in 2025. It will lead to generation of Rs. 2,097 Crores in 2020, which will increase to Rs. 2.457 crores in 2025. Importantly it will be able to employ 2.73 lakh personnels.

Apart from cashewnut, around 20 lakh MT of cashew apple will be available in 2020 for processing. Along with the others fruits like mango, kokum, jamun and karonda, they will be used for processing. The cashew apple will also contribute to generate the income.

EDUCATION IN CASHEWNUT RFRS, VENGURLE

Name of the student	M.Sc./ Ph.D.	Year of Completion	Thesis title	Major recommendation/ findings
R. C. Gajbhiye	Ph.D.	2014	Foliar application of nutrient with reference to growth yield and quality of cashew (<i>Anacardium occidentale</i> L.) cv. Vengurla-4 under South Gujarat conditions.	<ul style="list-style-type: none"> Production of laterals (m²) and panicle (m²) were recorded significantly the maximum when plant sprayed with urea 2% and 19:19:19 2% during both the years and in pooled analysis. Minimum duration of flowering in cashew cv. V-4 has been recorded in urea 2% during both the years of study and it resulted in early harvest of the crop. The attributes like, number of male flowers, perfect flowers and total number of flowers per panicle were noticed significantly maximum under the treatments urea (2%) and 19:19:19 (2%). While, sex ratio was found significantly higher under the treatments urea (2%), 19:19:19 (1 & 2%), 13:0:45 (1 & 2 %) in cashew during both the years of experimentation. Higher value of fruits per panicle was noted in urea (2%) and 19:19:19 (2%) during both the years in cashew. Similar trend was also observed in fruit set (%), fruits harvested per panicle, fruit retention (%) and number of nuts/m² during both the years of study of cashew cv. V-4. Average nut weights (g), apple weight (g), apple volume (ml) were significantly maximum in urea @ 2% (T₉) and 19:19:19 @ 2% (T₂) during both the years and pooled study. Nut yield (kg/plant and t/ha), shelling (%) and kernel grade (kernel count/lb) of cashew cv. V-4 were significantly highest in urea @ 2% and 19:19:19 @ 2% during both the year and pooled study. Kernel quality in terms of protein, carbohydrate and fat (Ether ext.) content of cashew Vengurla-4 were also significantly affected by foliar application of different water soluble nutrients during both the years and pooled study. Significantly, a higher value of kernel protein content (%) was recorded with urea (2%) and 19:19:19 (2%). Whereas, kernel carbohydrate content (%) was significantly higher with 19:19:19 (2%) followed by urea (2%). On other hand, kernel fat content (%) was significantly maximum in 19:19:19 (1%), followed by 00:00:50 1% (T₇), 13:0:45 2% (T₅) and 0:52:34 2% (T₄) treatments. The highest BCR (1:3.45) was obtained with treatment T₉ having net returns of 92945. However, the cashew growers who are intended to spray water soluble 19:19:19 NPK fertilizer, they can get benefit cost ratio of 1:2.48 with all other necessary management practice, under South Gujarat agro-climatic conditions.

MAIN RESEARCH WORKERS IN CASHEW AT RFRS, VENGURLE

Name and designation	Organization	Present status Working/ retired	Major areas of research
Dr. D. P. Sawake Former Horticulturist Vengurle	Dr. B. S. K.K.V., Dapoli	Retired and no more	Development of Cashew variety V-3, V-4, V-6 and V-7. Softwood grafting technique, Nutrient management, spacing, rejuvenation techniques, soil & water conservation techniques.
Dr. R. T. Gunjate, Former, ADR, RFRS, Vengurle	Dr. B. S. K.K.V., Dapoli	Presently working as Director, Reliance Ago- limited, Jamnagar, Gujarat	Mass multiplication of cashew graft at Vengurle during 1990-1998 and trained the village youth for mass multiplication of cashew graft and further area expansion as well and responsible for establishment of large number of cashew nurseries in Konkan played important role in development of cashew varieties, Vengurla-6 and 7 & 8.
S. B. Deshpande, Former Jr. Cashew Breeder, AICRP- Cashew, Vengurle	Dr. B. S. K.K.V., Dapoli	Retired	Development of cashew variety, Vengurla-6, 7 and 8 and large scale production of F ₁ cashew progenies. Produced and supplied large number of Cashew grafts.
Dr. P. M. Haldankar, Former Horticulturist (AICRP- Cashew), Vengurle	Dr. B. S. K.K.V., Dapoli	Presently Working as Associate Dean, College of Hort., Mulde, Tal. Kudal	Intercropping of cucurbitaceous crops during initial years in kharif, growth regulators and pollination attractant for yield enhancement. Release of cashew variety Vengurla-8. Demonstrated hand pollination to cashew growers for higher fruit set and yield in cashew.
Dr. R. C. Gajbhiye Horticulturist (AICRP-Cashew), Vengurle	Dr. B. S. K.K.V., Dapoli	Working	Pollination technique in cashew. Use of Pollinator attractants and growth regulator for yield enhancement. Large scale production, plantation and evaluation of F ₁ cashew progenies at Vengurle and other stations and handled ICAR Ad-hoc project <i>Evaluation of F₁ cashew progenies in Konkan region of Maharashtra</i> . Produced and supplied large number of Cashew grafts of cashew cv.V-4, V-7 to cashew growers of Maharashtra, Goa, Karnataka and other states. Development and Release of cashew variety Vengurla-9.
Shri. V. N. Jalgaonkar, Former Jr. Entomologist, AICRP-Cashew, Vengurle	Dr. B. S. K.K.V., Dapoli	Working as Entomologist, AICRP- Rice, ARS, Karjat	Refinement in earlier recommendations on chemical management for TMB and Thrips in cashew

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STATUS OF CASHEW RESEARCH AND DEVELOPMENT IN NEH REGION

M.G. Nayak and A.S. Singh

Director (Acting), ICAR-DCR, Puttur; SMS (Horticulture) &Co-PI AICRP cashew
KVK (ICAR), Tura

INTRODUCTION

The cashew was earlier remained localized to coastal regions and later it slowly spread to plains and of late to hilly regions of several states for soil conservation purposes. It is believed that the cashew gained entry to NEH region particularly Meghalaya, part of Assam, Mizoram, Tripura in fifties of last century onwards specially to prevent soil erosion in lands utilized for zoom cultivation. Cashew nut was introduced at Garo Hills in 1960-61 by the Soil conservation Department of Assam. The main reason for introduction of Cashewnut plantation is to cover the abandoned land under shifting cultivation. After Meghalaya was declared as a state, the Garo Hills was divided into three districts. All these three districts located in the southern part have the potential for cashew cultivation. At present the Garo hills are further divided from three to five districts. Carved from the erstwhile State of Assam, Meghalaya became a full-fledged State on 21st January 1972. Meghalaya is one of the state among the Eight sisters in the North East of India, covering an area of 22489 sq.km. and has highest area and the productivity was higher than the National average of 750kg/ha under cashew among NEH States (Table 1).

Cashew production in Garo Hills Meghalaya

Year	Area (ha)	Production (MT)	Productivity (Kg/ha)
1997-98	6238	6313	1013
1998-99	6248	6335	1014
1999-00	6401	6419	1003
2000-01	6320	6294	996
2001-02	6347	6418	1011
2002-03	6649	6730	1012
2003-04	6708	6787	1012
2004-05	6767	8846	1308
2005-06	6787	11207	1652
2006-07	6823	11300	1656
2007-08	7016	11691	1666
2008-09	7599	13027	1714
2009-10	8358	14352	1717

Source: Area, production and yield of principal crops in Meghalaya, Directorate of Economics and Statistics, Government of Meghalaya and Directorate of Agriculture, Government of Meghalaya, Shillong

STATUS OF CASHEW IN NEH REGION

In the NEH region, the cultivation of the crop is mainly concentrated in South and West Garho hill districts of Meghalaya, hilly tracts of adjoining Dubri and Golpara districts of Assam and Southern part of Tripura state. In other parts such as Jiribom and Moreh regions of Manipur state, a few pockets in Kokrajar and Kamrup districts of Assam, Vairangte and Kolasib areas of Mizoram, Itanagar in Arunachal Pradesh, Dimapur region of Nagaland a few small orchards and stray trees were seen or small cashew gardens were raised to a limited extent. The total planted area in NEH region as a whole gradually increased over years with a meager improvement in productivity (Fig.1).

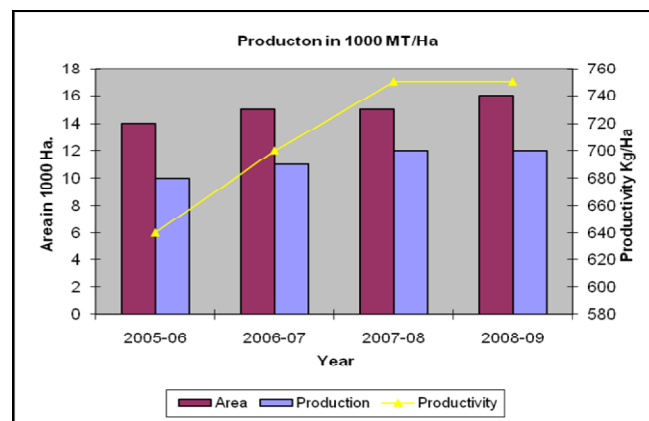


Fig.1: Area, Production and Productivity of Cashew in NEH States

Major portion of available cashew plantations in the region were raised from seeds of underscript origin. They vary in their plant behavior, yield performance and quality of nuts (both physical and nutritional constituents) and the produce comes from such plantations are of mixed nature. Majority of cashew plantations are of seedling origin since the plants were directly raised in main field by dibbling seeds. Segregation of cashew types and seedling origin of plantations and poor management are some of the reasons for the erratic yield performance.

In the entire region it is observed that proper Plantation management practices are not practiced except for a round of weeding during the nut picking period. Regular spacing was not adopted due to which the trees had grown wild and canopies have gone unmanageable. Planting were raised at very closer spacing of 2 M x 2 M, 5 M x 5 M or at the maximum of 6 M x 6 M or at times erratic in nature. Closer planting of plants resulted in total drying of lower branches and twigs and thus only top of the canopy gets exposed to sun. Pruning and training practices were not at all followed and also other practices such as manuring, canopy

management, plant protection which lead to the creation of cashew forests in all the cashew growing belts of the region (Fig. 2). Majority of plants remained non-flowered till January – February of the year irrespective of types and low temperature. Peak harvest coincided with pre-monsoon showers in April – May and harvest continues till June. The major cashew pest reported in other cashew growing regions are not found damaging the crop seriously. A few locations in Assam particularly in and around Guwahati area, the symptoms of TMB damage were noticed. However, the drying of flower panicles noticed in many locations.

Picking of nuts starts from March and goes upto end of June or till the beginning of July. About 20-30% of the crop seems to be caught in early rains every year. The cashew nut which comes from later part of harvest coincides with the beginning of rainy season (May – June) which gets deteriorated in quality and physical appearance (Fig.3).



Fig.4. Trunk pruning at farmers plot in Garo hills



Fig.5. Limb pruned trees in farmers plot at Garo Hills.

GERMPLASM RESOURCES

Plantation of cashew were raised only using seedlings and thus variations in plant characters seen from plant to plant. The germplasm collection and survey efforts were initiated by ICAR-DCR, Puttur during 2003-04 and later by KVK, Tura under the AICRP Cashew during 2010 onwards. The state department of Agriculture & Horticulture, CPCRI(RS), Kahikuchi and Horticultural Research Station, Kahikuchi of Assam Agricultural University, Jorhat were also involved in the efforts.

Random cashew germplasm survey by DCR, Puttur in all these localities lead to identification of few types having uniqueness viz., bold nut, high yield, bunch bearing and early flowering etc. These material need to be compared with the recommended cashew varieties available in the country for selecting suitable type for cultivation in the region (Table 1).

Table 1: Salient features of promising germplasm collections from NEH Region

Collection No.	Accession No.	Farmers Name and Address	Branching Pattern	Flowering Season	Nut Size (g)	Age of the Tree (Years)	Expected Yield (Kg)	Any Special Character
Tehldala-1	NRC-486	Mr. Sazan Patwari, Tehldala, Mankachar Sub Division, Dobri District, Assam	Intensive	Early Season	Medium	8 – 10	6 – 7	Early Flowering type
Tikindhargiri-2	NRC-485	Minizing Nokma, Tikindhargiri, Selsella block, West Garho Hills, Meghalaya State	Intensive	Mid Season	Medium to bold	7	9	Boldnut, Mid season flowering type
Jlribom-1	NRC-513	Cashew Development Officer, (CDO), Jiribom Horticulture Farm, Manipur State	Intensive	Mid Season	Medium	30 -40	30	Mid season flowering Medium nut size type
Nirjali-1	NRC-510	Director, North East Regional Institute of Technology, Nirjuli, Itanagar, Arunachal Pradesh	Extensive	Early to Late	Medium	15 – 20	25	Bearing twice in a year (Early and Late)
Tura-1	NRC-484	Programme Co-ordinator, KVK, (ICAR), TURA, West Garhoo Hills, Meghalaya	Intensive	Early	Medium	12	7 – 8	Early flowering type
Nagichera-1	NRC-491	Deputy Director of Hort., Nagichera Hort Farm, Agarthala, Tripura State	Intensive	Early	Medium to Bold	23	12 – 15	Early flowering type
Nagichera-4	NRC-492	Deputy Director of Hort., Nagichera Hort	Intensive	Early to Late	Medium	23	15 - 18	Early flowering type

		Farm, Agarthala, Tripura State						
Chirangpara-1	NRC-525	Stray plant, in the premises of Water Supply Board of Meghalaya	Intensive	Very Early (Sept. – Oct.)	Medium	6	--	Very Early (Sept. – Oct.) flowering type

CROP MANAGEMENT

During the demonstration of cashew plantations by the soil conservation department of Assam at farmers field, they maintained the proper spacing of 7 x 7m and maintained the plants with the available farm manure and chemical fertilizers. Now no more demonstrations are taken up by the soil & conservation department. Farmers of Garo hills started plantation of cashew following their own spacing with average of 2 x 2 m spacing sowing directly the seeds. They neither put any fertilizer nor follow any kind of pruning. In few decades KVK, Tura made an effort of on-farm testing on pruning technology and limb and trunk pruning. Awareness was created in few farmers' fields. Farmers accepted limb pruning technology in Garo hills because of faster fruiting in limb pruned trees compared to trunk pruning.

PEST & DISEASE OCCURRENCE

As per survey team of DCR scientists, it was found that incidence of mosquito and symptom of cashew stem and root borer in few plants were observed. However, no pesticides were recommended or used by the farmers for controlling these pests.

POST HARVEST PROCESSING

Officially, Meghalaya is having 3 post harvest processing units and 10 nos. of low cost cashew processing unit of steaming systems just recently introduced. The neighbouring state of Assam is also having a few cashew processing units and procure the raw materials from Meghalaya.

PROCESSING FACILITY

In the whole of NEH region the processing of cashew nut is mainly concentrated in Mankachar area (Dobri district of Assam). Recently, a few small scale processing units were also established in Tura of Meghalaya and in also in Tripura state. Homestead processing units were also procured and established by the Department of Horticulture in a few of NEH States such as Manipur, Meghalaya under NHM or Technology Mission Programme to encourage processing in the region.

The existing traditional processing factories are in and around Mankachar and were of drum roasting type and the shelling using mallets and the whole process was unhygienic. The whole process requires modernization to provide the best product of cashew. The cashewnut shell liquid (CNSL) a byproduct of processing out of cashew shell is also lost in the traditional drum roasting system. The encouragement on-farm processing or co-operative processing with small processing units (modern types) can improve the processing capacity in the region with the benefits directly to farmers.

TRADITIONAL KNOWLEDGE ASSOCIATED WITH CASHEW CULTIVATION AND USE :

Cashew plantations are generally raised directly from the cashew seeds. Before planting dry grasses are put as heap and burnt. After one day of burning of the planting site freshly harvested cashew seeds are directly sown in soil. The cashewnut tree bark, fruit and leaves are used as medicine for treating inflammation and urinary disorders.

SUGGESTED PRODUCTION TECHNOLOGIES FOR THE REGION

The region has the vast potentialities for cashew cultivation but also with several problems to tackle. The problems are encountered in cultivation aspects which can be tackled with technological interventions as proven technologies of cultivation are available in the country. Several cashew production technologies practiced elsewhere in the country can either be directly adopted or with experimentation and slight modifications. Following are some of the technologies which are most needed and can bring immediate impact on cashew production in the region.

HIGH YIELDING VARIETIES OF CASHEW

Forty three high yielding cashew varieties are available in the country which were evolved and recommended for cultivation in different states (*Bhat, et al., 2010*). More than 21 varieties are having kernels of most preferred grade (W 180 – W 210). A few varieties among released have been later found not much useful for cultivation in the present days and are stopped from recommendation as they have smaller nut size, susceptibility to pests and disease and other such problems. Cashew varieties which are early season fruiting such as Priyanka, V-1, V-4, Ullal-3, Ullal-4, NRCC-Sel-2 can be adopted in the region to overcome the problem of nut spoilage due to early rains. Available varieties and locally available better performing types can be evaluated and recommended for cultivation in newer areas. Senile and poor yielding trees can be rejuvenated with such elite types by topworking.

PLANTING MATERIAL REQUIREMENT

Softwood grafting technique has been standardized in the late eighties both at Directorate of Cashew Research and AICRP on Cashew. This technique has been commercialized for large scale production of cashew grafts. In India over 150 lakh cashew grafts are being produced annually

by this method both by Government and Private Sectors. Two cashew nurseries with scion bank were established in Tripura State and need to be established in other localities of the region to cater the planting material requirement of the region. Softwood grafting initiated in the region requires a bit of standardization for the region. The low temperature prevails during the growth period, cold injury to the young plants, lack of seedling vigour in the potting mixture used, poor softwood growth etc were observed in the region where nursery work was initiated.

SPACING AND CANOPY MANAGEMENT

The cashew plantations established hitherto were without proper plant to plant or row to row spacing. The plants were either very closely planted or were erratic without adoption of any proper spacing concept. Plants were either not trained or pruned and the trees have grown lanky without having sufficient canopy exposed to sunlight. The regular spacing recommended for cashew is 7.5 M x 7.5 M or 8 M x 8 M elsewhere in the country. As the soils are very fertile and the region receives high rainfall the plants need wider spacing of 8m x 8m for the regular plantations in this region. Growing cashew at closer spacing can only be advised where intensive farming can be taken up.

Cashew canopy can take erratic shape if plants are not pruned and trained from the beginning of their orchard life. In due course the whole canopy becomes unmanageable and yield declines. Entire NEH region has not adopted the technique as a result no proper canopy shape can be seen. The cashew trees can be trained with modified leader system or open centre system for widely spaced plants. Minimum skirting by removal of low growing branches to ease the cultural operations, picking of nuts and improve plantation hygienic condition and detopping to overcome apical dominance and canopy opening for better sunlight penetration need to be practiced in the region.

MANURING AND NUTRIENT MANAGEMENT

The plantations observed in the region were not found applied with any manure or fertilizers. The natural farming is observed in most part of the region. The fertilizer usage at a recommended dose can advance the flowering by 15-20 days with synchronized flowering in the season. The fertilizer requirement of the locality can be worked out based on soil test. In general the recommendations available in other parts of the country can be considered as a base line for deciding the dosage.

Recommended fertilizer doses for cashew have been determined to different agro-climatical zones where cashew is grown. If chemical fertilizers are applied continuously to the soil, the soil health without sufficient organic matter will be affected. It is desirable to have more than 1.0% organic carbon content in the soil. It has been found that farm yard manure or compost of 30 to 35 kg/adult tree along with chemical fertilizers (500 g N, 125 g P₂O₅ and 125 g K₂O) gave best results. The region can be considered as the 'organic hub' of the country as no chemical

fertilizers or pesticides were big used for cashew. In case this needs to be done, the plantations are to be maintained with the manurial requirement.

SOIL AND MOISTURE CONSERVATION TECHNIQUE

Cashew is usually planted in hilly terrains and degraded soils in the country. In such soils erosion prevention measures used to be undertaken which also help in moisture conservation. When planted in hilly region, terrace (platform) at the base of individual plant or line terrace for entire plant row can be taken up. The terrace in the base of the plant helps to ease the cultural operations and manuring, picking of nuts and other farming activities. Several methods of soil conservation technique have been evaluated in different regions of the country.

REJUVENATION IN CASHEW

It was believed that tropical fruits trees do not respond to pruning. Most of the older plantations were raised without any canopy management which lead to uneven growth, drying of lower twigs and branches with unmanageable canopies. At present, it is advised to adopt modified leader system of tree training or open centre type of canopy in regular or widely spaced plantations. In older plantations the heading back by severe pruning can be attempted in trees of exhausted canopies for rejuvenation. The best time for such an operation is immediately after the harvest of the annual crop. Depending on the cashew varieties redevelopment of canopy, the flowering and fruiting in newly formed canopy takes place either in the first year of pruning or in the subsequent year. The plant to plant care is essential to protect such pruned plants from Cashew Stem and Root Borer damage (CSRB). Genetically inferior types which do not give satisfactory performance can be replaced with newer varieties by top grafting technique (**Fig.4 & 5**) on new flushes of newly developed canopies.

In the NEH region most of the plantations are old and senile which needs rejuvenation. The pruning and canopy redevelopment in the plantations in potentially good yielders and replacement of existing canopies with new and suitable varieties in genetically poor yielders is essential. However, the conditions and suitability of the gardens be assessed in advance before implementing the rejuvenation programme. In the region absence of CSRB offers better scope for rejuvenation of the crop. Most of the plantations are of less than 20 years old and are more suitable for rejuvenation.

CROP PROTECTION

Pest and disease and their management

Cashew is susceptible to two major pests viz., Tea Mosquito Bug (TMB) and Cashew Stem and Root Borer (CSRB) and several other minor pests. Depending on the damage severity the recommendations available for the effective management of these pests be made use.

In NEH region cashew was not much damaged by any serious pests and diseases. The major serious pests of cashew like Tea Mosquito Bug was seen damaging the crop only in few localities such as Guwahati and Dubri districts and surrounding areas. Even here the pest occurrence was seen only on few plants and not of serious nature. In case the presence of pest causes serious damage, the management techniques already available elsewhere in the country be adopted.

ROLE OF DEVELOPMENTAL AGENCY AND OTHER LINE DEPARTMENTS

District Horticulture department of West Garo Hills in Meghalaya, Directorate of Agriculture in Manipur and Tripura state are doing area expansion of cashew under the integrated horticulture management programme but in not on a large scale. From NABARD funding around 500 acre of cashew was developed through an NGO in South West Garo hills.

PROSPECTS OF CASHEW CULTIVATION IN THE REGION

North Eastern Hilly Region has vast potential for cashew area expansion and productivity improvement. Huge land area which was brought under zoom cultivation can be utilized for area expansion and adoption of minimum cashew production technologies in the region can enhance the productivity in a shorter period. Introduction of high yielding cashew varieties, screening and identification of high yielding varieties and local types to overcome the adverse effect of climate of the region and rejuvenation of existing cashew grooves by pruning, top working, modernization of processing facilities and with other practicable improved agrotechniques can bring the change in cashew scenario of the region and the country.

FUTURE PROSPECTS OF CASHEW IN NEH REGION AND THE STATE

Almost all the cashewnut plantations in Garo Hills are from the seedlings. Farmers have not maintained the proper spacing and they get very less production. In recent decades Department of Horticulture of Garo Hills has introduced few improved grafted varieties like Priyanka, V-4 and VRI-3. Due to less production, farmers have started cutting their cashew trees and started shifting other crops such as rubber. If cashew cultivation is demonstrated few farmers plots using improved varieties & technologies than farmers may trust. Most of the cashew plants are very old and farmers never do the pruning and training. More awareness on pruning and training is to be given so that their production can be increased. Most of the raw cashewnuts produced is being taken away to neighbouring states at cheaper price. Some NGO's are trying hard to motivate with the low cost cashewnut processing units so that farmers may process the produce locally.

Advantages:

The region is having several plus points listed below to encourage the expansion of cashew cultivation.

- The NEH region is blessed with fertile soil having rich humus content and soils with high water holding capacity.
- High and assured rainfall above 2000 mm (June to September), bright sun shine and other required climatic conditions for the crop.
- Land availability of clearly felled hillocks which used for zoom cultivation.
- Knowledge about cashew cultivation among the growers of the region.
- Abundant man power and labour available for the crop in the locality.
- Processing facilities existing in the region and also scope for modernization of processing facilities.
- Financial assistance and technical support offered by Development Departments through technology mission or National Horticulture Mission etc.
- Demand for the kernel in the region and also from neighbouring countries of the region.

Disadvantages:

The region do suffer with a few lacunae listed below due to which cultivation of cashew did not gain importance.

- The untimely rains in the summer months (March – April) during which crop of the late flowering types of the region will be spoiled and lost.
- Prolonged winter during flowering season (October – February) delays the flowering and fruiting.
- Non availability of suitable variety of cashew identified for the region and non availability of standardized agro techniques for the region.
- Heavy weed growth during moisture availability in soil (particularly rainy season) which requires more expenditure on cultivation of the crop.

- Lack of cashew nurseries in the region for the supply of elite planting material.
- Lack of skilled manpower or resource personnel for training the nursery men or growers of cashew.
- Poor outdated processing facilities which require modernization.

There is no Research station working on this crop and nursery unit in nearby North east states and hence noting much progress could be done in the region. It is a very difficult to procure grafted cashew seedling etc. from Kolkata or Bhubaneswar by road. Recently, a voluntary centre of AICRP-Cashew has been provided at Tura under KVK for the development of region specific technology development. However, this requires suitable scientific supportive manpower for getting a break through.

STATUS OF CASHEW RESEARCH AND DEVELOPMENT IN ODISHA

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INTRODUCTION

Odisha is situated in the east coast of India and lies between 17°49' N & 22°34' N latitudes and 81°27' E and 87°29' E longitudes. It spreads over an area of 1,55,707 sq. km (4.74% of India) and is the 10th largest state in the country. As per the 2011 census, the population of Odisha is more than 4.19 crores and it is the 11th largest populated state (4% of total the country). Out of the total population, about 83.32% of the population lives in rural area. Farmers and agricultural labourers constitute 65% of the total workforce.

The climate of the state is tropical, characterized by high temperature, high humidity, medium to high rainfall and a mild winter. The normal rainfall is 1451.2 mm of which 75 to 80% is received from June to September from South-West monsoon. The actual rainfall received and rainy days varies from district to district. The occurrence of natural calamities such as drought, flood and cyclones are quite frequent. The mean annual temperature of the state is 26.89⁰c with mean annual maximum of 32.56⁰c and mean annual minimum of 21.30⁰c.

Odisha holds a strong position in the cashew economy of the country by accounting for nearly 16.69 % of the area and 14% production of cashew nuts in the country. During the year 1954-55, cashew plantations were raised in the state by the Department of Soil Conservation, for soil conservation. Later on, the State Forest Department and Orissa Forest Development Corporation were involved in the cashew plantation for reclamation of degraded forest lands. The establishment of Orissa State Cashew Development Corporation in 1979-80 for development of cashew on commercial basis was a major niche in the history of cashew crop in Odisha. Most of the cashew area lies with the farmers and a little with government organizations.

Odisha is divided into ten agro-climatic zones (Fig. 2) and cashew cultivation is taken up in nine agro-climatic zones except a small region under Eastern Ghat (Kandhamal, Kalahandi, Nuapada and Bolangir) (Fig. 1) located in high altitude and experiencing extreme climate conditions (Rath, 2007). The major cashew growing area is located in East and South Eastern Coastal Plain, Mid-Central Table Land, Eastern Ghat High land Zone and North- Central Plateau Zone of the state (Agril. Statistics, 2013).



Fig. 1 Cashew Growing Areas of Odisha



Fig. 2 Agro-Climatic Zones of Odisha

All India Co-ordinate Research Project (AICRP) on Cashew was established in Odisha during 5th Five Year Plan period with head quarter at Bhubaneswar under Orissa University of Agriculture and Technology (OUAT), Bhubaneswar which was the starting point of cashew research in Odisha. The main objectives of the project are:

- Collection, conservation and maintenance of germplasm
- Evolving high yielding varieties with export grade kernels and tolerant/ resistant to pest and disease.
- Standardization of agro-techniques for crop under different agro-climatic condition.
- Evolving cost effective and efficient pest and disease management practices.

Another project, Multi State Cashew Research Project funded by World Bank was initiated in 1982 under OUAT at Bhubaneswar. The main objectives of the project were demonstration and training on cashew propagation. However, the project was abolished during the year 1986-87.

AREA, PRODUCTION AND PRODUCTIVITY OF CASHEW IN ODISHA

About 180.41 thousand ha area is covered under cashew plantation with production capacity of 85.50 thousand MT (Hubballi, 2015). In the initial stage of cashew research in the state, the area under cashew was only 6,000 ha while it became ten times during 1993-94 and again 68 per cent increase in the area occurred during the following year (1995-96). Due to occurrence of super cyclone in 1999, the cashew plantations were very much affected particularly in the coastal belt damaging the entire new plantation and the cashew area came down to 84,000 ha. However, efforts were taken to start re-planting of cashew in the cyclone affected area as well as to take up new plantation of cashew in other area in the state as result of which the area of

cashew in the succeeding year increased to 90,000 ha. The production of cashew was 43,000 MT in 1993 and slow increase in the production was noticed in the following years. The production of cashew was also affected due to super cyclone in 1999. During sixties productivity of cashewnut was 360 kg ha⁻¹ and it remained around 700 kg ha⁻¹ up to the year 2000. Thereafter, cashewnut productivity was increased to 850 kg ha⁻¹ during 2005-06. However, cashewnut productivity in the state was much below than the targeted nut yield of 2 ton ha⁻¹ because of the reason that existing cashew plantations (25-30%) were of seedling origin. The production and productivity of cashew is presented in the Table 1.

Table 1 : Area, production and productivity of cashew in the state of Odisha

Year	Area ('000ha)	Production ('000MT)	Productivity (kg ha ⁻¹)
Pre 1966 era	6.00	2.00	360
1993-94	60.19	43.42	812
1994-95	60.60	37.20	679
1995-96	101.85	43.00	720
1996-97	105.00	40.00	670
1997-98	108.60	45.50	750
1998-99	114.00	50.00	750
1999-2000	84.00	40.00	670
2000-01	90.00	59.00	700
2001-02	110.00	59.00	570
2002-03	120.00	70.00	810
2003-04	124.00	71.00	850
2004-05	126.00	74.00	810
2005-06	120.00	78.00	860
2006-07	125.00	84.00	860
2007-08	131.00	90.00	860
2008-09	137.00	95.00	693
2009-10	143.00	84.00	641
2010-11	149.00	91.00	669
2011-12	158.00	97.00	683
2012-13	163.91	100.84	685
2013-14	166.91	85.71	679
2014-15	180.41	85.50	474

GERMPLASM RESOURCES

All India Coordinated Research Project on Cashew (AICRP on Cashew) was initiated in the year 1975 under Orissa University of Agriculture and Technology, Bhubaneswar. Since the inception of the project, many cashew germplasm have been collected and preserved in clonal cashew germplasm conservation block (Regional Field Gene Bank) of the centre. During the year 1990, the cashew germplasm block was established with 47 entries collected from different coordinating centers of cashew research of India (viz. Anakkayam, Bapatla, Vengurle, Vridhachalam and Odisha). In the subsequent years, elite cashew germplasm were collected from different AICRP centers of the country as well as within the state and total collections were raised up to 93 during 1999.

It is worth mentioning that, due to super cyclone during 1999, most of the germplasm were partially or completely damaged. Out of 93 accessions, only 40 accessions could be reassembled and transferred to a new germplasm conservation block during the year 2002 along with another 15 freshly collected germplasm. Till date, the centre has collected and preserved 109 numbers of cashew germplasm which were collected in a phased manner from different parts of India as well as within the state over a span of 14 years. Out of 109 cashew germplasm, 37 are local types and rests 72 are collected from different cashew research stations of the country.

Passport data of 100 germplasm has been sent to National Bureau of Plant Genetic Resource (NBPGR), New Delhi for obtaining Indigenous Collection (I.C.) number. Till date 57 germplasm accessions have been characterized and characterization process is still going on for rest of the germplasm, which have completed 6th harvest or 10th year of planting.

BREEDING EFFORTS

The centre has done commendable work in the field of cashew breeding. As per mandate of the project cashew breeding is continuing in the centre since 1995. The research station has released three cashew varieties (1 selection and 2 hybrids) viz. Bhubaneswar-1, Jagannatha (BH-6) and Balabhadra (BH-85). Bhubaneswar-1 a selection from WBDC-5(V-36/3), was released during the year 1989 (Fig.3). Two cashew hybrids viz. Jagannatha (Bhubaneswar cluster-2 x VTH-711/4) (Fig.4) and Balabhadra (Bhubaneswar-1 x BPP-8) (Fig.5) were released by State Variety Release Committee during the year 2008 and recommended for cultivation in the state of Odisha. Now these two hybrids are under evaluation in Multi Locational Trial-III (MLT-III) since 2003. During the year 2001-2003 under the **“Net Work Programme on Hybridization in Cashew”**, 2006 F₁ cashew hybrids were developed (utilizing the germplasm available at the centre) and planted in the field at 4m x 4m spacing for preliminary evaluation. Preliminary evaluation of these 2600 F₁ hybrids revealed that nine hybrids viz. A1-105, B2-32, F4-24, E5-20, B6-27, D6-19, C2-6, E7-2 and E7-6 are showing promising performance with respect to yield attributing traits and nut yield. These hybrids have been clonally multiplied and again planted in the field following standard package of practices for further evaluation and future release.

Table : Salient features of released cashew types, Bhubaneswar Centre

Cashew types	Bhubaneswar-1	Jagannatha (BH-6)	Balabhadra (BH-85)
Parents	WBDC-5 (V-36/3)	Bhubaneswar cluster-2 x VTH-711/4	Bhubaneswar-1 x BPP-8
Av. no. of nuts panicle ⁻¹	10-12	3-4	6-8
Av. nut weight(g)	4.6	8.6	7.4
Shelling(%)	32.0	32.5	29.0
Potential nut yield (ton. ha ⁻¹)	1.6	2.0	2.0
Kernel grade	W 320	W 180	W210



Fig. 3 Bhubaneswar-1

Fig. 4 Jagannatha (BH-6)

Fig.5 Balabhadra (BH-85)

Under Multi-locational Trial, till date 29 cashew types have been evaluated out of which 7 genotypes viz. BPP-8(H2/16), H-1608 (Dhana), Vengurla-4(V-4), Vengurla-9(H-303), NRCC Sel.-2, H-68 and H-320 recorded promising performance under Odisha conditions. Evaluation of cashew types is still going on under MLT-III and MLT-V (Performance of Released Cashew Varieties). However, it is to be mentioned here that cashew types like Jagannatha (BH-6), Balabhadra (BH-85), BPP-8 (H2/16), V-4 and H-1608 (Dhana) are widely cultivated in the state.

CROP MANAGEMENT

Soil

A great variation of soil types are found in the state due to the type of parent materials, topography and influence of climate. The major soil types and districts suitable for cashew cultivation are presented below.

- (i) **Red soil:** Koraput, Rayagada, Nabarangpur, Ganjam, and Dhenkanal
- (ii) **Deltaic alluvial soil:** Cuttack, Puri, Gajapati and Ganjam
- (iii) **Coarse saline and Alluvial Soil:** Puri, Khordha and Ganjam.

- (iv) **Brown and Forest soil:** Rayagada and parts of Ganjam and Nayagarh
- (v) **Mixed red and yellow soil:** Sundargarh

Irrigation

Cashew is generally grown as a rainfed crop in Odisha. Some of the elite farmers of Dhenkanal district are irrigating the crop during early stages of plant growth. Constructions of shallow bunds in the sloppy lands have been practised by some of the cashew farmers as measures of water and soil conservation practices in Koraput and Rayagada districts of Odisha. Few rich farmers of Dhenkanal district irrigating the new cashew plants through drip irrigation.

Manures and fertilizers

Cashew is mostly grown as a wasteland crop in the state without much care and management. Application of manure and fertilizers to cashew plantation is almost rare by farmers in the state. The fallen dried leaves of the cashew plants are the only source of nutrient for the crop. At present, balance fertilizer is applied only in less than 5 per cent cashew plantations i.e. in other words it can be claimed that the cashew crop is grown mostly organically. However the recommended fertilizer dose for cashew in the state of Odisha is 500:250:250 g of N:P:K kg plant⁻¹ (Table 3).

Table 3. Recommended Fertilizer Schedule for Cashew in Odisha

Age of plant	Fertilizers(g/ plant)		
	Urea	Rock Phosphate	Muriate of Potash (MOP)
1 st year	215	315	85
2 nd year	435	625	170
3 rd year	650	935	250
4 th year	870	1250	335
5 th year and above	1085	1560	415

Canopy management

Canopy management in cashew is not a very common practice in the state of Odisha. Majority of the cashew plantations in Odisha were established without proper training and pruning or canopy management. Such plantations became unmanageable due to erratic branching and uneven spreading of canopy. As a result cashew forests were created without much nut production. Now a days canopy management is practised to some extent in recently developed cashew plantations.

Inter-cropping

Inter-cropping in cashew plantation is not a very common practice in Odisha. Generally cashew is grown as mono crop without much care and attention. However, in the recent years it is observed that the tribal people were growing inter-crops like maize, arhar, ground nut, sweet potato etc. This practice helps farmers to earn additional income till the cashew plants comes to full bearing stage. As per the recommendation of AICRP on Cashew, Bhubaneswar, under normal spacing (200 plants ha⁻¹) of cashew based inter-cropping system, colocasia gave maximum return after 3 years along with the main crop followed by brinjal, okra and cowpea.

CROP PROTECTION

Cashew Stem and Root Borer (CSRB) is the most important insect pest of cashew in the state. Old cashew plantations of seedling origin found in the districts of Ganjam, Nayagarh and Khordha are more prone to CSRB attack. On an average 4 to 6% trees are infested by CSRB causing 1 to 2 % mortality of plants annually particularly in the coastal belt of Odisha. However, the incidence of this pest is low (less than 2 %) in the inland districts like Rayagada, Koraput and Mayurbhanj districts.

Tea Mosquito Bug (TMB) is the second most important pests of cashew in the state found regularly in areas adjacent to Andhra Pradesh viz., Ganjam, southern part of Khordha and parts of Koraput district. However, the incidence is sporadic in the district of Khordha, Nayagarh, Rayagada and Dhenkanal. Outbreak of TMB was recorded in coastal districts including Bhubaneswar during 2008-09 (QRT Report, 2012). Low incidence of the pest was again observed in and around Bhubaneswar in 2013-14 (Annual report, 2014-15). However, sudden rise in temperature more than 35° c during March-April check the pest population under control.

The occurrence of flower thrips, *Haplothrips ceylonicus* (Schmutz) and *Frankliniella schultzei* (Trybom) were observed predominant during flowering in cashew in coastal region of Odisha. At the peak incidence period population of *H. ceylonicus* and *F. schultzei* constituted in the ratio of 78.8% and 21.2% of the total population (Patnaik *et al.*, 1987 and Annual Report, 2014-15).

Among other insect pests, Shoot Tip Caterpillar, Leaf Miner, Leaf and Blossom Webber, Apple and Nut Borer and Leaf Beetle were found in low to medium intensity in both coastal and inland districts of Odisha. Black ant (*Camponotu* sp.) is a pest of tender twigs, nuts and inflorescence which bites the tender shoot and leaves and causes blacking and drying of affected parts was reported first time from Odisha in 1982 and the insect is found throughout the year in the cashew plantation.

CASHEW DISEASES

Die back of cashew and cashew gummosis are two common diseases of cashew found in Odisha conditions. The intensity of damage was noticed to the extent of 2 to 5 % in Bhubaneswar where as gummosis is very much common in old senile plantation.

Plant protection measures

Plant protection measures against the pests and diseases are adopted by the elite cashew growers of Odisha. Now farmers have been motivated through awareness programme on management of different pests and diseases of cashew. Phytosanitation and application of chlorpyrifos on the affected portion have been recommended against CSRB while 3 round sprayings with L-Cyhalothrin – Profenophos - L-Cyhalothrin alternatively at 20 days interval starting from flushing in cashew against TMB and other foliage feeding and sucking pests which occur during the flowering and fruiting time in cashew.

POST HARVEST PROCESSING

Cashew processing in Odisha continues with its traditional manual operations. Though mechanization is introduced to some extent, complete mechanization or automatic processing is yet to be established. Availability of skilled and cheap human labour and better quality of kernel under manual processing with minimum cost limits the scope for extensive mechanization in the cashew processing. Therefore, a majority of the processing work is done through manual labour. Factories in general have mechanization in roasting/boiling and packing. Predominance of manual labour continues in the process like shelling, peeling and grading. About 327 numbers cashew Processing units have been established in Odisha with processing capacity of 1.20 lakh MT. Fourteen numbers of cashew processing units have been sanctioned under National Horticulture Mission (NHM).

The possibility of utilization of cashew apples has been explored in the State. Odisha State Cashew Development Corporation (OSCDC) has standardized the protocol for preparation of cashew apple RTS with the help of Department of Post Harvest Management, OUAT, Bhubaneswar. OSCDC is creating awareness among the farmers about cashew apple utilization through training and demonstration. A small scale cashew apple processing industry has been established by OSCDC in the state which is selling cashew RTS in the brand name of “**KALINGA JUICE**”.

VALUE ADDED PRODUCTS:

Cashew processing plants have been set up in Odisha for cashew kernel which is the main product of cashew plant. However, few plants have started extracting the Cashew Nut Shell Liquid (CNSL) the main by product of cashew which comes out during the time of processing cashew nuts. OSCDC has set up cashew apple juice extraction unit for preparation of RTS in the name of Kalinga Juice but the product has not yet been commercialized. Awareness has been created among the people involved in cashew trading on multiple uses of cashew apple viz., beverages like Juice, Syrup, Squash, Juice, Concentrate, Blended and carbonated beverages and other products like jam, fruit bars, leather, candy, tutti fruity, fruit toffee, canned cashew apple, chutney, pickle, dehydrated cashew apple products etc.

Recipes

Cashew kernel is used as an ingredient for number of dishes in Odisha like pitha (cake), payas, khiri, chhenapoda (Cheese cake) and in number of sweet preparations. In few places of Nayagarh and Dhenkanal districts, the immature cashew kernel is directly cooked like vegetables for preparation of curry. In the district of Ganjam cashew apples are cut into pieces and used in preparation of chutney.

TRADITIONAL KNOWLEDGE ASSOCIATED WITH CASHEW CULTIVATION AND USE (MEDICINAL ETC.)

Very limited information has been documented on various indigenous technologies related to cashew cultivation in Odisha. New leaves of cashew plants are used against stomach problem in Khordha and Nayagarh districts of Odisha. Cashew apple is used as a curative against scurvy and stomach ailments like dysentery and diarrhea. Cashew apple juice, without removal of tannin, is used by people as a remedy for sore throat and chronic dysentery. Cashew apple liquor is used for medicinal purposes for ailments like worms, sickness, cold, body ache etc in Koprput and Raygada districts of Odisha.

ROLE OF DEVELOPMENTAL AGENCIES AND OTHER LINE DEPARTMENT

There are three sets of agency viz. the State Sector including Department of Soil Conservation (DSC), Department of Forests (FD), Department of Horticulture, Department of Revenue (RD) etc; Corporate Sector like Orissa State Cashew Development Corporation (OSCDC) and Orissa Forest Development Corporation (OFDC); and Private growers involved in cashew cultivation.

Department of Soil Conservation (DSC)

The first pioneering effort to grow cashew in the public sector in Odisha as a plantation crop was initiated by the Department of Soil Conservation during 1954-55. The first raised cashew is in eroded watersheds of two major river valley projects, namely the Hirakud (Sambalpur district) and the Machkund (Koraput district). Subsequently, cashew plantation was expanded to other eroded areas and wastelands of the state. By the end of 1999-2000, the DSC had planted cashew over an area of 81,787 ha in Odisha. SCD raised cashew under as many as 20 soil conservation schemes/programmes and only two schemes operated for 20 years or more. All other schemes made sporadic provision for cashew plantations and had frequent interruptions.

Grown up and new (raised from 1981-82) plantations were distributed under the Integrated Tribal Development Agency (ITDA) and Economic Rehabilitation of Rural Poor (ERRP) Programme among the people below the poverty line. After establishment of the Orissa State Cashew Development Corporation (OSCDC) in April 1979, the Soil Conservation Department transferred the cashew area to the OSCDC for commercial operation. Currently, the DSC is having around 1650 ha of cashew plantations under its control. With a view to promote environmental and soil conservation measures, the Soil Conservation Department takes up plantation of cashew in the waste lands of farmers and after three years, the plantation is handed over to the farmers.

Forest Department

The Orissa Forest Department raised cashew plantation from 1956-57, basically as an anti-cyclone and forest conservation and rehabilitation measure. Cashew has been raised under various Five Year Plan Plantation Schemes such as creation of coastal shelter-belt in Cuttack, Puri, Ganjam and Balasore districts, Drought Prone Area Programme (DPAP) in Kalahandi and Khandhamal districts and rehabilitation in the tornado affected areas of Keonjhar district. In the initial plan periods, cashew plantation by Forest Department was rather slow. The Department geared up its efforts during the Fourth Five Year Plan. Explicit plantation of cashew in forest areas was stopped since Seventh Five Year plan beginning from 1985-86 as it was decided to continue cashew plantation operations mixed with other important forest species such as Teak, Bamboo, Casuarina and Eucalyptus etc.

Revenue Department

The Collectorate, Dhenkanal which is a part of the Revenue Department of the Government of Odisha raised cashew in 1981-82 under a plantation scheme, which intended to give employment to the people belonging to the weaker sections of the society and to expand cashew area in the state. It raised cashew over 5823 ha of Government land and 12857 ha of private land in 16 blocks of the district during the year. Plantations in Government lands could

be done only in 96% of the targeted area. But in case of private lands, achievement exceeded the target by 974 ha. The 'Massive Cashew Plantation Scheme (MCPS)' was discontinued thereafter.

Odisha Forest Development Corporation (OFDC)

The OFDC was established in September, 1962 with the prime objective of undertaking scientific exploitation and marketing of forest produce and resource. As an afforestation measure, OFDC took up cashew plantation in the forest areas mixed with other crops as well as explicitly cashew in certain pockets. There were irregularities in plantations due to funds constraints and expiry of tenure of *ad hoc* cashew plantation programmes. Cashew plantation by OFDC was completely stopped from 1992-93 onwards due to fund constraints. The maintenance of existing gardens was also hampered due to lack of funds. Cashew plantation programmes were implemented in Berhampur and Bhubaneswar Divisions and both the division have about 18,705 ha. of cashew plantations. In the year 2005-06, OFDC received one crore rupees under National Horticulture Mission for rejuvenation of the cashew plantations. For harvesting the nuts, every year OFDC leases out the cashew garden through open tender. Since 2004-05, however leases were given for three years. The lease is only for harvesting the nuts without any maintenance and rejuvenation of the gardens due to which nut yield was reduced in the subsequent years.

Odisha State Cashew Development Corporation (OSCDC)

The Government of Odisha established Orissa State Cashew Development Corporation Ltd. in April, 1979 for all round development of cashew in the state and mainly to implement the corporate component of the Multi State Cashew Project (MSCP), which operated in four states including Odisha to extend necessary promotional thrust to cashew sector in India. Since then the Corporation has taken viable steps to increase area under cashew by organizing various awareness campaigns such as farmers training, field days, seminars, exhibitions etc. During eighties, a number of elite varieties of cashew have been identified and demonstrated in the farmers' field basing upon which large scale seedling based plantations were taken up in the state. In 1993, the OSCDC Ltd was declared as "Nodal Agency" for development of cashew in the State. The OSCDC Ltd. introduced hybrid grafts in the state in 1996 through implementation of ICDP (Integrated Cashew Development Programme) by procuring grafts from the nurseries of Goa, Karnataka and Maharashtra and distributed to the beneficiaries. Subsequently OSCDC established its own nurseries for production of grafts to meet the growing demand of the state. Graft production by the nurseries was initiated during the period from 1997 to 2000 with initial production of about two lakh grafts per year. Since seedling based plantations were discouraged for their non-economic non-synchronous production, the hybrid graft availability is now treated as the basic requirement for area expansion of cashew in the state. Now the OSCDC Ltd. has 572 cashew plantations over an area of 28,314.27 hectares spread over 20 districts of which 284

plantations over an area of 12,337 hectares are old and senile. OSCDC manager the plantations through auction on annual as well as 3 years leasing basis. The OSCDC is now taking up replanting work in existing plantations by removing old and senile cashew trees with high yielding varieties of cashew grafts. From the year 1999-2000 till 2013-14 nearly 60,000.00 ha was covered under re-plantation with part assistance from Directorate of Cashew and Cocoa Development. The OSCDC Ltd. has established 17 cashew clonal nurseries. A total of 18.82 lakh grafts of high yielding cashew varieties were produced in the year 2012-13. During 2013-14, 26.82 lakh of grafts were produced. OSCDC Ltd. has become a front runner in production of Quality Planting Material (QPM) both inside and outside the State. OSCDC has produced around 30 lakh of high yielding varieties of cashew for the year 2014-15.

Directorate of Cashewnut and Cocoa Development (DCCD)

The Directorate of Cashew nut and Cocoa Development (DCCD), Kochi, Govt. of India has been supporting the following cashew development programme in Odisha:

1. Development of model clonal gardens/cashew demonstrations
2. Plant protection in cashew
3. Farmers' training programme on cashew cultivation
4. Establishment of Regional Nurseries

National Horticulture Board (NHB)

National Horticulture Board is also providing back ended subsidy for establishment of big orchards. With regard to steps to boost production of cashew, various cashew development programmes are being implemented under NHM with following major objectives

- a) Financial assistance extended for integrated development of cashew in the country through adoption of end to end holistic approach.
- b) New plantation development in potential areas with high yielding varieties
- c) Removal of senile plantations and replanting with HYV.
- d) Human resource development
- e) Intensive post harvest management and processing with value addition
- f) Rejuvenation of existing cashew plantations by adopting improved farming practices.

National Bank for Agriculture and Rural Development (NABARD)

NABARD is assisting for cashew plantation in tribal districts with WADI model. Emphasis is given for cultivation of cashew in lands under FRA. Cashew development in Odisha has been a project

– programme - scheme based activity. Huge amount of financial and human resources have been deployed in cashew through as many as 55 programmes operated by the Department of Soil Conservation, Forest Department, Odisha State Cashew Development Corporation, Odisha Forest Development Corporation and Horticulture Department. The state and Union Government have assisted and sponsored the programmes through development plans and programmes.

CONVERGENCE WITH OTHER PROGRAMMES TO INCREASE PRODUCTION AND PRODUCTIVITY

The programmes like creation of water sources, plastic mulching, micro-irrigation, pollination support, creation of post harvest management infrastructure, marketing linkages are also being extended to cashew growers with a view to increase production and productivity of cashew in the state. Capacity building of cashew farmers and entrepreneurs are being made out of Human Resource Development (HRD) components of NHM. Registration has already been made with National Clean Development Mechanism (CDM) Authority to earn Carbon Credit out of the cashew plantation grown under various schemes since 2012-13.

FUTURE PROSPECTUS OF CASHEW IN THE STATE

There is ample scope for cashew area expansion and establishment of processing plants in the state due to availability of large tracts of land in the inland districts, favorable climatic conditions for the crop, self sufficient energy management, well communication through rail, road, airport and availability of labour for cashew processing. Due to low or no use of chemical pesticide and fertilizer in most of the cashew plantations of Odisha, organic production of cashew can be exploited. Networking of NGO and SHG could be exploited for increasing the area and production as well as processing of cashewnut. There is a huge demand for planting material in the state as government is planning to take up cashew plantation covering an area of 75,000 ha. by 2019-20.

RESEARCH NEED OF THE STATE

In order to increase the production and productivity of cashewnut in the state research on following aspects are required.

Development of new cashew varieties suited to changing climate scenario of the state; Development of cashew varieties having synchronized flowering, short flowering and fruiting phase; Evolving high yielding varieties with export grade kernels; Development of dwarf and compact varieties suitable for high density planting;

1. Standardization of agro-technique for the crop under different agro-climatic conditions of the state; Rejuvenation technique for old and senile cashew orchard; Development of suitable cashew based model for sustainable production; Use of micro-nutrient for quality kernel; Standardization of Agro-technique for organic cashew cultivation; Standardization of Agro- technique for high density planting with micro-irrigation; Efficient use of cashew leaf litter for production of vermicompost;
2. Development of IPM for TMB and other pest complex of cashew; Advanced technologies for early detection of CSRB in cashew plant as CSRB is a major problem in cashew plantations of the state.

STRATEGIES FOR AREA EXPANSION IN THE STATE

Cashew is one of the most important plantation crops grown in the state. The present area under cashew is about 1,80,410 ha. but there is scope for taking up cashew plantation over more than 10.00 lakh ha. in the state. In area expansion programme, government is planning to take up cashew plantation in another 75,000 ha. area by 2019-20 to meet the shortfall in cashewnut production (34,500 ton) in the state. Following strategies are to be adopted to increase cashew area in the state. More than 50% of the existing cashew plantations are old and senile with low productivity which can be replanted with high yielding cashew grafts to enhance the productivity.

1. Convergence of different government programmes and schemes/projects i.e. NHM, RKVY, MGNREGS, Watershed Mission, ITDA and OTELP will not only increase area but also boost the cashewnut production in the state.
2. Cyclone devastated plantations in Ganjam districts can be revived easily with co-operation from Forest Department
3. Awareness must be created among all the players (farmers, processors and entrepreneur) in cashew sectors on improved cultivation practices, post harvest handling and processing of cashew.
4. Recruitment of Cashew Sevak at district level for two years to promote awareness.
5. Formation of Farmer Groups of common interest for holistic development.
6. Establishment of cooperative collection and marketing centres.
7. Involvement of Krishi Vigyan Kendras for transfer of improved cashew cultivation practices
8. Involvement of NGOs for cashew area expansion and management of the crops.
9. Modernization of processing units for quality kernel production.
10. Development of cottage industries for small and marginal farmers.
 - i. Declaration of Odisha as organic cashew producing state.

Strategies for increasing area, production and productivity of cashew in the State

Following strategies are to be adopted to increase area, production and productivity of cashew in the state.

1. Adoption of recent technology on cashew cultivation like Good Agricultural Practices (GAP), Integrated Nutrient Management (INM), Integrated Pest Management (IPM), mechanization, harvesting and post-harvest management of cashew
2. Planting of more than one variety in commercial cultivation & Generation of cashew grafts of desired variety.
3. Production and distribution of planting materials by promoting model cashew nurseries and their accreditation; Strengthening infrastructure especially for the production of quality planting materials.
4. Promotion of high yielding varieties for different agro-climatic condition of Odisha; Promotion of suitable package of practices for various agro-climatic zones of the state
5. Intercropping in newly established cashew orchards and canopy management of cashew through training and pruning.
6. Recycling of cashew leaves for organic nutrient and awareness of soil conservation measures for better growth and survival of the cashew plants.
7. Replanting of senile areas owned by Corporations (3.23 lakhs hectare) with high yielding clone and Rejuvenation of existing old cashew plantations by top working.
8. Dissemination of new technologies through campaigns, workshop and specific training to cashew grower.

Processing enhancement

There are 327 cashew processing units in the state which are mostly located in remote places and are mostly Micro and Small Scale Industries (MSMEs). The industry processes around 1.2 lakh metric tons of RCN per year (OSDCD Ltd, 2015). Odisha produces around 100,000 metric tons of Raw Cashew Nuts (RCN) per annum, which is around 13.6% of India's RCN production. RCN sector is earning annual revenue of Rs. 950 crores for the state. By converting RCN into kernel the sector earn an additional amount of Rs. 250 crores ([www. odicashew.com](http://www.odicashew.com)). Sixty percent of the existing plants have boiling technology (eco-friendly) while 40 % of the processing industries are still using roasting technology. Only 15 % processing industries are modernized and have modern technique of processing, grading, sorting and packing. The cashew industry provides direct employment and livelihood to around 30,000 rural poor women of the state. Odisha cashew processing industry facing a shortfall of 34,500MT RCN which is imported from different African countries such as Ivory Coast, Benin, Ghana, Guinea Bissau, Tanzania and Mozambique (OSDCD, 2015). Odisha Cashew processors Association (OCPA) had started a certification course on cashew processing with the objective to create skilled manpower and employment, at ITI, Berhampur-Ganjam, jointly with Industry Department of State Government on Public Private Partnership (PPP) mode. This is the first-of-its-kind programme in the world and already two batches have passed out successfully.*ir*

STATUS OF TRIBAL SUB PLAN

The Scheduled Tribe (ST) population of the State according to 2011 census report is 8,145,081. This constitutes 22.1 % of the total population of the State and 9.7 per cent of the total tribal population of the country. Malkangiri district of Odisha has the highest proportion of STs (57.4 per cent) followed by Mayurbhanj (56.6 per cent), Rayagada (55.8 per cent) and Nabarangapur (55 per cent). Out of sixty two (62) types of STs, living in Odisha, Khond is the most popular tribe followed by Gond. The survival of tribal communities critically depends on land and forest resources.

During the year 2015-16, for the first time the centre has started its activities in tribal districts of Odisha. About 200 tribal farmers of Keonjhar and Rayagada districts were trained on different aspects of cashew such as propagation, production technology, plant protection measures and cashew apple utilization etc.

MAJOR CONSTRAINTS IN CASHEW CULTIVATION AND PROCESSING

The major constraints in cashew cultivation in the state are:

1. Cashew plantations are developed from seedlings of unknown varieties as the farmers are ignorant about improved varieties and the advantage of planting grafted cashew plants; Non-availability of true to type cashew grafts in time.
2. Most of the plantations in the state are very old and unproductive; Mostly waste lands are diverted for cashew cultivation in the state.
3. Lack of awareness about the latest technologies of cashew cultivation; No or very low use of fertilizer and pesticide by the cashew grower.
4. No or fragmented efforts by the government and private organizations for development of cashew sector in the state; Obtaining forest department clearance is a major challenge for removal of existing old trees. Many of the cashew plantations possessed by OSCDC/ OFDC belong to Forest KISSAM.
5. Many of the plantations are notified for distribution under Dafayati Right. Those plantations are neither being distributed to the beneficiaries by the districts functionaries nor could be utilized for doing replanting by OSCDC. No maintenance operation could be undertaken in those plantations for which the productivity is reducing drastically year after year. Land alienation by government for various developmental projects lead to destruction of areas of cashew plantation. Allotment of equal proportion of land in other districts could compensate the extensive cashew production programme.
6. Lack of adequate funding is another challenges for under taking cashew plantation by OSCDC Ltd. Allocation of replanting cost from State budget can facilitate more acres of cashew replanting.

CONSTRAINTS IN CASHEWNUT PROCESSING IN THE STATE

Odisha is the third largest producer and processor of cashewnut in India.

1. Inadequate storage space for sorting and drying of RCN leads to sale of stock to outside states.
2. Availing finance from banks for procurement of RCN is the biggest hurdle for the processing units. Due to lack of adequate storage space and finance, 15-20% of RCN are sold outside. Processors are forced to import RCN from African courtiers which are not only poor in quality but also processors have to pay heavy import duty for the same.
3. Processing units do not follow any uniform packaging and grading and neither there is any enforcement of ISO bar coding or HACCP or GMP or IDSOP bar coding.
4. Inadequate R and D training towards maintaining export standard packaging, hygiene and other mandatory enforcement by the processing units located inside.
5. There is lack of testing laboratory for quality control and quarantine measures.
6. There is a need for common infrastructural facilities to support holistic development and value addition. These include, farm level drying yards, village level processing centers for cashew apple, supplementary infrastructure at ports to handle raw nuts and kernels and so on.
7. The processing units have not been able to develop a common brand name in the national and international market in the line of 'Palasa Cashew' although there is scope for developing the same. However, the units supply the cashew kernel to the market with their own brand name. But this does not lead to the establishment of a reputed brand to have a stronghold in the national and international market.
8. The processing units in Orissa were hesitating to sell their produce within the state as they had to pay high Value Added Tax (VAT) to the tune of 12.5 per cent on the sale of cashew kernels. The VAT in Andhra Pradesh was 4 per cent and in Maharashtra was 2.5 per cent.
9. The working capital requirement of the processing units is much higher than the term credit support provided by the banks. In such cases the processors have resort to outside and non institutional sources often at a rate of interest ranging between 60 and 120 % per annum.

EDUCATION IN CASHEW

Cashew research in Odisha had started during 5th Five Year Plan period with the establishment of AICRP on Cashew, OUAT, Bhubaneswar. Since then, 22 M.Sc. and 7 Ph.D. research have been conducted on different aspects of cashew and brought out numbers of scientific findings for dissemination of knowledge to the extension functionaries.

RESEARCH WORKERS

Since inception of the project, eminent research scientist have worked in AICRP on Cashew, Bhubaneswar and contributed immensely in the field of cashew research in Odisha. Consolidated lists of notable scientist who have worked in AICRP on cashew, Bhubaneswar have been presented in Annexure I.

OTHER RELEVANT INFORMATION

Production of Quality Planting Material (QPM)

The popular varieties grown in the State are V-4, Jagannath (BH-6), Balabhadra (BH-85), BPP-8, H-1608. Year wise graft production in the state is presented in Table 4.

Table 4. Year wise cashew graft production in the state

Year	Production of grafts (Nos.)
2004-05	14,03,516
2005-06	17,38,800
2006-07	19,24,459
2007-08	20,39,839
2008-09	24,04,541
2009-10	24,02,961
2010-11	24,88,379
2011-12	25,59,100
2012-13	22,13,555
2013-14	38,14,104
2014-15	36,54,684
2015-16	37,68,905

The quality planting material required for area expansion programme are produced in the state jointly by Orissa University of Agriculture and Technology (OUAT) and Registered Private Nurseries accredited by NHB and DCCD. Cashew nurseries are also being promoted in both public and private sector out of NHM assistance and assistance from DCCD. Odisha is self sufficient in hybrid cashew graft production. OSCDC has production potential of 30 lakhs cashew grafts in its 17 clonal nurseries which are sufficient to undertake 15,000 hectares of cashew plantations each year. The list of accredited nursery in the state are presented in Table 5.

Table 5 : List of accredited nursery in the state of Odisha

1.	Orissa State Cashew Development Corporation Ltd. (11 Nurseries)
i.	Ghatika, Khurda
ii.	Khatnahata, Khatanahata, Dhenkanal
iii.	Niamuhan, Niamuhan, Khurdha
iv.	Solar, Jaipur
v.	Sijuapatrapada, Ghatika, Khurda
vi.	Raijhar, Jajpur, BandhaPalli, Byree
vii.	Bhuinpur, Khurdha, Khurdha Rd., Jatni
viii.	Bhangamal nursery, Bhangama, Dhenkanal
ix.	Lahanga, Khurdha, Jatni
x.	Pitapalli, Khurdha
xi.	Sanapalla, Khordha
2.	M/s. Nilakantha Nursery, Nilakantha Bhavan, Gandhi Mandira Road., Dhenkanal – 759 001, Orissa. Ph: 06762 -35702 / 08437122244 Fax– 06762 – 32130
3.	M/s. Shakti Nursery, At – Tangi, P.O. Kotasahi, Dist. Cuttack – 754 022, Orissa. Ph: 0671-2873510 Mob: 09337258007

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Annexure - I

MAIN RESEARCH WORKER IN CASHEW

Name and designation	Organization	Present status Working/ Retired	Major area of Research	Present address with phone/Mobile number
Dr. M. S. Das Ex. Prof.,	Dept. of Entomology, OUAT, Bhubaneswar	Retired	Crop protection	Soubhagya Nagar, Bhubaneswar-751003
Dr. S. N. Mishra Ex. Prof.,	Dept. of Horticulture, OUAT, Bhubaneswar	Retired	Crop improvement and Crop management	Brit Colony, Nayapalli Bhubaneswar
Dr. Pravu Charan Lenka Ex. Director, Planning Monitoring and Evaluation	OUAT, Bhubaneswar	Retired	Crop improvement and Crop management	Plot No. 504(P), Baramunda, Bhubaneswar-751003 M. No.-0943716830
Dr. Ajay Kumar Pattnaik, Ex. Officer - In-Charge	AICRP on Cashew, OUAT, Bhubaneswar	Retired	Crop management	Plot No. 1189, Behind Bharatpur Post Office, Shyampur, Bhubaneswar-751003 M. No.-09437960398
Dr. K. C. Mohapatra Ex. Professor	Dept. of Fruit Science and Horticulture Technology OUAT, Bhubaneswar	Retired	Crop improvement	Plot No. 1000/375, Jagamohan Nagar, Khandagiri-751030 M. No.-09937371500
Dr. P. Tripathy, Assco. Professor	Presently in Dept. of Vegetable Science, OUAT, Bhubaneswar	Working	Crop Improvement and Crop management	Dept. of Vegetable Science, College of Agriculture OUAT, Bhubaneswar-751003 M. No.-09438867762
Dr. P. K. Panda, Horticulturist	AICRP on Cashew OUAT, Bhubaneswar	Working	Crop management in Cashew	AICRP on Cashew, Directorate of Research, OUAT, Bhubaneswar M. No. – 09437780914

Dr.(Mrs.) Kabita Sethi Jr. Horticulturist.	AICRP on Cashew OUAT, Bhubaneswar	Working	Crop Improvement	AICRP on Cashew, Directorate of Research, OUAT, Bhubaneswar, M. No. – 09040012162
Dr. B. C. Jena Ex. Professor and Head	Dept. of Entomology, OUAT, Bhubaneswar	Retired	Plant protection	Plot No. 1815/1817, Jagamara, Barabari, Lenka Sahi, PO. Khandagiri-751030 M. No.-0977404406
Dr. H. P. Patnaik Ex. Professor and Head	Dept. of Entomology OUAT, Bhubaneswar	Retired	Plant protection	Sector 5/492, Niladribihar, Chandrasekharapur, Bhubaneswar-751012 M. No.-09437697424
Dr. L. N. Mohapatra, Professor	Dept. of Entomology OUAT, Bhubaneswar	Working	Plant protection (TMB and CSRB)	Dept. of Entomology, College of Agriculture, OUAT, Bhubaneswar-751003, M. No. – 09437958295
Dr. C. R. Satapathy, Professor & OIC, AICRP on Honey Bee and Pollinators	Dept. of Entomology OUAT, Bhubaneswar	Working	Plant protection (TMB and CSRB)	AICRP on Honey Bee and Pollinators, Dept. of Entomology, College of Agriculture, OUAT, Bhubaneswar -751003, M. No. – 09437013677
Dr. R. N. Mohapatra, Assco. Professor	Dept. of Entomology OUAT, Bhubaneswar	Working	Plant protection (TMB and CSRB)	AICRP on Honey Bee and Pollinators, Dept. of Entomology, College of Agriculture, OUAT, Bhubaneswar-751003, M. No. – 09437937551
Dr. P. C. Das, Professor	Dept. of Entomology OUAT, Bhubaneswar	Working	Plant protection	Dept. of Entomology, College of Agriculture, OUAT, Bhubaneswar-751003, M. No. – 0943403444
Dr. S. K. Mukherjee Assco. Professor & OIC, AICRP on Cashew	AICRP on Cashew OUAT, Bhubaneswar	Working	Plant protection	AICRP on Cashew, Directorate of Research, OUAT, Bhubaneswar, M. No. – 09438676370

STATUS OF CASHEW RESEARCH AND DEVELOPMENT IN TAMILNADU

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INTRODUCTION

Tamilnadu state is broadly classified into two natural divisions i.e., (a) the coastal plains and (b) the hilly western areas. It is further classified as Coromandal plains consisting of Kancheepuram, Tiruvallur, Cuddalore, Villupuram, Thiruvannamalai and Vellore and alluvial plains of Cauvery Delta expanding to Thanjavur, Nagapattinam Thiruvarur and part of Trichy and dry southern plains in Madurai, Ramanathapuram, Sivagangai, and Kanyakumari Districts. The Western Ghats averaging 3000' to 8000' of height run along the western part with the hill groups of Nilgiris and Anamalais on either side of it. Palani hills, Varashanad and Andipatti ranges are the major off-shoots of Ghats. The other prominent hills comprise of Javadhu, Shervarayan, Kalrayans and Pachai Malais. These ranges continue south of river Cauvery. A Plateau is found between these hills and the Western Ghats with an average elevation of 1000 feet raising west-ward. The highest peak Doddabettah in the Nilgris is 8650' above mean sea level.

Climate:

The climate of Tamil Nadu is basically tropical. Due to its proximity to the sea, the summer is less hot and winter is less cold in plains, the maximum daily temperature is 44.4°C and the minimum temperature is 4.4°C. Tamil Nadu is mostly dependent on monsoon rains, and thereby is prone to drought when the monsoons fail. The climate of the state ranges from dry sub-humid to semi-arid. The state has three distinct periods of rainfall. Advancing monsoon period, south west monsoon from June to September, with strong southwest winds; North east monsoon from October to December, with dominant north east winds; and occasional cyclone; Dry season from January to May with unpredicted summer showers during May

The special feature of climatic conditions in Tamil Nadu is that the four seasons are not distinct and overlap with immediate next season. In the plains there is no winter season and in the hills summer is not severe allowing continuous production of horticultural crops in the state. There are areas with temperate climate (above 2000m), subtropical climate (1000 – 2000m), humid tropical climate 500 – 1000m and tropical climate (upto 500m) to accommodate all possible types of horticultural crops. These overlapping seasons have made possible grapes to grow round the year, vegetables and spices in all possible crop rotations and systems of planting. Nearness to the equator and the presence of long stretch of Western Ghats, discontinuous Eastern Ghats and presence of hills and hillocks in the Plains help moderation of climate to ensure the required heat units and degree – days for growing

different kinds of horticultural crops. Cashew growing districts of Tamilnadu are; Cuddalore, Ariyalur, Pudukkottai, Sivagangai, Nagapattinam, Theni, Thirunelveli, Thanjavur and Kanyakumari. Among them Ariyalur and Cuddalore districts in Tamil Nadu state were considered to have the maximum area and production under cashew. But land ceiling legislation restricted the expansion of cashew sowing in Kerala, as demand for cashew nuts grew. Cashew popularly known as the 'Gold mine' of wasteland was initially introduced into the Cuddalore district (then South Arcot) from Konkan coast of Kerala in the early 19th century during British period mainly to meet out their demands of raw cashew nut, as the landscape favoured growth of cashew trees. Cashew is generally grown on neglected land, soils prone for high degree of erosion and usually no intensive soil disturbing activities are required for this crop.

Regional Research Station (RRS), Vridhachalam

The Research Station, Vridhachalam was established in 1963 as Cashew Research Station under Tamil Nadu Agricultural University. After the start of All India Coordinated Research Programmes, RRS Vridhachalam became one of the All India Coordinated Research Centre for Cashew during 1971. This was later (1982) upgraded as Regional Research Station (RRS) under NARP for north eastern zone of Tamil Nadu. It is the lead centre for North Eastern Zone of Tamilnadu which lies in 11°30' N latitude and 79°26' E longitude at 46.7m above mean sea level. Cultivable area of old and new farm are 23.16 and 40.47 ha respectively. Groundnut, sesame and cashew are the mandatory crops of this station.

Climate and Soil

The mean annual rainfall is 1200 mm. The mean maximum temperature is 27^o C to 42^o C and that of the minimum temperature is 19^o C to 24^o C. The soils type of this station is red laterite / sandy soil with a pH range of 6.5 – 7 and EC 0.05 dS m⁻¹. In respect to nutrient status of the soil, low (0.2%) in the organic carbon low in available N, medium in available P and medium in available.

SPREAD OF TNAU VARIETIES

Total Cashew Area - 1.40 lakh ha

VRI – 2	-	30 %
VRI – 3	-	20%
VRI (cw) H-1	-	10%

Area, Production and Productivity of Cashew in Tamilnadu

Year	Area (000ha)	Production (000MT)	Average Productivity (kg/ha)
1993-94	96.77	19.20	203
1994-95	97.20	22.00	232
1995-96	77.36	30.93	330
1996-97	79.00	30.00	390
1997-98	80.50	30.00	390
1998-99	83.00	35.00	460
1999-00	85.00	45.00	540
2000-01	86.00	59.00	750
2001-02	90.00	46.00	570
2002-03	92.00	50.00	570
2003-04	95.00	51.00	600
2004-05	105.00	53.00	610
2005-06	121.00	56.00	640
2006-07	123.00	60.00	670
2007-08	123.00	65.00	700
2008-09	131.00	68.00	519
2009-10	133.00	60.00	472
2010-11	135.00	65.00	507
2011-12	136.00	68.00	519
2012-13	136.42	62.40	469
2013-14	139.4	67.40	484
2014-15	140.42	67.00	478

Source: DCCD, Kochi

District wise Area and Production of Cashew in Tamilnadu (2012-13)

S.No.	District	Area (000ha)	Production (000MT)	Productivity (kg/ha)
1.	Ariyalur	38673	13791	0.36
2.	Coimbatore	148	198	1.34
3.	Cuddalore	37124	37997	1.02
4.	Dharmapuri	1	1	1.00
5.	Dindigul	509	324	0.64
6.	Erode	115	90	0.78
7.	Kancheepuram	255	151	0.59
8.	Kanyakumari	2186	2019	0.92
9.	Karur	37	23	0.62

10.	Krishnagiri	17	10	1.70
11.	Madurai	219	142	0.65
12.	Nagapattinam	2757	1503	0.55
13.	Namakkal	2	1	1.00
14.	Perambalur	1	1	1.00
15.	Pudukottai	21657	12138	0.56
16.	Ramanathapuram	155	91	0.59
17.	Salem	27	15	0.55
18.	Sivagangai	5713	1410	0.25
19.	Thanjavur	3544	947	0.27
20.	Theni	7329	4361	0.60
21.	The Nilgiris	0	0	0.00
22.	Thiruvallur	349	180	0.52
23.	Thiruvannamalai	9	6	0.67
24.	Thiruvarur	4	3	0.75
25.	Thoothukudi	1011	599	0.59
26.	Tirupur	306	408	1.33
27.	Thiruchirapalli	960	549	0.57
28.	Thirunelveli	6177	5620	0.91
29.	Vellore	32	20	0.62
30.	Villupuram	6504	4667	0.72
31.	Virudhunagar	90	53	0.59
TOTAL		135424	87320	0.64

Source: Department of Horticulture and Plantation crops, Chennai

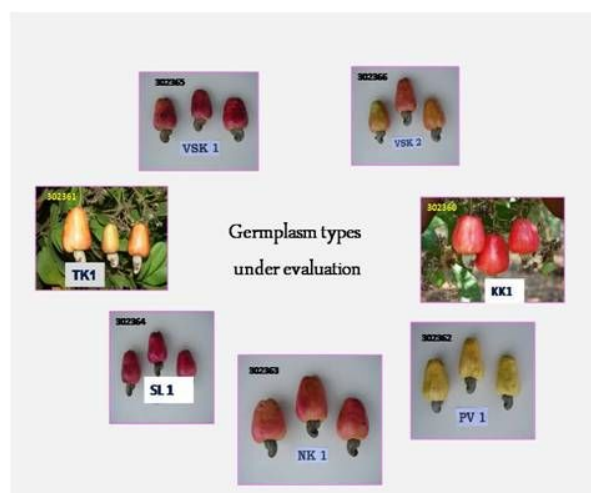
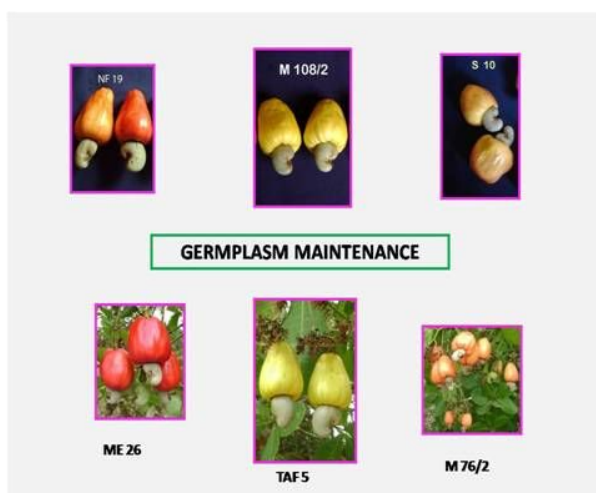
Cashew area in Cuddalore district is around 37000 ha with productivity of 1 tonne/ha. The higher productivity is due to high rainfall (>1000mm) as compared to other districts and most of the farmers planted high yielding VRI-3 varieties. The district was severely affected by cyclone 'Thane' during December 2011. The cyclone became a boon to cashew plantations in the district in a different way. Though 50 per cent of the cashew area was affected by cyclone, various efforts by Regional Research Station, Vridhachalam along with Government of Tamilnadu with massive replanting programmes restored the lost area within a year. Due to the cyclone, most of the older plantations were destroyed. Under Thane Cyclone Rehabilitation programmes, high density cashew plantations were established in 900 ha with drip and fertigation in Cuddalore district.

Other districts having significant area under cashew are Pudukkottai, Sivagangai, Villuppuram, Thirunelveli and Theni districts. Though Sivagangai and Theni are not coastal districts, the soil and climate is very well suited for cashew cultivation and have the potential to increase the area and productivity. Other districts having potential to expand area under cashew is Thanjavoor, Thoothukudi, Dindigul, Virudhunagar and Coimbatore. Pachamalai hills in Trichy district also have potential to increase cashew.

GERMPLASM RESOURCES

The clonal cashew germplasm conservation block (Regional Field Gene Bank) was established during the years 1971 and further collections were added in the years 1989, 1994, 1999, 2012 and 2016 at Regional Research Station, Vridhachalam. Total numbers of cashew germplasm maintained in the Regional Field Gene Bank at RRS, Vridhachalam is 265. Research work continued under The All India Coordinated Research Project on Cashew since 1971. At the Regional Research Station, Vridhachalam cashew germplasm collection has been made since 1963. The accessions were collected from forest plantations, farmers field and research stations of Tamil Nadu, Kerala, Maharashtra and few from other countries. As a result 265 germplasm accessions were being conserved in the Regional Cashew Field Gene Bank (RCFGB) of the Regional Research Station, Vridhachalam.

In the Regional Cashew Gene Bank (RCGB), the clonal accessions were panted during 1994. Cataloguing was done for 125 cashew germplasm accessions. These accessions have been grown in rainfed condition by adopting the recommended package of practices. The cataloguing has been done in accordance with the IPGRI descriptors. The catalogue contains characterization data expressed in 68 data fields (01-68). 106 accessions have upright and compact tree habit (84.8%) and the branching habit was extensive in 98 accessions. Maximum number of accessions had mid-season flowering and 78 accessions had compact inflorescence and medium sex ratio. The nut weight was intermediate in 59 accessions (47.2%) and low in 64 accessions. 21 accessions had medium cumulative nut yield and 104 accessions had low cumulative nut yield. The selections were made from the germplasm at the Regional Cashew Field Gene Bank of Vridhachalam and released as varieties for cultivation viz., VRI-2 and VRI-3. The VRI-2 is popular among the farmers for its drought tolerance. VRI-3 is famous for its medium nut size and high yield.



BREEDING EFFORTS

The breeding efforts of Regional Research Station for improving the cashew yield, quality pest and disease tolerance for the past 50 years is described below.

Selection

VRI-1, VRI-2, VRI-3 and VRI-4 of Regional Research Station, Vridhachalam were also selections made out of the germplasm.

Hybridization

Hybridization work was carried out and planted during 2005, 2006 and 2008. The promising F₁ hybrids to suit the objectives alone were selected and carried over for further evaluation.

The hybrids planted during 2005, 2006 and 2008 were evaluated for characteristics namely high yield, cluster bearing, good fruit set, high % of bisexual flowers, bold nuts, dwarfness and easy peeling testa. Many promising hybrids were identified.

Cashew hybrids in pipeline

HC-6 - Dwarf F₁ hybrid of the cross between VRI 3 X KGN-1. Tree is 3m in height, low spreading, intensive branching habit, 3-5 fruits per cluster, 4-6 kg nut yield per tree which is suitable for high density planting system @ 500-1250 plants per hectare. The great advantage is no canopy management is required when planted in high density planting system.





HC-10 - F₁ hybrid of the cross between VRI 3 x KK 1, medium nuts 7.4g, more number of fruits per cluster (8-10 fruits per cluster), easy to peel testa. High yield (15 kg nuts/tree at the age of 10 years), Stable yield even during drought years.


HC-25- F₁ hybrid with more number of nuts/cluster (18 nuts)

HC-30-F₁ hybrid of the cross between VRI 3 x PV-1, medium nuts (8.0 g.)

VARIETIES RELEASED

List of varieties released

S. No.	Name and Year of release	Yield (kg/ha)	Salient features	Variety
1.	VRI-1 1981	1450	<ul style="list-style-type: none"> Nut weight 5.0 gram Kernel grade W 240 Shelling percentage 28 Yellow fruits Suitable for coastal sandy tracts 	
2.	VRI-2 1985	2000	<ul style="list-style-type: none"> Nut weight 5.15 gram Kernel grade W 240 Shelling percentage 28.5 Yellow fruits Performs well in all cashew states of India Declared as National variety Suitable for rainfed cultivation Suitable for wastelands/drought prone areas 	
3.	VRI-3 1991	2700	<ul style="list-style-type: none"> Medium nut size of 7.10 gram Kernel grade W 210 Shelling percentage 29.1 Pinkish red fruits Compact canopy, Early flowering Easy peeling of testa Suitable for export, Fruits highly palatable less acidic. 	
4.	VRI-4 2000	3320	<ul style="list-style-type: none"> Nut size 6.63 gram Kernel grade W 240 Shelling percentage 28.5 Compact canopy Mid-season flowering type 	
5	VRI (cw) H-1 2009	2900	<ul style="list-style-type: none"> Compact canopy Cluster bearing (6-10 	

			fruits/panicle) <ul style="list-style-type: none"> ▪ Medium nuts 7.2 grams ▪ Shelling percentage 30.5 ▪ Kernel count W 210 ▪ Easy peeling testa ▪ Tolerates drought in rainfed condition 	
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IMPORTANT VARIETIES WHICH ARE POPULAR AMONG FARMERS

S. No.	Salient features	Approx. Area covered (ha)	Potential yield (kg/ha)
1.	VRI-2 This variety was released in the year 1985. It is a seedling progeny of a high yielding tree of a village Kattupalli of Chengulpet district. The nuts are medium in size, 100 nut weigh 512 g with a shelling percentage of 28.5. The kernels confirms to W 240 count. The mean yield is 8.13 kg of raw nuts/tree with an estimated yield of 2000 kg/ ha. The apple is yellow, conical in shape with a mean weight of 45 grams. This variety is drought tolerant and suitable for rainfed cultivation in all cashew growing states in India. It is declared as a national variety because of its stable performance in wide range of agroclimatic zones.	40000	2000
2.	VRI-3 This variety was released in the year 1991. It is a seedling progeny selected from Edianchavady village of South Arcot district. The nuts are medium in size. The 100 nuts weight is 718 g with a shelling percentage of 29.1 per cent. The kernels confirm to a grade W 210 counts. It has recorded a mean yield of 12.7 kg/tree/ year with an estimated yield of 2700 kg/ha. The apple is pear shaped, pink colour and weigh 50.8 grams. This variety is having a special character of compact canopy, easy peeling of testa and medium nut size of export quality. The variety is very well suited to Tamil Nadu conditions. The yield performance is higher especially in irrigated conditions. This variety is suitable for High Density Planting (HDP) and Ultra High Density Planting. Tolerates annual pruning under HDP system.	35000	2700
3.	VRI (cw) H-1 This was released in the year 2009. It is a hybrid using the parents from germ plasm M 26/2 X M 26/1. Female parent (M 26/2) : Collection from Edaiyanchavadi village, Cuddalore district and released as VRI 3, high yield, bold nut and easy peeling testa. Male parent (M 26/1): Collection from Edaiyanchavadi village, Cuddalore district and	5000	2900

	<p>maintained in the germplasm, high yield and cluster bearing, tolerant to Tea Mosquito Bug.</p> <p>The nuts of VRI (cw) H1 are medium in size. The 100 nuts weight is 720 g with a shelling percentage of 30.5. The kernels confirm to a grade W 210 counts. It has recorded a mean yield of 14.5 kg/tree/ year with an estimated yield of 2900 kg/ha. The apple is pink with yellow tinge. This hybrid is having a special character of compact canopy, easy peeling of testa and bold nut size of export quality. The apple colour is pink with yellow tinge and the shape is round and the apple weight is ranging from 50.0 to 53.5 g. This is recommended for all the cashew growing districts of Tamil Nadu. The variety is very well suited to Tamil Nadu conditions especially rainfed areas. This variety is also suitable for HDP and UHDP under drip irrigation. Tolerates pruning.</p>		
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MANAGEMENT TECHNOLOGIES

Softwood grafting technology has been recommended for taking up commercial multiplication of cashew. As far as top working is concerned beheading the unthrifty old plantations originated from seedling progenies during June-July and grafting on 60 days old emerged shoots during July-August recorded a higher survival of 73 per cent as compared to rest of the months. Soft wood grafting registered a survival of 72.14 per cent during July-August using VRI 3 scions as against veneer grafting method by the same variety. In general, beheading at 1 m height was found to be superior over that of 0.75 m height.

In Tamilnadu application of 1100g urea, 1250g super phosphate, 500g muriate of potash for a well grown tree is essential for better growth of the canopy and yield of nuts. The fertilizer schedule and dose was standardized according to the age of the tree starting from one year old tree to a tree above 5 years old which bears economic yield. This works out to additional net profit of Rs. 3588/ha. The cost benefit ratio was 1:3.

Fertilizer schedule for cashew

S. No.	Age of the tree	FYM (Kg/tree)	Urea (g/tree)	SSP (g/tree)	MOP (g/tree)
1.	One year	10	150	200	100
2.	Two years	20	300	500	200
3.	Three years	30	450	750	300
4.	Four years	40	600	1000	400
5.	Five years	50	1100	1250	500

Recent studies at Regional Research station, Vridhachalam for nutrient requirement of high density cashew plantation, 225:75:75 Kg NPK/ha is recommended. The nutrient uptake studies revealed that a fertilizer dose of 1000:125:250 g NPK/tree is required for a productive tree in irrigated field or trees grown in high rainfall area.

Intercropping

Cashew is planted at a spacing of 7m x 7m. Cashew being a perennial crop is having a long juvenile pre-bearing age and the interspaces are not properly utilized. Growing intercrops up to four years of planting helps for maximum harvest of sunlight, water and nutrients per unit area. Raising of intercrops like groundnut and black gram were proved suitable as intercrops in cashew variety VRI-3 with additional returns of Rs. 35514 per hectare without any harmful effect on the yield of cashew nuts. The cost benefit ratio was 1:2.71. Raising direct sown vegetables like bhendi, cluster bean, radish, ridge gourd and amaranthus, gave profit and cost benefit ratio is more than 2. Bhendi is an ideal direct sown vegetable during early phase of growth. Both January sowing as well as July August sowing of vegetables as intercrops is recommended. In high density planting, vegetables can be grown as intercrop every year after pruning the cashew trees during July first week.

High Density Planting

High Density Planting System was developed to improve the production and productivity of cashew nuts per unit area. Cashew planting at a closer spacing of 5 x 4 m with a plant population of 500 plants per hectare yielded 3250 kg nuts per hectare. The high density planting technology (5x4m) with 500 plants per ha recorded a higher BCR of 3.35 when compared with the recommended plant population of 200 plants (10 x 5m or 7 x 7m) per hectare (BC Ratio of 1.50). Partial Budgeting Analysis has revealed that a net return of Rs. 68,875/- could be obtained every year from 6th year onwards. A fertilizer dose of 225:75:75 kg per hectare was standardized for higher yield in high density planting system. Training the plants and regular annual pruning for canopy architecture is necessary to enable maximum sunlight penetration, increased flowering and yield. This technology was included for adoption in the Agriculture policy note of the Government of Tamil Nadu during 2010-11. Technology was adopted in 1200 acres under 'Thane Rehabilitation Programme' of the state government and included in the State Horticulture Crop Production Guide 2012-13.

Pruning and Foliar Spray Technology

In Tamil Nadu, cashew faces a serious problem of low productivity due to various reasons such as variation in seedling progenies, poor plant population and poor fruit set due to unpredictable climatic changes which need to be addressed in a war footed manner. Most importantly, cashew bears on three month old current season's shoot. Any foliar spray of nutrients (in addition to the recommended fertilizer dose) at new flush stage and flowering stage have direct effect on the flowering, fruit set and yield. So far, a standard practice of pruning combined with foliar spray schedule for cashew is lacking. At this juncture, it becomes necessary to release this standardized technology to enhance the yield and productivity of cashew to meet out the increased demand for kernels in the country and elsewhere in the world. The technology consisted of pruning tertiary branches every year during June-July to induce more number of current season's shoots followed by a foliar spray schedule. The

foliar spray schedule consisted of NPK 19:19:19 @ 1 % at new flush stage (August), mono-ammonium phosphate @ 1 % + boron 0.1 % during flowering (December) followed by third spray of TNAU Panchagavya 3 % during fruit set stage (January-February). This technology resulted in an yield increase by 42 % in station experiment conducted over three years.

Field observations showed that at each spray interval, the prevalent natural enemy population was temporarily decreased up to two weeks due to repellent action of nutrient sprays. Thereafter, natural enemy population gradually built-up to normal population. Nutrient sprays did not cause any toxic effects on the prevalent natural enemy population in the experimental fields. Pruning the trees annually to remove tertiary branches help to enhances light interception, photosynthesis and yield apart from increased production of current season's shoots. The pruned trees are to be swabbed with Fytolan 4g/ltr or neem oil 5% on the cut ends to avoid dieback. For the management of stem borer swabbing the trunk up to 1 m with neem oil 5% or tar + kerosene 1:1 ratio is necessary to prevent egg laying by the stem borer. As pruning produces more number of new flushes, a preventive spray of Profenophos 1.5 % against Tea Mosquito Bug has to be given.

Development of dwarf hybrids suitable for ultra-high density planting system

All the varieties and hybrids developed and released in the country are of spreading in nature and hence, pruning becomes an essential operation which is time and labour consuming. It also requires good skill for pruning and canopy management to optimize the current season's shoot production and increased yield. Hence, here comes the importance of a dwarf cashew hybrid/variety with zero canopy management. Dwarf hybrid/variety has not been evolved so far in the country.

A new semi dwarf F_1 hybrid cashew has been evolved named HC 6 (Hybrid Cashew 6). It is a small tree with 3.0 m height and 2.8-3.0 m canopy spread. It has intensive branching habit, small leaves, short internodes and profuse flowering with more number of bisexual flowers. It yields 3.5 kg nuts /tree which is high and unusual as far as dwarf cashew plants are considered (as reported in Brazil - dwarf cashew plant bears only 250g nuts/tree). The morphological and genetic dwarfness of the plant HC 6 has been confirmed by various stomatal and anatomical analysis. Attempts have already made to develop more number of high yielding dwarf hybrids by backcross breeding methods using this HC 6.

Ultra-high density planting system in cashew

Based on the necessity of closer planting technologies with canopy management strategies, a new special grant project has been acquired by the scientist during AICRP (Cashew) workshop 2009 at TNAU, Coimbatore. The project was sanctioned and implemented during 2010-11. The Ultra-high density plot laid out at RRS, Vriddhachalam is a successful venture. The trial plot with

three spacing 3x2m, 4x2m and 5x4m and two varieties of national importance VRI 3 and Vengurla 4 were very much appreciated by the Quinquennial Review Team during 2012.



New findings from the experiment

Canopy management started from one month after planting. Basic framework of the plants was done within six months after planting with defined number of primary, secondary and tertiary branches. The spacing 4 x 2 m was the best for canopy management, light interception, more number of current season's shoots, flowering panicles, fruit set and yield. Due to proper canopy management, the trees were brought to flowering and yield from first year after planting itself. A yield of 1520 kg nuts per hectare recorded in 4 x 2 m spacing at 2nd year after planting itself. The technology would be a great boon to the cashew farmers in the country for high remuneration from first year itself.

CROP PROTECTION

Integrated Pest Management

a) Management of Cashew Stem and Root Borer (CSRB)

In the Integrated Pest Management strategy, both prophylactic as well as curative control measures are recommended.

Prophylactic Control Measures

Prophylactic measures such as phytosanitation, training of grafts, avoidance of planting reservoir host plants and chemical treatments are recommended. The base of the tree trunk to the height of three feet should be treated with coal tar + kerosene in the proportion of 1:2 to protect the cashew trees from the pest attack. Treating the base of the tree with neem oil 5%

coupled with Chlorpyrifos (0.2%) per tree basin is recommended to prevent the pest infestation. The planting of other host plants such as moringa and silk cotton plants should not be undertaken in or vicinity of cashew plantations. Otherwise, these trees would act as source of shelter for multiplication of the pest.

Curative Control Measures

After appearance of the initial pest infestation, the curative measures are recommended to minimize the pest menace. Different curative measures are summarized as follows:

(i) Mechanical removal of grubs

Periodical removal and destruction of different development stages of pest such as eggs, grubs, pupae and adults residing on or inside the tree minimize the fresh infestation in the orchards. The grubs should be removed from the infested trees by means of a chisel. Care should be taken not to remove the healthy bark during grub removal. The plants having more than 50 per cent bark damage should be uprooted to prevent spread of pest from infested to healthy trees.

(ii) Chemical control

- Immediately after removal of grubs, the portion of infested trees should be sprayed or swabbed with Chlorpyrifos 0.2% or neem oil 5% to prevent the re-infestation of the pest.
- Injection of Profenophos 2% through bored holes/tunnels (or) root feeding of Profenophos @ 20 ml + equal volume of water (20 ml) is effective controlling the pest and preventing re-infestation.
- Soil application of granular insecticide: phorate 10G @ 100g per tree around the tree basin followed by copious irrigation to the trees is recommended for controlling the pest.

Soil application of entomopathogenic fungus

The green muscardine fungus, *Metarhizium anisopliae* causes 16-30 per cent and 100 per cent mortality of the grubs in the field and laboratory tests respectively. Hence, soil application of the spawn @ 250 g + 5 kg of Farm Yard Manure (FYM)/ tree enhances natural control of the pest by inducing establishment of the pathogen under field conditions.

Management of Tea Mosquito Bug (TMB)

A scheduled spraying comprising three rounds of insecticidal spray viz., first spray with Profenophos at flushing season (November-December), second spray with Chlorpyriphos or L-cyhalothrin at flowering season (December-January) and third spray with Acephate 0.1% at fruiting stage (January-February) is recommended for the control of Tea mosquito bug. Its cost benefit ratio is 1:9.1 Since, neem trees serves as breeding site for development and spread of the pest (TMB), the neem trees inside the cashew orchards and vicinity of the cashew orchards should be simultaneously sprayed with insecticides to prevent the migration of the pest and consequent spread of new infestation.

CASHEW PROCESSING UNITS IN TAMIL NADU

The cashew processing industry in Tamil Nadu was started in 1960 by the cashew factory owners from Quilon, Kerala. They established many cashew factories in the State after 1970, with the objective of earning huge profit from cashew processing as the wage was very low in Tamil Nadu compared to Kerala. The cashew processing industry in the state is monopolized by private sector. In fact, the government of Tamil Nadu has comparatively less interference in cashew industry. Moreover, there are no cashew factories under the government sector or in the co-operative sector in Tamil Nadu. At the same time, there is no strict factory licensing system under implementation in the state. It is interesting to point out that nearly 90 per cent of the cashew industries of the state are concentrated in Kanyakumari district. Recently several cashew industries are coming up in Panruti area of Cuddalore district because of availability of quality nuts and labour for processing. Several medium and big industries exporting cashew are in Cuddalore district.

VALUE ADDED PRODUCTS

Tamil Nadu Agricultural University is giving training on Cashew apple value addition to women self help group members through Krishi Vigyan Kendras, Post Harvest Technology Labs and its Research Stations. At KVK, Vridhachalam trainings were conducted during 2015-16 for value addition and product packaging methods to 237 number of farmers and farm women. The trainings on preparation of value added products from cashew apple, their marketing and packaging methods were given to the participants.

RECIPES MADE OUT OF CASHEW APPLE

The products prepared by the women self help group members of Cuddalore district after getting trained on preparation of cashew apple product training at RRS, Vridhachalam are cashew apple juice, squash, syrup, pineapple, blended squash, ready to serve beverages.

TRADITIONAL KNOWLEDGE

Cashew Nursery: Soaking of cashewnuts in cowdung solution is followed by people traditionally to improve the germinability of the stored nuts

Seedling Production: Seeds are collected from high yielding trees of the farmers own farms and sown for producing seedlings for planting

Pest Control: Swabbing waste engine oil mixed with neem oil to the tree trunks is traditionally followed by farmers of Tamilnadu to prevent cashew stem and root borer laying eggs in the roots.

Panchakavya: Traditional spraying / soil application of Panchakavya, a natural bio stimulating mixture prepared from 5 products of cow origin for deterring pest and to get quality bold nuts. Nut setting also improved in panchakavya sprayed fields.

Traditional use: *Cashew nut shell-oil:* mild purgative, used in folk medicine for treatment of hookworm, cracks on soles of feet, warts, corns, leprosy sores.

Modern use: *Cashew nut:* used in mental derangement, sexual debility, nervous prostration following seminal emission, morning sickness in pregnancy, palpitation of heart, rheumatic pericarditis, loss of memory as a sequel to small pox; *Kernel:* good for weak patients suffering from incessant and chronic vomiting; *Kernel-oil:* antidote for irritant poisons; *Liquor made from fruit:* diuretic.

Homoeopathy: for boils, warts, wounds and different types of cracks in legs; used sometimes in case of leprosy

ROLE OF DEVELOPMENTAL AGENCIES AND DEPARTMENTS

NABARD

As many as 643 acres of land had been covered under the 'WADI' Tribal Development project of the National Bank for Agriculture and Rural Development in Pachamalai benefiting an equal number of families. Pachamalai is located on the border of Tiruchi and Salem districts. Mango and cashew orchards will be raised under this. NABARD has taken up the project at an estimate

of Rs. 8 crore, which included Rs. 6 crore grant, credit for Rs. 1 crore, and contribution of labour equivalent to Rs. 1 crore by the tribal people. The project was implemented in 41 villages - 6 in Tiruchi district and 25 in Salem side of the hills. The project aims at ensuring livelihood assistance to the tribal people and planting of cashew and mango saplings on 643 acres formed a part of this component. On each acre, 94 saplings have been raised – 54 mangoes and 40 cashew – for ensuring livelihood for the tribal people on a sustained basis, that each family would get an annual income of Rs. 12 lakh, once yield commences from these crops. 'VRI 3' had been raised in the cashew area while the mango saplings included *banganapalli*, *imampasandh*, and *malgova*. The villages covered in Tiruchi district, included Top Sengattupatti, Puthur, Nachilipatti, Karuvankadu, N. Puthur, Boothakal, Thannerpallam, Kambore, and Solamatthi. On the Salem side, the project is implemented in Periyapakkalam, Gunavarai, Neyvasal, and Odaikattuputhur.

Department of Horticulture and Plantation Crops, Tamilnadu

Under National Horticulture Mission, the department of Horticulture implements the following schemes in cashew promotion.

- Establishment of New Gardens
- Rejuvenation / Replacement of senile plantations
- Nursery upgradation

Special Package implemented under cyclone Thane Rehabilitation programme

In Tamil Nadu, due to Cyclone Thane hit on 30.12.2011, 48,040.90 Ha. of horticulture crops was damaged which includes the perennial crops like Cashew in an extent of 36,517.08 Ha. in the districts of Cuddalore and Villupuram. Hon'ble Chief Minister announced a Special Package on 04.02.2012 for horticulture crops to rehabilitate the affected farmers at an outlay of Rs.724.26 crores to be implemented for a period of five years. Cashew replanting has been completed in an area of 8,228.40 ha with the proposed target of 8,678.59 ha. which includes the area replanted by gap filling in the partially affected fields in an extent of 7,428.59 ha. normal planting in an area of 350 ha. and High Density Planting in an area of 449.81 ha. The balance area of 450.19 ha. is being covered under High Density Planting now. Around 900 ha. was targeted to be covered with High Density Cashew orchard with drip irrigation under NMSA.

Besides to provide irrigation facility to High Density Cashew Orchards, the Government sanctioned a sum of Rs.1,140 Lakhs to provide 270 Nos. of bore wells to 60 Joint Liability Groups (JLGs) and 210 individual farmers of Cuddalore and Villupuram. So far, 59 Nos. of bore wells for JLGs and 90 Nos. of bore wells for individual farmers totally 149 borewells have been completed at an outlay of Rs.686.185 Lakhs. Totally around 900 hectares were brought under

Cashew High Density planting, 121 nos. of bore wells were erected and 862 ha. of Cashew High Density orchard were provided with drip irrigation facility.

The following demonstrations were conducted at Thane rehabilitated HDP cashew plantations by the scientists of Regional Research Station, Tamil Nadu Agricultural University.

Name of the Programme	Organized by	Year	Sponsor
Pruning and Foliar spray demonstration at Vegakollai village, Panruti Taluk, Kurinjopadi Taluk and Vridhachalam Taluk of Cuddalore district	Regional Research Station in collaboration with Dept. of Horticulture, Tamilnadu	2012 2013 2014 2015	Sponsored by NHM

Active participation of Tamil Nadu Agricultural University in Thane cyclone Rehabilitation Programme

Thane cyclone occurred on 30.12.11. A swirl wind at a speed of 100 – 135 km/hr devastated the cashew plantations in Cuddalore and Villupuram districts. The cyclonic storm with rains lasted for about 8- 12 hours. The heavy swirl wind damaged vast area of both horticultural and agricultural crops of these two districts. The scientists of Regional Research Station, Tamil Nadu Agricultural University initiated and took



Cyclone damage to cashew plantations in coastal Tamilnadu

part actively in Thane Rehabilitation measures. Survey of affected parts of Cuddalore district was taken up in a war-footed manner by the scientists of AICRP-cashew to assess the extent of damage to cashew crop and provide necessary suggestions for rejuvenation and recommendation to the Government of Tamil Nadu. The recommendations were accepted and implemented by the government for livelihood enhancement of the cashew farmers. This centre produced quality grafts of cashew varieties VRI 3 and VRI (Cw)H1 and Jack PLR1 for the thane Rehabilitation programme. A technical bulletin has been prepared and distributed to the cashew farmers; technology dissemination was given through AIR and TV. The scientists are involved in rendering technical guidance for establishing a model high density cashew orchard with drip fertigation by the District Collector, Cuddalore at Meliruppu village of Panruti Taluk in an area of 10.73 ha. Under the guidance of Regional Research Station, Tamil Nadu Agricultural University, Thane affected fields were replanted with high yielding VRI 3 and VRI (cw) H1 varieties under high density planting. Till date 900 hectares of HDP cashew established under Thane rehabilitation programme.

Directorate of Cashew and Cocoa Development (DCCD), Kochi

The following are the schemes implemented by DCCD Kochi in collaboration with Research Institutes, Krishi Vigyan Kendras, State Department of Horticulture and NGOs in the state.

1. HRD in Cashew and Cocoa
 - Training programme on cashew and cocoa within the state
 - Exposure visit
2. Publicity for Crop Promotion
 - State level seminar on Cashew and Cocoa
 - District level seminar on Cashew and Cocoa
 - Cashew/Cocoa Fair/Field day
 - Exhibitions, Advertisements, Printing of Literatures, training of farmers, campaign, documentation and publicity through AIR, Doordharsan etc. for the promotion of Cashew and Cocoa.
3. Production forecast for Cashew
4. Production of planting materials
5. Upgrading Nursery infrastructure to meet accreditation norms
6. New plantation development for Cashew and Cocoa
7. Front Line Technology Demonstration
Regional Research Station Vridhachalam organizes the farmers training programmes, District Level Seminars, State Level Seminars, production forecast programme, value addition of cashew apple training programme and FLTD programme by getting funds from DCCD, Kochi in Tamilnadu.

Promotion/training schemes organized by RRS sponsored by DCCD, Kochi

Title of the Scheme	Sponsors	Year
Three day training on cashew cultivation technologies for farmers of Cuddalore district	GOI-DCCD, Kochi.	2011
One day district level seminar on cashew cultivation technologies for farmers of Cuddalore district	GOI-DCCD, Kochi.	2011
One day district level seminar on High density planting system for improving cashew yield-Cuddalore and Ariyalur districts	GOI-DCCD, Kochi.	2011
Pilot Demonstration on Cashew Apple utilization	GOI-DCCD, Kochi.	2011
Pilot Demonstration on Cashew Apple utilization	GOI-DCCD, Kochi.	2012
Trainings on Cashew Production technology	GOI-DCCD, Kochi.	2012
One day district level seminar on cashew cultivation technologies for farmers of Cuddalore district	GOI-DCCD, Kochi.	2012

One day district level seminar on High density planting system for improving cashew yield-Cuddalore districts	GOI-DCCD, Kochi.	2014
Three days Improved production technologies for Cashew for two batches	GOI-DCCD, Kochi.	2014
Two days state level Seminar on Cashew	GOI-DCCD, Kochi.	2014
Cashew apple utilization Training	GOI-DCCD, Kochi.	2015
Three days Farmers Training Programme on Cashew production technologies	GOI-DCCD, Kochi.	2015
District level seminar on cashew cultivation technologies for farmers of Pudukkottai and Sivagangai districts	GOI-DCCD, Kochi.	2016

T AFCORN

Tamil Nadu Forest Plantation Corporation Limited (T AFCORN) is a public sector company owned by Government of Tamilnadu. T AFCORN owns about 16,000 ha. Cashew plantations as per the following list.

S.No.	Region	Plantation (Area in ha)
1	Aranthangi (Pudukkottai district)	930.2
2	Karaikudi (Sivagangai district)	2620.42
3	Pudukkottai	1137.33
4	Tirukoilur (Thiruvannamalai District)	2.02
5	Villuppuram	2471.36
6	Vridhachalam (Cuddalore and Ariyalur districts)	8441.84
	Total	15603.09

FUTURE PROSPECTS

Future Research Strategies

- Development of cashew foliar nutrient consortia for enhancing yield and quality of cashew nuts.
- Hybridization to improve the existing varieties for high yield bold nuts, cluster bearing habit. Short flowering period and high shelling percentage.
- Identification of types with compact canopy suitable for high density planting.
- In High Density planting system, studies on major and micro nutrient uptake has to be carried out for developing site specific nutrient recommendation package. Evolving a high yielding dwarf variety is the prime need of the hour to suit the HDP/UHDP system in the country.

- Dwarf hybrids evolved must be subjected to marker assisted RAPD/AFLP mapping to identify the dwarfing gene for further studies.
- Standardization of techniques for organic cashew production.
- Standardization of integrated nutrient management system for improving productivity.
- Developing IPM packages against key pests of cashew.
- Studies on photosynthesis, transpiration, osmoregulation and CO₂ gas exchange in relation to drought tolerance of cashew.
- Research on physiology of cashew for high fruit set and yield.
- Macro and Micro nutrient studies on partitioning of nutrients and CN ratio.
- *In vitro* production of cashew planting material.
- Cashew stem and root borer causes 20% loss of trees every year – which necessitate the need for evolving suitable technology of using bio control / fungal agents to control the adult population. Development of pheromone trap also needed
- Detection mechanism for identifying the presence of Cashew Stem and Root borer inside the tree/tunnel by ultrasonic sound mechanism / infra red rays.

Future Strategies for improving cashew cultivation in the state

- Massive replanting programme has to be taken up using the high yielding varieties of regional importance. All the senile unproductive plantations has to be replaced with high yielding varieties and hybrids to improve the productivity
- Allotment of fertile lands to grow cashew to exhibit full potential of the crop.
- Adoption of high density and ultra high density planting systems wherever possible to increase the yield per unit area.
- Development of compact and dwarf high yielding cashew variety suitable for high density and ultra high density planting system to double the yield.
- Providing drip irrigation facilities to small and medium growers in a subsidises.
- Availability of good quality planting material during planting season.
- Development of cashew based integrated farming system including all the agricultural components, bee keeping, goat rearing, etc. to make cashew plantation a profitable venture giving employment and income during off season also.
- Evolving pest and disease tolerant / resistant varieties against tea mosquito bug and cashew stem and root borer.
- Transfer of technology through farmers participatory mode of technology development.
- Small scale processing units has to be setup by the government for higher remuneration for the farmers.
- Non- traditional under-utilized hilly slopes like Pachamalai and Kolli hills of Tamilnadu may be explored for organic cashew cultivation.
- Diversification of products from nuts, CNSL and cashew apple.
- Following Good Agricultural Practices in cashew cultivation and Good Manufacturing Practices in cashew nut processing will improve the marketability of cashew kernels.

ICAR-AICRP (CASHEW) TRIBAL SUB-PLAN PROJECT

Tribal sub plan as in operation at Regional Research Station, Tamilnadu in which Kolli hills of Namakkal District has been selected for promoting cashew cultivation. Awareness training on cashew cultivation was imparted to 50 tribal farmers of Kolli hills on 9.10.2015.

MAJOR CONSTRAINTS IN CASHEW CULTIVATION AND PROCESSING

Major constraints in Production

- Since it was considered as a neglected crop, only poor soils and degraded lands are allotted for cashew cultivation. Hence the potential yield of cashew was not realized in these soils.
- Accumulation of pest complex, old and senile population reduce the productivity of the plantation.
- Irregular monsoon causing earlier or late flowering and sows a negative impact on yield.
- Cyclone and winds causing uprooting of trees.
- Rising temperatures during flowering causes drying up of inflorescence.
- Drought period from January to April/May causes reduction in yield
- Incidence of Tea Mosquito Bug causing poor nut setting and poor yield.
- Cashews stem and root borer causing death of bearing trees. There is no effective control measure and saving of affected trees.
- Late pruning affects flowering and nut setting.
- Weeds and parasitic plants increase the cost of cultivation.
- Wrong choice of varieties – Economic loss due to low price offered to smaller nuts

Major constraints in Processing

- Timely availability of raw nuts.
- Import of cashew nuts causing fluctuation in price.
- Labour intensive work. Increasing wages reduces in profit.
- Most of the labourers engaged are women labourers leading to social problems.
- The cashewnut shell liquid has to be handled with care. Accidental handling will cause injuries to the workers.
- Increasing electricity charges cause more expenditure.
- Government policies – there is no adequate schemes for small scale cashew processors.
- Quality of the imported nuts.

EDUCATION IN CASHEW

Name of the student	M.Sc. / Ph.D.	Year of completion	Thesis title	Major recommendations / findings in bullet points
K.Murali	M.Sc.	2012	Standardization of pruning and foliar spray schedule for canopy management and yield in cashew under high density planting system	Pruning and Foliar spray Technology released. The technology consisted of pruning tertiary branches every year during June-July to induce more number of current season's shoots followed by a foliar spray schedule. The foliar spray schedule consisted of NPK 19:19:19 @ 1 % at new flush stage (August), mono-ammonium phosphate @ 1 % + boron 0.1 % during flowering (December) followed by third spray of TNAU Panchagavya 3 % during fruit set stage (January-February).
Mr.Prasanna Kumar	M.Sc.	2013	Effect of tertiary pruning and foliar spray on growth and yield of cashew under high density planting system	
Students of B.E.(Irrigation Engineering) of Anna University, Chennai	Internship programme	2012	Drip and fertigation in high density planting system in cashew	Students of B.E.(Irrigation Engineering) of Anna University, Chennai were given on-campus training on drip irrigation system and exposure training at C.Ramakrishna Padayachi Cashew Processing and Exporting Unit, Panruti, Cuddalore district, Tamil Nadu.

MAIN RESEARCH WORKERS IN CASHEW

Name and designation	Organization	Present status Working / retired	Major areas of research	Present address with phone/mobile number
Dr.M.S.Aneesa Rani Professor of Horticulture	TNAU	Working	Horticulture - Cashew Breeding	Regional Research Station, Vridhachalam Pin:606001 9788923254
Dr.S.Jeeva Professor of Horticulture	TNAU	Working	Horticulture - Cashew Breeding	Horticultural College and Research Institute for Women, Navalur Kuttapattu, Trichirappalli. Pin: 620009 Mobile:9843980865

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STATUS OF CASHEW RESEARCH AND DEVELOPMENT IN WEST BENGAL

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INTRODUCTION

West Bengal is endowed with six agro climatic situation. Among the various crops cultivated in six different agro climatic conditions cashew is one, which is adopted in the red and laterite zone as well as the coastal areas of West Bengal. The soil and climate of these areas do not permit every crop to flourish. But as cashew is a hardy, drought tolerant, soil binding thus erosion-checking crop, it has acclimatized itself into this region after its introduction from Portugal to the southern part of the country and thereafter from those areas to the eastern part of the country. The state produces about 16% of the total production of cashewnut in the country. At present West Bengal has cashew area of 11.36 thousand hectares with a production of 13.00 thousand metric tons and productivity of 1096 kg/ha (DCCD, 2016). Six districts, viz. Purba Medinipur, Paschim Medinipur Bankura, Purulia, Parts of Birbhum and Burdwan together contribute about 94% of cashewnut production in the state.

Area, Production and Productivity

The red and laterite zone comprises of more or less 5 districts, viz. Bankura, Purulia, Paschim Medinipur, Parts of Birbhum and Burdwan. The coastal area where cashew is grown comes under only one district viz. Purba Medinipur. Paschim Medinipur District comprises of 4 Sub-Divisions namely Medinipur sadar, Kharagpur, Jhargram, Ghatal. The geographical area of the district is 9,29,528 ha. The soil type comprises of Vindhyan Alluvium and Lateritic soil. The climate is characterized by hot summer, cold winter, abundant rainfall and humidity. The land is characterized by hard rock upland, lateritic covered area, flat alluvial and plain. Extremely rugged topography is seen in western part of the district and rolling topography is experienced consisting of lateritic covered area. The soil is poor to medium fertile. Rivers like Kangsabati, Silaboti, Dulong, Subornarekha, Keleghai and their tributaries are flowing through the district and thereby enriching the cropping system of this district. Net cropped area of this district is about 5,73,575 ha and drought prone area is about 3,35,248 ha. (Jhargram, Kharagpur and Medinipur Sadar Sub-Division). Normal rainfall of this district is 1550 mm and average rainfall is 1522 mm (12 years). Besides agriculture crops, there is ample scope of growing horticultural crops like fruits, flower, specially cashewnut. Cashew nut is cultivated in area of 6925 ha and with a production of 3324 MT.

Table : Block wise cashew cultivation in Paschim Medinipur District

Block	Cashewnut Plantation	
	Area (Ha)	Production (MT)
Medinipur sadar	150	72
Salboni	810	389
Keshpur	850	408
Garbeta-I	1000	480
Garbeta-II .	1050	504
Garbeta-III	930	446 .
Sadar Kharagpur-I	150	72
Narayangarh	150	72
Keshiary	25	12
Jhargram	747	358.6
Nagram	200	96
Sankrail	150	72
Jamboni	175	84
Mohanpur	20	9.6
Binpur-I	178	85.44
Binpur-II	120	57.6
Gopi-I	70	33.6
Gopi-II	100	48
Khareapur-II	50	24
Total	6925	3324

Source: GOWB, 2010 - 2011

Total area of Bankura district is 6,88,200 hectares out of which forest area is 1,47,700 hectares, while the high land and medium land are 1,76,915 and 1,50,611 hectares respectively. The huge land area may be put to productive use by undertaking plantation and other activities, which may generate gainful employment. The population density is 464 per sq. km. (almost half of the state average) and per capita land availability is more. Again highland covers an area of 1,76,915 Hec. where traditional cultivation of paddy is not remunerative. The district with dry climatic condition and vast wasteland has great potential for undertaking plantation. Area of cultivable wasteland in the district is 18,846 hectare, a major part of which can be utilised for the purpose. In Bankura, there are large number of cashew trees but the quality is poor. An effort is being made to introduce Vengurla-4 and H-2/16 variety, which have commercial value. It has been seen that people are highly motivated in taking up this since their own land is utilized for plantation under their ownership.

Purba Medinipur District comprises of 4 Sub-Divisions namely Tamluk, Haldia, Contai, and Egra. The geographical area of the district is 4,30,140 lakh ha. The district is surrounded by the Bay of Bengal and Balasore district of Orissa state in its South, Paschim Medinipur in its West, Howrah district in the North and South 24 Parganas in the East. Purba Medinipur district is mainly a land of agriculture and more than 80% of the total population is residing in

the villages and the rural economy is based on Agriculture and Agro-based small industries. The district Purba Medinipur falls under two agro-climatic zones namely, i) Bindhiya alluvium zone covering 6 blocks ii) Coastal saline zone covering 19 blocks. The Climate of this district is characterized by hot-summer with high humidity, abundant rainfall and moderate winter. On the basis of soil type, rainfall, source of irrigation, the entire district has been categorised under 3 Agro-Ecological situations. Net cropped area of this district is about 304800 ha. The experience of drought and flood are common in this district and sometimes one is followed by another in a year. Normal rainfall of this district is 1683 mm and average rainfall is 1752 mm (12 years average). Cashewnut is cultivated in area of 3430 ha and with a production of 2919 MT and productivity is 851kg/ha.

The district Birbhum situated between 23° 32' 30"(right above the tropic of cancer) and 24° 35' 0" north latitude and 87° 5' 25" and 88° 1' 40" east longitudes, and about 1,757 sq miles (4,550 km²) in area. The climate on the western side is dry and extreme, but is relatively milder on the eastern side. In summer temperatures can shoot above 40 degrees celsius and in winters it can drop to around 10 degrees celsius. It receives annual rainfall of around 1,300 mm, mostly in the monsoon months (June to September). The dry plateau feature makes the land in the west less fertile compared to the plains in the east. Agriculture is dependent upon the rains in monsoon or has to be supplemented with irrigation in other seasons Birbhum is primarily an agricultural district. While forests occupy 159.3 km² of land, 3,329.05 km² are used for agricultural purposes. 91.43 per cent of the population lives in the villages. Around 75 per cent of the population is dependent on agriculture.

Cashew area, production and productivity in West Bengal over the years:

Year	Area ('000 ha)	Production('000 tonnes)	Productivity (kg/ha)
1993-94	6.90	3.99	596
1994-95	7.00	3.28	490
1995-96	8.68	6.96	870
1996-97	9.00	6.00	870
1997-98	9.00	6.00	860
1998-99	9.00	8.00	890
1999-2000	9.00	8.00	900
2000-01	9.00	6.00	900
2001-02	9.00	7.00	780
2002-03	9.00	8.00	890
2003-04	9.00	9.00	760
2004-05	9.00	8.00	800
2005-06	10.00	10.00	950
2006-07	10.00	10.00	1000
2007-08	10.00	10.00	1000
2008-09	11.00	11.00	1000

2009-10	11.00	10.00	909
2010-11	11.00	11.00	1000
2011-12	11.00	5.00	500
2012-13	11.00	12.06	1096
2014-15	11.36	13.00	1096

Source: DCCD, Kochi

GERMPLASM RESOURCES

There are at present 286 germplasm collections, collected from local areas as well as all over the cashew growing states of the country and conserved as clonal progeny at the field gene bank of AICRP on Cashew at the Regional Research Station of the Bidhan Chandra Krishi Viswavidyalaya, Jhargram, Paschim Medinipur district of West Bengal. Collections were made starting from 1982-83 till 2015-16. In the early years i.e during 1982 - 1986 seeds were collected from various cashew growing states and planted as seedling progenies, later selections were made from the seedling progeny during 2004-05 to establish the field gene bank with clonal progenies. Among the 287 germplasms 77 are secondary germplasm accessions, 126 are F1 progenies, 24 are primary germplasms collected from local areas and 60 are varieties from different centres including two varieties developed at the Jhargram centre. Apart from this centre few varieties and germplasm are maintained at the orchard of Department of Spices and Plantation Crops, Faculty of Horticulture, Mohanpur, Nadia, West Bengal.

BREEDING EFFORTS

Efforts on breeding for developing new and region specific varieties were started since 1982 under AICRP on cashew at Jhargram, West Bengal. Initially, the crop improvement in cashew generally included the development of high yielding varieties with bold nut, cluster bearing habit, high yield (> 8kg/tree), higher shelling percentage, less susceptibility to pest and diseases etc. Screening of germplasm for those characters had lead to identification and release of variety named Jhargram- 1 during 1989 and distributed to the farmers for cultivation.



The tree Jhargram-1 is upright and medium compact. The branching is intensive type. The variety flowers in the season of January – February (Mid season flowering type). The nut weight is 5g, bears average 10nuts/panicle and a maximum of 77nuts/panicle, Yield is average 8.5 kg/tree, yield per unit area is 10.46 Q/ha, shelling is 30% with a kernel grade of W320. The apple is very attractive and juicy (54%) with a sugar content of 8.19%.

After almost 25 years, another germplasm was selected and released as Bidhan Jhargram – 2. A selection was made from the cashew seedling population of H-2/15.



The tree of Bidhan Jhargram- 2 is upright with compact canopy; large sized bottle green coloured leaves, intensive flowering (12.8 inflorescence/ m²) and inflorescences are compact, medium length and pyramid shape. It has cluster bearing habit, bold nuts, high shelling percentage, yielded consistently with average yield of more than 8 kg/tree at 6m x 6m spacing. The yield at 7th harvest was 13.5 kg/tree. Its production potential is three times more (2.5 q/ha) than the National average productivity (0.772 q/ha). This variety is not affected by Tea Mosquito Bug (TMB). It is a mid-season flowering variety having 3-4 fruits/ panicle with golden yellow coloured apples. The mean apple weight is about 63 g with juice content of 68.9%. The nuts are bold with average nut weight of 9.2 g, Kernel weight 2.85 g and 32% shelling with W180 kernel count, thus making it suitable for export purpose. The variety is recommended for red and laterite soil zone of east coast of West Bengal. This variety was found superior over popular varieties in the East Coast like BPP-8 and Jhargram-1.

At present breeding strategies has been further concentrated on producing hybrids by crossing between selected mother plants having specific traits.

Through multilocation trials four varieties namely, BPP–8, Dhana, Kanaka and Madakkathara and three germplasm namely H-255, M-15/4 and H-303 have been found suitable and thereby recommended for growing under the red and laterite zone of West Bengal.

CROP MANAGEMENT

Cashew is a neglected crop of West Bengal. Farmers plant cashew in waste upland where there is all sorts of scarcities in the land starting from water to nutrient. Moreover once after planting, upto harvesting very little attention is given to the plants. Once the plants start yielding farmers visit their plots for harvesting the nuts. So generally management part is almost absent except some weeding during the time of harvesting.

AICRP on Cashew, BCKV, Jhargram centre is carrying out research work for proper management of cashew plants in the red and laterite zone of West Bengal since 1982. The technologies developed from the three decade's work are as follows:

Fertilizer dosage of 500 g nitrogen, 250 g P_2O_5 and 250 g K_2O per plant per year produced the best yield and are recommended for the region. The highest yield per plant and per block was recorded from trees planted at 10m x 5m rectangles and 6m x 6m x 6m triangular systems of planting respectively. Sub soil polymulch was found to be an effective method of moisture conservation and helps effectively to overcome the problem of moisture stress during the dry season. In situ cashew leaf composting has been found to add substantial amount of organic manure in soils of cashew plantations. The best time of pruning has been standardized and it is during July to August.

Pigeon pea was found to be the best suitable intercrop in cashew plantation with maximum profit under West Bengal condition during initial years of plantations. Other suitable intercrops are cluster bean, black gram and groundnut. During winter season if irrigation facilities are available then seed spices like coriander, dill and fenugreek are suitable intercrops under cashew plantation. Under high density plantation 6m x 4m spacing was recommended with a fertilizer dose of 150 Kg N + 50 Kg P_2O_5 and 50 Kg K_2O per hectare per year. Farmers of the state are regularly trained on various aspects of cashew orchard management, but response is nominal.

CROP PROTECTION

Among factors reducing the yield of cashew, insect pests are the most important ones. It has been recorded that neglected plantations suffer more due to different insects. During 2014-15 the AICRP on cashew, Regional Research Station, Jhargram, Paschim Medinipur had surveyed different locations of cashew growing area to find out the insect pest status and demonstrated the techniques to manage pests.

The insect pests mainly observed were Cashew Stem and Root Borer, Leaf and Blossom Webber, Leaf Miner, Thrips, Shoot tip Caterpillar, Tea Mosquito Bug, Apple and Nut Borer, Aphids, Mealy Bugs etc. Cashew stem and root borer was recorded one of the most important pest in this region. Mainly two species of CSRB were observed in West Bengal i.e. *Batocera rufomaculata* and *Placaederus ferrugineus*. The pest incidence starts from April onwards and peak infestation noticed during June-September and there after decreases. Economic loss caused by this insect is severe and ranges from 4-20% in this state. Leaf and blossom webber (*Lamida moncusalis*) is another important pest in this state. It is an occasional pest but having potentiality to cause damage on foliage. During 2014-15 there was huge infestation of this insect. Economic damage may reach up to 80%. Leaf miner (*Acrocercops syngamma*) is a regular pest of this area and almost all the local, hybrid, high yielding varieties are infested by this insect. Mainly new flushes are infested more and pest incidence was observed year round. Economic losses range from 5-10%. Two species of thrips namely black and yellow are observed in this state. The pest

infestation starts in new flush and after initiation of panicle they move to panicle and continue sucking cell sap upto maturity of apple and nut. The pest incidence is observed throughout the year and huge flower drop observed due to attack of thrips. Shoot tip caterpillar was mostly observed after vegetative flush. The infested main tip die due to pest attack but side branches initiated. These side branches also bear panicle but the nut quality is very poor. The pest incidence mainly observed in November to January. Economic losses range from 3-10%.

Tea mosquito bug was absent in this region earlier but from last two years there is high incidence of this sucking insect. The insect appears in a sporadic way during November and continue to cause damage upto February. Some varieties were recorded very susceptible to this pest (Priyanka, Bidhan Jhargram - I). Although this was a negligible insect of this state but day by day it is becoming one of the major problems of this region. Apple and nut borer usually observed in late part of fruiting season. During 2014-15 the pest incidence was observed from February and continue upto March. The pest attacks both apple and nut and immature stages suffers most.

Minor insects :- A few minor insects were also observed while doing the survey. Among those minor insects aphids and mealy bugs are important. These insects were observed in few locations and extent of damage is very negligible.

Natural enemies :- During the survey as well as in the experimental plots of AICRP at Jhargram centre, some beneficial insects were also recorded and those are different species of coccinellids and spiders, braconids. Ichneumonid wasp, chrysoperla etc. Among these spiders and coccinellids were predominant .

POST HARVEST PROCESSING

There are over 250 processing units in the industry, processing and roasting cashew nuts. Over 1,000 people work in this cluster, annual turnover is Rs. 137 Million. Central Co-operative Banks The major markets for the sale of the roasted cashewnuts are Uttar Pradesh, West Bengal, Bihar and New Delhi. All the processing units in this industry are small and micro firms. Major products from processing units of West Bengal are Special Grade (W-180), Double (W-240), W-320, American (W-320), JH (Special and Double half variety), SP (Split- smaller than JH), 1/4th (Small Broken) The industrialists face several problems in the processing of cashewnuts The traditional process is followed by the cluster and there is no recovery of CNSL in the roasting process. There is a lot of breakage of finished cashew kernels. The availability of raw cashew nut is seasonal and hence production is dependent on availability at competitive prices and market demand. Only 6-8% of the requirement of raw cashew nuts is met from local sources and the rest is procured from outside states like Orissa, Andhra Pradesh, Assam, Tripura and Meghalaya. Cost of procurement of raw material is high due to the above mentioned reason. Comparatively large units market their product at their own level. There is no export from the cluster till date.

The Paschim Medinipur district is predominant in agriculture with 70% of the population dependent on agriculture and allied activities. At the same time, huge potential exists for various industrial activities in the district. Presently, the main industrial area is around Kharagpur. Small Scale industrial clusters are also coming up in Jhargarm, Chandrakona Road, Garhbeta and Midnapore. These units are based on agriculture, forest produce, animal husbandry, chemicals and engineering. Therefore, there is great scope for promoting entrepreneurs for establishing cashew-processing units around this zone. Establishment of cashew processing units at the growing areas will definitely support the farmers to get the exact price of raw nut. The existing industries in Purba Medinipur where improvement, technological up-gradation and further investments can be profitably done include units based on cashew processing and packaging.

RECIPES

All over the world it is known mostly by its nuts owing to its unique taste, free availability and multifarious uses in the kitchen, bakery and confectionery. In West Bengal also all forms of the cashew kernel is used for preparation of various recipes starting from sweet dishes to bakery products, curry, fries, and health drinks etc. Immature kernels are also used to make curry with past of poppy seeds and mustard.

But usually cashew apple is not utilized for making any household recipes. The tribal people consume its juice as fresh or after fermentation and making country liquor. It is also taken away by the tribals for feeding the cattle. Though AICRP on Cashew is training the tribals for utilizing cashew apple for making syrup, jam, RTS etc., but it has not been popularized till now.

TRADITIONAL KNOWLEDGE ASSOCIATED WITH CASHEW

Cashew is planted in West Bengal since long back in the coastal areas of Bay of Bengal such as Digha, Contai, Ramnagar areas of the district of Purba Medinipur. It was spread in those area as a soil binding and erosion checking forest. Later on for the similar cause it has been introduced to the Western part of the state with red and laterite soil cover. Therefore, the people of those areas were acquainted with this plant since long back. They utilize almost all parts of the cashew plant for various purposes. The wood, dry leaves and shell of nut are used as firewood. Cashew Nut Shell Liquid is utilized as lubricating oil for bullock cart and also as insecticide. The cashew apple is used for making country liquor.

ROLE OF DEVELOPMENTAL AGENCIES AND OTHER LINE DEPARTMENTS

The West Bengal government is planning to set up an agri export zone for cashew nuts spanning the districts of Midnapore (East and West), Bankura, Birbhum and Purulia. The state government had mandated knowledge services organisation Cygnus Business Consulting and Research to carry out a feasibility study for the proposed export zone. The report, which was submitted recently, says that there is enormous potential for increasing production, processing and export of cashew nuts from the state. However, it is not likely to happen unless the state government initiates modernization of the entire value chain of farming like improved variety of seeds, better harvesting practices and adherence to international packaging standards. The Cygnus report has envisaged an investment of Rs 11.58 crore, 40% of which will come from the Centre, 10% from the state government and the remaining from private parties. It has also suggested that the initiative will improve the yield per hectare and increase the price realisation for the cashew nut growers of the areas.

In West Bengal, location specific activities were identified by NABARD in consultation with the participant tribal families and these include development of horticulture gardens with cashew. Wadi projects are aimed at tribal welfare through job creation. The project in West Bengal is estimated to benefit nearly 2,800 tribal families in Bankura, Birbhum etc (www.business-standard.com). Total 1000 WADI established in 1000 acre of land. Total 30000 Cashew Plants Planted under Bandwan Block, Purulia district, WB.

Area expansion programme of cashew in West Bengal has been encouraged by different government as well as non-government agencies over the years. These agencies are Department of Agriculture & Department of Horticulture of Government of West Bengal, some NGOs like Nari Vikas Sangha, Gramin Vikas Trust, PRADAN, Centre for Women's development studies etc.

FUTURE PROSPECTS OF CASHEW

Research Needs

- Developments of region specific high yielding varieties keeping in mind the soil and climate.
- Enhancement of productivity of the bold nut types through hybridization.
- Development and standardization of techniques for organic cashew cultivation.
- Utilization of remote sensing and sensor / microchip technology in pest management.
- Emphasis on cashew diseases and its management specially in cashew nurseries.
- Utilization of pheromone technology in cashew pest management.
- Frost tolerant types need to be selected from the existing germplasm of N-E states.

Strategies for increasing productivity

- Senile seedling plantations to be replaced by phased manner with well performing varieties.
- Rejuvenation of the old plantations by adopting proper management practices.
- Water harvesting and soil conservation measures required to be adopted to check the excessive fruit drop due to lack of moisture during fruit setting.
- Proper agro-techniques to be adopted from the very beginning of planting thereby healthy cashew orchards can be established.
- Development of more efficient pest management strategies to minimize the avoidable losses due to insect pests and diseases.
- Crop improvement by crossing between plants bearing bold nuts, high yielding, nuts with high shelling percentage with plants bearing nuts in cluster, high yielding, high shelling percentage.
- Training of rural women and youth on plant propagation techniques of cashew to popularize cashew grafts among the farmers.

Strategies for increasing production

- Area expansion by bringing potential areas of traditional cashew regions and expanding cashew cultivation to non – traditional areas.
- Adopting modern as well as indigenous efficient technologies for utilizing nutrient, water and pest management techniques.
- Rejuvenation of the old plantations by adopting proper management practices.
- Replacement of seedling non- productive orchards with high yielding types.
- Potential new areas should be identified in the traditional and non-traditional areas of West Bengal.
- Policy decision needs to be taken up at state level to bring non-traditional areas under cashew cultivation.
- Programmes like area expansion under National Horticulture mission should continue.
- Engagement of the private organizations for dissemination of the technologies to the appropriate community.

STATUS OF TRIBAL SUB-PLAN PROJECT

AICRP on Cashew, RRS, BCKV, Jhargram Centre is implementing Tribal Sub Plan programme in the districts of Paschim Medinipur and Purulia in West Bengal since 2013. During the past three years 10 training programmes were organized and in each training programme 50 tribal farmers were trained on various aspects of cashew cultivation. The tribal villages adjoining to Jhargram subdivision were selected for implementation of area expansion programme. There were 22 families showed interest in cashew cultivation. But they have very little land of their own,

therefore, ultimately 10 farmers were selected for area expansion programme. Total land area was 10 ha. BPP – 8 variety was supplied to them. The plants were spaced at 7m x 7m distance. Pit size was 60 cm x 60 cm x 60cm. The women farmers of the village (32 Nos.) had done the works like digging of pits, application of manure and fertilizer, planting of grafts, mulching with black polythene etc. Employment generated was 899 man days among which 739 man days were for women. Total numbers of grafts planted were 2300. They were given practical training on layout and land preparation, pit digging, planting of cashew grafts, mulching with polythene. The area was fenced with bamboo and polynet.

The nursery was established at Patharchakri village, in the Jhargram block. The women farmers of the village had taken training on nursery activities of cashew. There were 32 members. They have given polythene packets, punching machine, polythene tubes, grafting knives, agroshed net, polypipes, polynet, vermicompost, cow dung manure, neem cake, fertilizer, mustard cake, cashew seed (one quintal) etc. Two shades were established, one with bamboo and straw and another with concrete pillar and asbestos. One dug well was constructed.

The processing unit was established at the godown of the Tribal Cooperative Society at Jhargram which was rented by a Self Help Group namely Jaher Ayo S.H.G., Panisola A.M.S.V. having ten members for running the cashew processing unit.

MAJOR CONSTRAINTS IN CASHEW CULTIVATION AND PROCESSING

In West Bengal, originally cashew was introduced for afforestation programme, particularly in those areas that were infertile and experienced dry climatic conditions. However, later on expansion in area under cashew was carried out for the economic value of cashew. In general, cashew receives very little attention as a crop. It is considered more as a forest tree rather than horticultural crop, since cashew does not require much attention compared to other crops. Therefore, growers incur minimal production costs for maintenance of cashew orchards.

Most of the cashew orchards in West Bengal are still seedling plantations of non-descriptive origin. The farmers are not interested growing high yielding grafted cashew plants. This is because grafted cashew requires more care than seedling ones. The farmers generally grow cashew on wastelands and they never invest for the management of the crop. Whatever return they obtain after few years from the wasteland is realized as profit.

Mostly, the farmers use a spacing of 15 ft X 15ft. for planting seedling cashew plants and the only orchard operation they follow is harvesting in the dry season. Therefore, after a few years the trees develop large canopies. Even after harvest, the left out seeds germinate during the rainy season and gradually grow into big trees. Some of the forest trees also grow in between the cashew plants. Consequently, lack of removal of those plants out of place resulted in severe overcrowding and low productivity as trees advance in age. Low yields in cashew have also been attributed to pest and disease incidence.

Cashew is usually grown on marginal lands where farmers face long dry periods without any access to irrigation, it is not only the area of land and resources that is limiting but also the high labour inputs required to grow many annual crops during the short rainy season. Since the family labour is relatively and frequently unemployed, some income from crops like cashew helps to supplement family income and cashew planting and harvesting is often carried out by family labour.

West Bengal lacks in processing units. Apart from Purba Medinipur district, there is no processing unit at all in other cashew growing areas. Therefore, growers market their produce through local traders and middlemen who collect and supply processors in Orissa. Prices at farm-level are not remunerative because of the middlemen. Since cashew can assure a good income, considering the range of products it can give from the nut alone, the problems facing the production sector need to be given attention. These include the limited supply of grafted plants of recommended varieties, occurrence of pests and diseases, especially anthracnose during the reproductive phase, low level of knowledge of farmers on production and post-harvest technologies brought about by poor communication links to production areas and the lack of financial resources for farmer groups to embark on processing of their crop of nuts and cashew apples. There is a wide gap in the extension follow up after implementing various schemes of cashew under National Horticulture Mission.

EDUCATION IN CASHEW

Name of the student	M.Sc. / Ph.D.	Year of completion	Thesis title
N. Chattopadhyay	Ph.D.	1993	Evaluation of germplasm and standardization of agro-techniques for cultivation of cashew in laterite zone of West Bengal.
Mini Poduval	Ph.D.	2002	Some aspects of organic management of cashewnut plantation
Khurshid Alam	Ph.D.	2007	Cashew Based Cropping System and evaluation of cashew germplasms in the new alluvial zone of West Bengal.
L.S.Singh	M.Sc.	2007	Effect of biofertilizers and nitrogenous fertilizer on growth, performance of six genotypes of cashew under Terai Agroclimatic zone of West Bengal.
Dipak Murmu	M.Sc.	2009	Evaluation of cashew germplasms in the new alluvial zone of West Bengal.
Ashok Mal	M.Sc.	2009	Soft Wood Grafting in Cashew
L.S. Singh	Ph.D.	2011	Effect of plant bio regulators (PGRs) on flowering, fruit-set and yield of cashew var. Jhargram-1 and on growth and graft success of cashew rootstock.
Mohinur Rahaman Biswas	Ph.D.	2014	Nutrient Management of Seed Spices under cashew scion Bank in the red and laterite zone of West Bengal.

MAIN RESEARCH WORKERS IN CASHEW

Name and designation	Organization	Present status Working/retired	Major areas of research	Present address with phone/mobile number
Dr. S.N. Ghosh, Professor	B.C.K.V.	Working	Crop Improvement, Nutrient management, Orchard Management etc.	Dept. of Fruits and Orchard Management, F/Horticulture, BCKV, Mohanpur, Nadia, West Bengal- 741 252 Ph. 09433224649
Dr. J.K. Hore, Professor	B.C.K.V.	Working	Propagation, Orchard Management	Dept. of Spices and Plantation Crops, F/Horticulture, BCKV, Mohanpur, Nadia, West Bengal- 741 252, Ph. 09477473506
Dr. Monilal Chatterjee, Professor	B.C.K.V.	Working	Plant Protection	Dept. of Agril Entomology, F/Agriculture, BCKV, Mohanpur, Nadia, West Bengal- 741 252
Dr. A. Bandopadhyay, Professor	B.C.K.V.	Retired	Breeding, Orchard Management	Dept. of Spices and Plantation Crops, F/Horticulture, BCKV, Mohanpur, Nadia, West Bengal- 741 252 Ph.09432230746
Dr. B. Bandopadhyay, Professor	B.C.K.V.	Working	Plant Protection	Dept. of Agril Entomology, F/Agriculture, BCKV, Mohanpur, Nadia, West Bengal- 741 252 Ph. 09432749348
Dr. Narayan Chatterjee, Professor	B.C.K.V.	Working	Orchard Management	Dept. of Spices and Plantation Crops, F/Horticulture, BCKV, Mohanpur, Nadia, West Bengal- 741 252 Ph. 09433614472
Dr. Sudarshan Chakraborty, Professor	B.C.K.V.	Working	Plant Protection	Dept. of Agril Entomology, F/Agriculture, BCKV, Mohanpur, Nadia, West Bengal- 741 252 Ph. 09433172986
Dr. S.B. Chattopadhyay, Professor	B.C.K.V.	Working	Orchard Management	Dept. of Vegetable Crops, F/Horticulture, BCKV, Mohanpur, Nadia, West Bengal- 741 252
Dr. Mini Poduval, Associate Professor	B.C.K.V.	Working	Crop Improvement, Crop Management	AICRP on Cashew, RRS, BCKV, Jhargram Paschim Medinipur, West Bengal – 721 507 Ph. 09434990054

ANY OTHER RELEVANT INFORMATION

Vast area of wasteland is available in the red and laterite zone of West Bengal. The waste lands are either uplands or medium lands with undulating topography. Cashew is the most suitable one for those undulating, semi arid, red and laterite zone because of its shallow and fibrous root system, nature of tolerance to drought, ability to check soil erosion, low requirement of water and nutrition. Cashew is largely grown in the state, mostly in the coastal belt areas under the Contai Sub-Division and in some parts of Jhargram and Paschim Midnapore. The crop has good prospect in the Bankura and Purulia districts. Most of the cashew grown in West Bengal is by default organic. But there is a great prospect of growing organic cashew under West Bengal condition by adopting various scientifically accepted and proved organic technologies. In West Bengal the incidence of tea mosquito bug is rarely noticed. Therefore, there is almost no risk of crop failure due to the devastating pest.

Cashew nurseries can be established by training of the self help groups. Thereby employment generation among the youth or women folk of the resource poor areas can be ensured. To increase the productivity of the old seedling cashew plantations rejuvenation technologies can be adopted and such orchards aging more than 25 years are recommended for gradual replacement with high yielding cashew varieties. Research priorities for the state should be projected towards development of region specific varieties through selection from the existing wealth of germplasms in different districts of West Bengal and also hybrids with specific required characteristics. Prospects are there to introduce water-harvesting structures in the uplands for intensive cultivation with intercrops under the cashew plantations. Recycling of the cashew biomass through composting would be beneficial for converting the uncultivable wastelands into fertile lands. Definite pest specific plant protection campaign needed to be regularized for creating awareness among the farmers. Proper and timely plant protection measures would definitely increase the productivity of the cashew trees.

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