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भा.कृ.अनु.प. - काजू अनुसंधान निदेशालय

ICAR-DIRECTORATE OF CASHEW RESEARCH

DARBE (P.O), PUTTUR-574 202, DAKSHINA KANNADA, KARNATAKA

TRAINING MANUAL

20th - 22nd MAY 2026



**National Workshop on Scientific Innovations for
Sustainable Cashew Production and Value Chain Development**

SPONSORED BY: DIRECTORATE OF CASHEW AND COCOA DEVELOPMENT (DCCD),
KOCHI, KERALA



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FOREWORD



Dr. Femina
Director



काजू एवं कोको विकास निदेशालय
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Cashew is an important horticultural crop of India, supporting the livelihoods of farmers, rural communities and a large workforce engaged in processing and value addition. India is a major producer and consumer of cashew, with 12,04,861 hectares under cultivation and 8,02,349 metric tonnes of raw cashew nut production during 2024-25. However, the growing requirement of the domestic processing industry continues to exceed domestic production. During 2025-26, India imported 14,85,994 metric tonnes of raw cashew nut, while 30,533 metric tonnes of cashew kernels were exported, highlighting both the gap in domestic raw nut availability and India's significant strength in processing and value addition. The increasing domestic and global demand therefore calls for greater emphasis on enhancing productivity, adopting modern technologies, improving quality and strengthening the entire cashew value chain.

Achieving these objectives will require concerted efforts in research, technology development and adoption, extension, capacity building and effective dissemination of scientific practices among those involved in the sector.

Recognising these priorities, the Directorate of Cashewnut and Cocoa Development (DCCD), in collaboration with ICAR-Directorate of Cashew Research (DCR), Puttur, organised the National Workshop on “Scientific Innovations for Sustainable Cashew Production and Value Chain Development” during 20th-22nd May 2026 at ICAR-DCR, Puttur, Karnataka. The workshop aimed to strengthen the technical capacity of officials associated with cashew development and familiarise them with recent scientific advances and innovations.

This training manual provides a practical reference for extension personnel, scientists and other stakeholders involved in cashew development. It promotes the adoption of scientific practices and highlights key areas for the future growth of the Indian cashew sector, including improved planting material, plantation rejuvenation, efficient resource management, climate resilience, mechanisation, pest and disease management, modern processing and value addition, with greater emphasis on strengthening domestic raw cashew production.

I am confident that this training manual will serve as a valuable reference for all those engaged in the development of the cashew sector and will contribute to translating scientific innovations into practical field-level interventions. I place on record my appreciation to ICAR–Directorate of Cashew Research, Puttur, and all the scientists, experts, officers and participants whose contributions made the National Workshop a meaningful platform for knowledge sharing and capacity building.

(Dr. Femina)
Director

PREFACE

Cashew occupies a significant place in India's horticultural economy, contributing to farm livelihoods, rural employment, processing and trade. At the same time, the sector is confronted with emerging challenges, including declining productivity in several production systems, climate variability, changing pest and disease dynamics, increasing demand for raw cashew nuts, labour constraints and the need for greater value addition. Addressing these challenges requires a coordinated approach that brings together scientific innovations, effective technology transfer and stronger linkages among research institutions, developmental agencies, industry and farming communities.

It is in this context that the National Workshop on Scientific Innovations for Sustainable Cashew Production and Value Chain Development, sponsored by the Directorate of Cashew and Cocoa Development (DCCD), Kochi, was organised at ICAR–Directorate of Cashew Research, Puttur, from 20–22 May 2026. The workshop was envisaged as a platform for capacity development of State-level Horticulture and Agriculture officials, scientists of AICRP centres on Cashew and ICAR institutes, and officers of Plantation Corporations. The participation of stakeholders from different cashew-growing states provided an important opportunity for sharing experiences, identifying region-specific challenges and strengthening coordinated efforts for the development of the Indian cashew sector.

The present training manual has been prepared as a resource to support the technical sessions and facilitate continued use of the knowledge gained during the workshop. It brings together important advances and practical recommendations related to high-yielding cashew varieties, commercial nursery management, improved planting systems, climate-resilient production, nutrient management, mechanisation and drone applications, integrated management of pests and diseases, pollinator conservation, information and communication technologies, cashew-based cropping systems, cashew apple and nut value addition, cashew processing and technology commercialisation.



A major emphasis of the workshop was on translating scientific knowledge into field-level action. Technologies developed through research can contribute meaningfully to the sector only when they are effectively transferred, demonstrated and adopted. In this regard, the Directorate remains committed to strengthening the interface between research and practice and to supporting stakeholders with validated technologies and practical knowledge for improving productivity, profitability and sustainability.

I am confident that this training manual will serve not merely as a reference document for the three-day workshop, but also as a practical knowledge resource for extension personnel, scientists, development officials and other stakeholders involved in cashew development. I hope that the knowledge and technologies presented here will be taken forward through field demonstrations, capacity-building programmes, institutional collaborations and farmer-oriented initiatives.

I place on record my sincere appreciation to all scientists and technical staff of ICAR–Directorate of Cashew Research, Puttur, and the collaborating institutions and organisations who have contributed to the preparation of this manual and the conduct of the workshop. I also acknowledge the support extended by DCCD, Kochi, and the participation of delegates from different cashew-growing states.

I wish all participants a fruitful learning experience and hope that the collective efforts initiated through this workshop will contribute towards a more productive, resilient, competitive and value-oriented Indian cashew sector.



J. Dinakara Adiga,

Director ICAR – Directorate of Cashew Research, Puttur, Karnataka

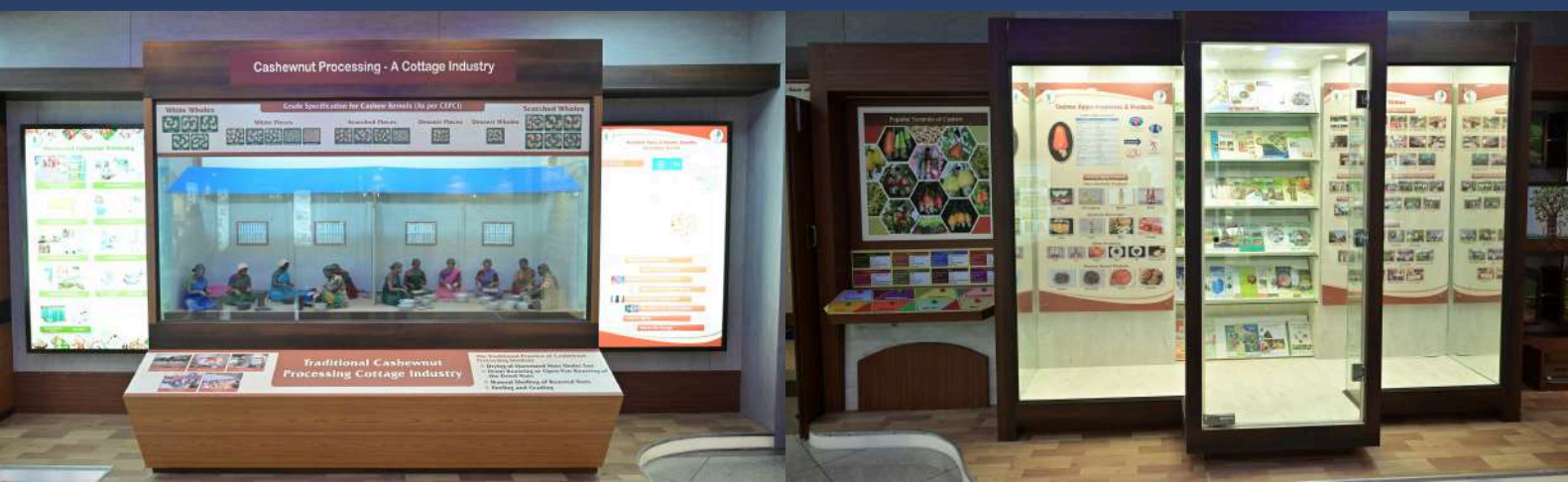
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Popular Cashew Varieties in India

Dr. Eradasappa E and Dr. Mohana. G.S.

Introduction

Cashew belongs to family Anacardiaceae and cultivated species is botanically named as *Anacardium occidentale* L. It is a fast growing; evergreen perennial tree well suited to the wet / dry tropical climate. The tree has a long productive life, perhaps up to 50 years, however in poor conditions the economic life of tree would be reduced. The main product of cashew is nut containing a kernel. Cashew fruit (also known as cashew apple) and cashew nut shell liquid (CNSL) are the other products. The nut is processed for edible kernel which is the economic product because of its taste and nutritional value. The cashew apple has various uses; it can be eaten as fresh fruit, or processed into juice and other products like jam, jelly, cider, pickles etc. Feni, a popular liquor is produced from cashew apple in the state of Goa. CNSL oil is a by-product obtained during the processing of raw cashew nuts from the spent shells of the nuts and is used in friction linings, paints, varnishes and other industrial applications.

Although cashew is native to Brazil, it has spread to many tropical countries of the world. Top five cashew producing countries are Côte d'Ivoire, India, Vietnam Tanzania and Benin (Source: FAOSTAT, 2024). The major export markets for the kernel are USA, Europe, Canada, Japan and Australia. China has also emerging as a major market. At present India is the largest consumer of cashews in the world and hence has huge potential in domestic market.

Although cashew is native to Brazil, it has spread to many tropical countries of the world. Top five cashew producing countries are Côte d'Ivoire, India, Vietnam Tanzania and Benin (Source: FAOSTAT, 2024). The major export markets for the kernel are USA, Europe, Canada, Japan and Australia. China has also emerging as a major market. At present India is the largest consumer of cashews in the world and hence has huge potential in domestic market.

The production of cashew in India 7.38 lakh tonnes from an area of 11.59 lakh ha with productivity of 637 kg / ha (FAOSTAT, 2024). Whereas the requirement is 17 lakh tonnes per year. Thus there is shortfall of more than 50% in raw cashew nut production and hence India imports raw nuts from African countries. There is also threat for the import nowadays as African countries have started processing of cashew.

The productivity is low particularly in Karnataka, Goa, Tamil Nadu, Andhra Pradesh and Odisha. The main factors for low productivity in these states are the large plantations under seedling origin of non-descript types, senile in nature and with poor management practices. In this context, cultivation of high yielding varieties is the most important step in improving the productivity of cashew. So it is imperative to grow high yielding cashew varieties adopting scientific cultivation practices for increasing the domestic production.

Development of High Yielding Cashew Varieties

Crop improvement research in India through evaluation of germplasm collections and hybridization and selection resulted in development and release of 68 varieties for cultivation. These varieties have been released from different research centers of SAUs and DCR (formerly NRCC). Among these varieties, 37 are selections and 28 are hybrids (Table 1).

Table 1: Center-wise cashew varieties released in India

Center	No.	Varieties Released
East coast		
Bapatla (YSR Hort.Univ, West Godavari)	9	BPP-1 to BPP-6, BPP-8, BPP-10, BPP-11
Vridhachalam (TNAU, Coimbatore)	5	VRI-1, VRI-2, VRI-3, VRI-4, VRI-5
Bhubaneswar (OUAT, Bhubaneswar)	4	Bhubaneswar-1, Jagannath, Balabhadra, Subhadra (OUAT Kalinga Cashew-1)
Jhargram (BCKV, Kalyani)	3	Jhargram-1, Bidhan Jhargram-2, Bidhan Bonsai Kaju
West coast		
Vengurla	9	Vengurla-1 to Vengurla-10 MB
Goa	6	Goa-1, Goa-2, Goa Cashew-3, Goa Cashew-4, Goa Cashew-5, Goa Cashew-6
Anakkayam (KAU, Thrissur)	4	Anakkayam-1, Dharashree, Akshaya, Anagha
Madakkathara (KAU, Thrissur)	11	K-22-1, Madak-1, Madak-2, Kanaka, Dhana, Priyanka, Sulabha, Amrutha, Damodar, Raghav, Poornima
Pilicode (KAU, Thrissur)	1	KAU Nihara
Ullal (UAHS, Shivamogga, Karnataka)	5	Ullal-1, Ullal-2, Ullal-3, Ullal-4, UN-50
ICAR-DCR Puttur	8	NRCC Selection-1, NRCC Selection-2, Bhaskara, Nethra Ganga, Nethra Vaaman, Nethra Jumbo-1, Nethra Ubhaya, Nethra Jumbo-2
Maidan Area		
Chintamani (UAS, Bengaluru) (Now Hogalagere, UHS, Bagalkot)	2	Chintamani-1 and Chintamani-2
Jagdarpur (IGKV, Raipur, Chhattisgarh)	1	Indira Kaju-1
Total	68	Selections : 37; Hybrids: 31

An attempt has been made in this chapter to present salient features of some popular and latest released cashew varieties and presented below.

AICRP Centers Map



AICRP ON CASHEW

- | | | |
|--|--|--|
| <ul style="list-style-type: none"> Guntur District, Andhra Pradesh
Cashew Research Station, (Dr. YSRHU) | <ul style="list-style-type: none"> Bhubaneswar, Odisha
Cashew Research Station, (OUAT) | <ul style="list-style-type: none"> East Singhbhum Dist, Jharkhand
Zonal Research Station, (BAU) |
| <ul style="list-style-type: none"> Ela, Old Goa, Goa - 403 402
ICAR - Central Coastal Agricultural Research Institute | <ul style="list-style-type: none"> Srinivasapura, Kolar Dist., Karnataka
Horticultural Research and Extension Centre, (UHS) | <ul style="list-style-type: none"> Jagdalpur-494 005, Chattisgarh
Zonal Agricultural and Research Station, (IGKV) |
| <ul style="list-style-type: none"> Midnapore West District, West Bengal
Regional Research Station, (BCKV), Jhargram | <ul style="list-style-type: none"> Belagavi Dist., Karnataka.
Horticultural Research and Extension Centre, (UHS) | <ul style="list-style-type: none"> Thrissur Dist., Kerala
Cashew Research Station, (KAU) |
| <ul style="list-style-type: none"> Valsad District, Gujarat
Agricultural Experimental Station (NAU) | <ul style="list-style-type: none"> Kasaragod District, Kerala
Regional Agricultural Research Station, (KAU) | <ul style="list-style-type: none"> Sindhudurg Dist., Maharashtra
Regional Fruit Research Station, (Dr. BSKKV) |
| <ul style="list-style-type: none"> Cuddalore District, Tamil Nadu.
Regional Research Station, (TNAU), | <ul style="list-style-type: none"> Tura, West Garo Hills Meghalaya, 14. ICAR
Research Complex for North Eastern Hilly Regions | |

Varieties released from AICRP (Cashew) Center, Bapatla, Dr.YSR Horticultural University, West Godavari,



BPP 8 (H 2/16)

BPP 8

It is a hybrid (H2/16) derived from the cross Tree No.1 x Tree No.39 and released in 1993 for general cultivation in Andhra Pradesh. It has been performing well in Orissa and West Bengal also.

This variety is superior to all the other six varieties developed from Bapatla. The variety has mean yield of 14 kg/tree with better nut size (8.2g). Shelling percentage (29%) of this variety is also better than the rest of the varieties released from Bapatla so far. Kernel grade is W 210 (export grade).

Varieties released from AICRP (Cashew) Center, Vridachalam, TNAU, Tamil Nadu

VRI-3

This is a selection from seedling progeny of a high yielding tree collected from a village Edayanchavadi in South Arcot District of Tamil Nadu and was released in 1991. It has 12.1% perfect flowers. The average yield of this variety is about 10 kg/tree, thus the increase over VRI-2 and VRI-1 being 35 to 39% respectively. The nut size is medium with 7.2g nut weight and shelling percentage of 29.1%. The kernel grade conforms to W 210 export grade. This variety is picking up fast among farmers of not only of Tamil Nadu but also of other states.



VRI (Cw)-5

It is a hybrid developed from the cross M 26/2 (VRI-3) x M 26/1. This was released in the year 2007. The canopy type is compact and branching habit is spreading. The average yield of this variety is about 13.2 kg/tree. The nut size is medium with 7.2g nut weight and shelling percentage of 30.5%. The kernel grade is W 210. 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.

Varieties released from AICRP (Cashew) Center, OUAT, Bhubaneswar, Odisha

Bhubaneswar-1

It is a selection from seedling progeny of WBDC V (Vengurla 36/3), a collection from Regional Fruit Research Station, Vengurla and released in 1989. Flowering season is from January to March with medium duration of 70 days. It has cluster bearing habit with about 12 fruits per bunch. This variety has average yield of 10 kg/tree with small nut size (4.6g nut weight). The shelling percentage is high (32%) with kernel grade of W 320. It has been found suitable for cultivation in the sandy and laterite soils of the East Coast.



Jagannath (BH 6)

It is a mid-season flowering (Jan-Mar) variety having bold nuts with 8.6 g nut weight. The variety gives an average nut yield of 2.1 t/ha (10.5 kg/tree) and possesses high shelling percentage (32.5 %).



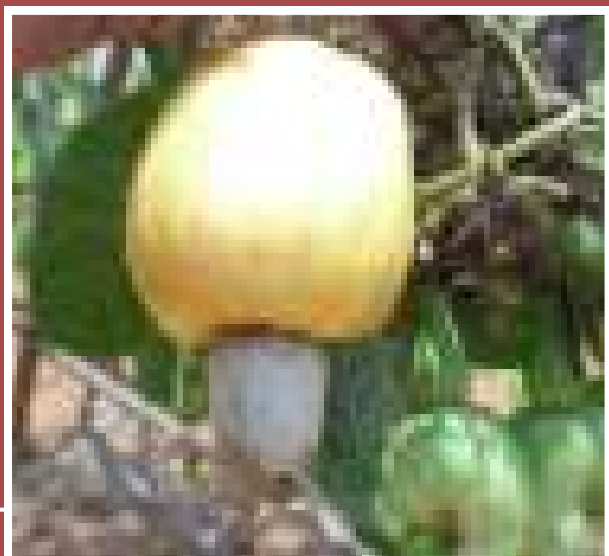
Balabhadra (BH 85)

It is an Early flowering (Dec-Feb) variety having bold nuts with 7.4 g nut weight. The variety gives an average nut yield of 2.0 t/ha (10.0 kg/tree) and possesses high shelling percentage (30.0 %).



Subhadra (OUAT Kalinga Cashew-1)

It is a hybrid variety released in the year 2023 for the state of Odisha. It starts flowering from Jan-Feb and harvesting season is Mar-May. It gives bold nuts with 8.6 g nut weight. The variety gives nut yield of 12.33 kg/tree and possesses high shelling percentage (30.65 %). Kernel weight is 2.6 g and export grade is W 180.



Varieties released from AICRP (Cashew) Center, Jhargram, BCKV, Kalyani, West Bengal

Jhargram-1

It is a selection from T.No.16 originally collected from Bapatla. It was released in the year 1989. It has a medium compact canopy and intensive branching habit. It has on an average, 6 fruits per bunch and yield of 8.5 kg/tree with small nut size (5g nut weight). Shelling percentage is 30 and kernel grade is W 320.

Bidhan Jhargram-2

It is selection made from seedling plantation of H-2/15 of Regional Research Station, Bidan Chandra Krishi Viswa Vidyalaya, Jhargram, West Bengal.

The variety has mid-season flowering habit with 3-4 fruits per panicle. Apple is golden yellow with a weight of 63g and a mean juice content of 68.9 per cent. The average nut weight is 9.2g with a kernel weight of 2.85g and high shelling (32%). The kernel grade is W 180. The variety can yield 13.5 kg/tree in 7th harvest.



Bidhan Bonsai Kaju

It is selection made from seedling plantation of A-18/4 of Regional Fruit Research Station, Vengurla, Maharashtra. It was released in the year 2023 for the state of West Bengal. It is an early flowering type (Feb-Jan) and harvesting season is May-June at Jhargram condition. It is a pruning responsive variety and suitable for ultra-high density (3m × 3m) and high density (4m × 4m) planting system. It is a cluster bearing type with 9-21 nuts per panicle. Apple is red with average weight of 34.5g and a mean juice content of 71.0 per cent. The nuts are small with average nut weight of 4.9g and kernel weight of 1.5g and high shelling (33.06%). The kernel grade is W 320. The variety can yield 14.6 kg/tree in 5th harvest (6m × 6m).



Varieties released from AICRP (Cashew) Center, Vengurla, KKV, Dapoli, Maharashtra

Based on the evaluation of selections from germplasm and hybrid progenies in varietal evaluation trials conducted at Regional Fruit Research Station, Vengurla, the Konkan Krishi Vidyapeeth (KKV), Dapoli has released the following seven varieties for cultivation in Maharashtra. These varieties have been found to perform well in Goa also. Vengurla-1 and Vengurla-4 are doing well in Uttar Kannada district of Karnataka also. Varieties such as Vengurla-4 and Vengurla-7 are in great demand from farmers.



Vengurla-7

Hybrid 255 evolved at Regional Fruit Research Station, Vengurla under Konkan Krishi Vidyapeeth, Dapoli was recommended for release under the name "Vengurla-7" in the XIII Biennial Workshop of AICRP on Cashew held in November 1997. Vengurla-7 is a hybrid developed from the cross Vengurla-3 x M 10/4 (VRI-1). The percentage of perfect flowers is very high (40%). Average yield is 18.5 kg/tree. It is a bold nut type with nut weight of 10g and shelling percentage of 30.5. Kernel grade is W 180.

The colour of apple is yellow with apple weight of 60g and with juice content of 75 per cent. Average weight of kernel is 2.9g. This variety is recommended for the Konkan region of Maharashtra and adjoining cashew growing regions of Goa and Karnataka.



Vengurla-4

This is a hybrid variety with the parentage of Midnapore Red x Vetore 56 and was also released in 1981. It is a cluster bearing type and with percentage of perfect flowers of 35 and fruit set of 6%. The yield of nuts is 17.2 kg/tree. The nut weight is 7.7g and shelling percentage is 31. The colour of the apple is red. Kernel export grade is W 210.

Vengurla-10 MB

This variety was released in year 2024 in AGM -2024 of AICRP-Cashew. It is a seedling selection from farmer's field. It is a low CNSL variety (7.85%) suitable for tender kernels for use in various culinary purposes. It takes 35 to 40 days for fruit set to maturity of tender nuts.

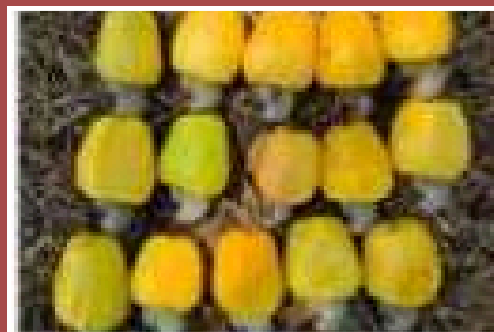


The tender nut weight is 8.80g and mature nut weight is 5.90g. The nuts weight is 8.9 g with 112 nuts per kg. It gives average tender nut yield of 12.68 kg/tree (7.24 kg/tree) and has shelling percentage of 31.18%. The apple colour is yellow and apple weight is 49.00 g. It is suitable for Konkan region of Maharashtra under rainfed condition.

Varieties released from AICRP (Cashew) Center, ICAR-CCARI, Goa

Goa Cashew- 1 (Balli-2)

Goa-1 was developed and released from ICAR Research Complex, Goa in 1999. It is the first cashew variety released from the state of Goa. It is a selection from accession Balli-2 which is originated from a tree located in Balli village of Quepem taluk of Goa.



The average yield of Goa-1 is 8.75 kg/tree with nut weight of 7.6 g, number of nuts per kg: 130–137 and the shelling percentage of 29.82. Kernel weight is 2.2 g. The kernel grade is W 210. Apple colour is yellow and with average weight of 66.7 g and with average juice content of 68.0% and TSS: 12.0° Brix.



Goa Cashew- 2 (Tiswadi-3)

Goa-2 was developed and released from ICAR Research Complex, Goa in 2007. It is a selection from Ela village of Tiswadi taluk of North Goa District. The average yield of 10-year-old tree is 10 kg/tree with nut weight of 10.2 g and the shelling percentage of 29.55. Kernel weight is 2.3 g and kernel grade is W 210.

Apple colour is yellowish orange with cylindrical shape and with average weight of 105 g. Juice content ranges from 72.0 % and TSS is 12.20° Brix.

Goa Cashew- 3 (Ganje-2)



This variety gives average yield of 12 kg /tree. The nut count per kg is 130-140 with average nut weight: 8.2 g; shelling percentage: 29.5%; kernel weight: 2.282 g; kernel grade W210; apple colour and shape: yellow and round; average weight of apple: 94.0 g; average juice content of apple: 69.17 %; juice TSS: 12.20° Brix.

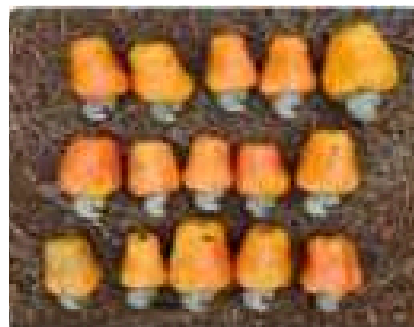
Goa Cashew- 4 (KN-2/98)



This variety gives average yield of 15 kg /tree. The nut count per kg is 120-125 with average nut weight: 8.2 g; shelling percentage: 29.5%; kernel weight: 2.68 g; kernel grade W210-W240; apple colour and shape: red and conical; average weight of apple: 107.5 g; average juice content of apple: 74.14 %; juice TSS: 13.80° Brix.

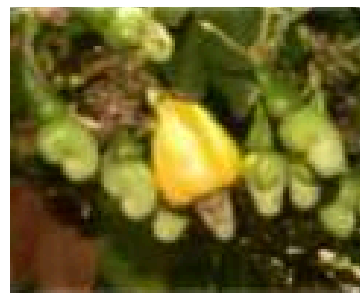
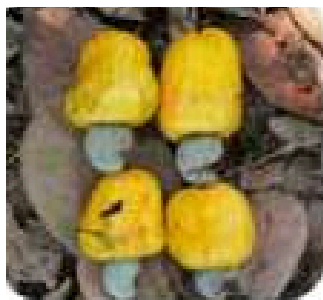
Goa Cashew- 5 (Tudal)

This variety gives average yield of 15 kg /tree. The nut count per kg is 120-125 with average nut weight: 9.3 g; shelling percentage: 28.69%; kernel weight: 2.22 g; kernel grade W210-W240; apple colour and shape: yellowish orange and cylindrical; average weight of apple: 90.3 g; average juice content of apple: 71.4%; juice TSS: 13.8° Brix.



Goa Cashew- 6 (HB-21)

This variety gives average yield of 14 kg /tree. The nut count per kg is 115-120 with average nut weight: 8.5 g; shelling percentage: 31.18%; kernel weight: 2.22 g; kernel grade: W210-W240; apple colour and shape: yellow and conical; average weight of apple: 78.0 g; average juice content of apple: 70.4%; juice TSS: 10.8° Brix.



Varieties from HRS, Hogalagere (Earlier at Chintamani), UHS, Bagalkot

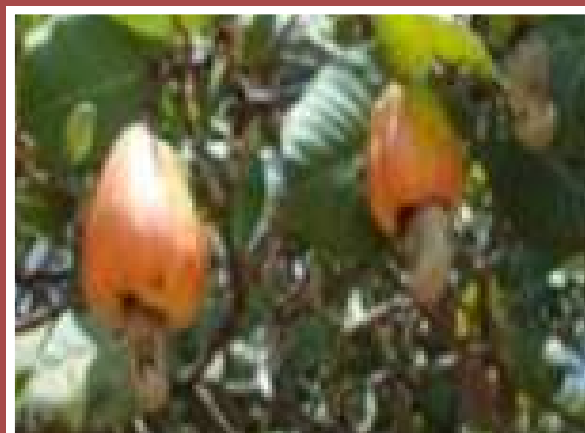
Chintamani-1

It is a selection from 8/46 Taliparamba, a germplasm collection from Taliparamba in Kerala and released in 1993 from ARS, Chintamani. This variety is recommended for plain region of Karnataka. Its flowering period is from January to April with 2-4 nuts per panicle. The average yield of this variety is 7.2 kg/tree as against the 2 kg/tree of the local varieties. The nut weight is 6.9g with shelling percentage of 31%. The kernel grade is W 210.



Chintamani-2

It is a seedling selection from ME 4/4 of ARS, Ullal and released in 2007 from ARS, Chintamani. This variety is also recommended for plain region of Karnataka. The canopy type is compact and with intensive branching. Its flowering period is from December to January. The average yield of this variety is 12.4 kg/tree. The nut weight is 7.9g with shelling percentage of 30%. The kernel weight is 2.35 g. The kernel grade conforms to W 210. The colour of the apple is red purple with average weight of apple of 70g. Juice content is 60%.



VARIETIES RELEASED BY AICRP (CASHEW) CENTER, MADAKKATHARA, KAU, THRISSUR

Madakkathara-2

This is a selection from germplasm collection made from Neduvellur in Kerala maintained at CRS, Anakkayam. This variety was also released in 1987. The mean yield is 17 kg/tree. The nuts are bold (7.3 g nut weight) with shelling percentage of 26.2%. Kernel weight is 2g having a count of W 240 export grade. Apple colour is red and with weight of apple 63.3g. Reducing sugar content is 7.8%.



Kanaka (H 1598)

It is a hybrid of cross BLA 139-1 X H 3 - 13 released in 1993 from CRS, Madakkathara. It is an early variety. Average yield is 19 kg/tree with a mean nut weight of 6.8g. Shelling percentage is 31%. Kernel weight is 2.1g and quality of kernels conform to W 210 export grade. Colour of apple is yellow.

Dhana (H 1608)

It is a hybrid of cross ALGD-1 X K 30-1 released from CRS, Madakkathara in 1993. It has cluster bearing habit. The mean yield is 17.5 kg/tree with a shelling percentage of 28. Kernel weight is 2.2g conforming to export grade of W 210. Yellow is the apple colour.



Priyanka (H 1591)

This is a hybrid with parentage of BLA 139-1 X K 30-1 with jumbo nut size developed and released from CRS, Madakkathara in 1995.

The yield of nuts is 16.9 kg/tree. The nut weight is 10.8g with kernel weight of 2.87g. Shelling percentage is 26.5. The export grade of kernels conforms to W 180. Colour of apple is yellowish red. Apple weight is 135g. Apple has 57.4% of juice.

Amrutha (H 1597)

This is a hybrid with parentage of BLA 139-1 x H 3-13 developed and released from CRS, Madakkathara in 1999. It has yield potential of 18.4 Kg/tree with nut weight of 7.2 g. Shelling percentage is 31.6 and with kernel weight of 2.2 g and kernel grade W 210. Colour of apple is yellow and apple weight is 76.0 g. Apple has 57.4% juice content. It is recommended to the state of Kerala.



Sulabha

It is selection released in 1996 with compact canopy and intensive branching. It is bold nut type with 9.8 g nut weight. The tree yields 21.9 kg of nuts with high shelling percentage (29.4%). The kernel weight is 2.88 g and grade is W 210. It bears light orange apples.

Varieties Released from AHRS, Ullal, UAHS Shivamogga, Karnataka

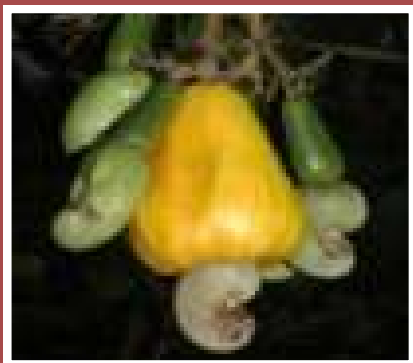
Ullal-1

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-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.

Varieties Released from ICAR-DCR, Puttur

Bhaskara

This variety was released during March 2006 for coastal region of Karnataka. This is having midseason 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.



Nethra Ganga

Nethra Ganga (H-130) is a jumbo nut hybrid, which yields 3 kg nuts / tree in 3rd year of planting with cluster bearing (10-20 nuts/panicle), jumbo nut size (12-13 g) was released for west coast region. It is highly precious, early flowering type with long fruiting duration.

It responds well to pruning and suitable for ultra-density planting system. The hybrid has high shelling percentage (29.9%) with big kernels (3.5- 5.0g) and kernel grade is W-130-150.

Nethra Vaaman

The country was hitherto lacking dwarf cashew genotypes and for the first time, the Directorate has identified a dwarf cashew variety named Nethra Vaaman. The dwarf genotype was selected from the seedling progenies planted out of imported bulk nuts samples of Brazil. Upon characterisation and evaluation, its slow growth and dwarf character was confirmed. This was evaluated for ten years and recently it is released and recommended for cultivation.



The Nethra Vaaman can be maintained with minimum pruning and trimming as an orchard management practice. The genotype is moderately susceptible to major pest of cashew i.e Tea Mosquito Bug (TMB) like any other cashew variety but it is easier to take up plant protection sprays as plants are dwarf. This variety is also amenable for homestead and terrace gardens, and for bonsai cultivation.

However, high yield cannot be expected because of its dwarf nature. Tree height (10th year) is 2.5 m (dwarf). Tree Spread (10th year) without pruning is 6.0 m. It has precocious flowering with long duration (>90 days). Nut weight is 5.5 to 6.0 g. It bears glossy, red colour, crispy and less fibrous cashew apples with 50 g weight. It has shelling percentage of 30% and the kernel grade is W 320. It shows special character of stem galling. Its nut yield is 1.2-1.5 kg (4th year of planting)



Nethra Samruddhi

It is a seedling selection from VTH 30/4 and released in the year 2025. It is an early flowering and flowering starts from Nov-Dec and harvesting season is Feb-Mar. It is a high yielding variety with 12.93 kg/tree. The nut weight is 8.34 g. it has a special feature alternate flushing after TMB incidence. This variety has high shelling percentage (30.10 %). The kernel weight is 2.5 g and export grade is W 210. It bears attractive red coloured apples which weigh around 40.85 g per apple. The apples have high TSS of 10-11°B with 72-75 % juice content.

Nethra Ubhaya

It is a selection from germplasm collection from KCDC plantation at Illanthila in Dakshina Kannada district of Karnataka in the year 1989 and it was evaluated and released in the year 2022. It is a dual purpose variety suitable for both nut and apples with desirable qualities. This variety is recommended for coastal region of Karnataka. Its flowering period is from November to March and harvesting season is Feb-April. The average yield of this variety is 8.00 kg/tree. The nut weight is 7.66g. This variety has highest shelling percentage of 34.66%. The kernel grade is W 210. It bears attractive yellow coloured apples which weigh around 81.24g per apple. The apples have high TSS of 14.93°B with 75.6 % juice content, less tannin content (3.43mg/100g).



Nethra Jumbo-1

Nethra Jumbo-1 is a jumbo nut hybrid released in 2021 for west coast region. Nethra Jumbo is an early season bearer with short flowering duration. The flowering starts from December and continues up to March and the peak flowering will be in January and February. The nut weight ranges from 11 to 13 g with an average nut weight of 12 g per nut. The nuts have high shelling percentage (29.1) with 3.66 cm nut length, 2.73 cm nut width and 2.41 cm nut thickness with 18.5 % of CNSL content in the shell. The kernels are bold with 3.4 g average weight and fits in to kernel grade W130. It bears attractive red coloured apples which weigh around 100g per apple with conical to obovate shape.



The apples have TSS of 13° B with 72 per cent of juice content. The season of harvest starts from January and continues till March end. The duration of harvesting period is less which helps to save the labour on picking of nuts. The early availability of raw nuts will help to catch high market price prevailing during early part of cashew season. A ten-year-old tree has a potential to yield around 10 kg per tree. The added advantage of this hybrid is uniformity in nut size, wherein, more than 90 % of nuts are uniform in size. As this hybrid is an early flowering type, the advantage of higher market price in the beginning of cashew season can be exploited. This hybrid can also escape severe pre monsoon moisture stress as compared to late varieties.



Nethra Jumbo-2

Nethra Jumbo-2 is a jumbo nut hybrid released in 2023 for west coast region. It is an early season bearer with short flowering duration. The flowering starts from December and continues up to March and the peak flowering will be in January and February. The average nut weight 12 g. The nuts have high shelling percentage (29.3). The kernels are bold with 3.4 g average weight and fits in to kernel grade W130. It bears attractive red coloured apples which weigh around 106g per apple. The apples have TSS of 11° B with 72 per cent of juice content.

The season of harvest starts from January and continues till March end. The duration of harvesting period is less which helps to save the labour on picking of nuts. The early availability of raw nuts will help to catch high market price prevailing during early part of cashew season. A ten-year-old tree has a potential to yield around 10.20 kg per tree. The added advantage of this hybrid is uniformity in nut size, wherein, more than 90 % of nuts are uniform in size.

For further information and assistance, please contact us at the email address mentioned below:

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Commercial Nursery Management in Cashew

Dr. Manjesh G.N.

INTRODUCTION

Cashew is a polygamo monoecious type i.e. flowers are either bisexual or staminate but both occur intermixed in the same inflorescence. This species is a cross-pollinated crop and plants propagated using seeds do not produce true to type and they exhibit variation in their progenies. The clonal progenies are true-to-type of the mother plant give relatively more uniform yield and come to bear earlier than the seedling-origin plants. The earlier efforts made on different vegetative propagation techniques (layering, grafting, and budding) at ICAR-Directorate of Cashew Research, different cashew research stations in the country, as well as All India Coordinated Research Project on Cashew (AICRP-C) centers, have concluded the superiority of the “Softwood grafting” technique over other methods of propagation and hence, this is recommended for commercial reproduction of cashew varieties for large scale spread. Grafting or graftage is the art of producing plants vegetatively by joining the tissues of plants to continue their growth together. The upper part of the combined plant is called the scion (bud, bud stick) while the lower part is called the rootstock having a root system (Fig. 1). Various steps involved in the commercial-scale production of cashew varieties by “Softwood grafting”, the establishment of scion bank, nursery maintenance, and nursery accreditation are detailed in this technical bulletin.

ESTABLISHMENT AND MAINTENANCE OF SCION BANK

The primary task of establishing of commercial nursery requires the establishment of a Scion bank for the desired varieties as per the saleable graft demands.

Production of Scion

Cashew varieties recommended for different cashew-growing states should be selected (Table 1). For the production of scion sticks the recommended cashew varieties should be established by adopting closer spacing of 4m X 4m (Fig. 2). The plants should be manured with the recommended dose of NPK (750g N, 125g P₂O₅, and 125g K₂O per plant) fertilizers at the monsoon season to obtain adequate production and continuous supply of scion sticks for commercial multiplication. The scion bank produces tender shoots and needs to be protected against tea mosquito bug and other sucking insect pests by taking up timely sprays of insecticide like acetamiprid (0.5 g per lit.) or λ-cyhalothrin (0.003%) or thiamethoxam (0.2g per lit.). The emergence of inflorescence and flowering is discouraged in the scion bank to maximize the production of lateral shoots and requires pinching the inflorescence.

Fig. 1: Components of a Graft (from left to right)



1. The Scion Stick



2. Rootstock



3. Graft

The scion bank should always be maintained at a desirable height hence, detopping is followed by maintaining a height of 1.5m to 2.0m from ground level, and pruning the deadwood is necessary and needs to follow annual pruning. The cut ends of shoots should face towards the ground to avoid the entry of rainwater which may lead to decay or attack of pest and disease incidence if the cut ends of shoots after pruning is exposed. The cut ends should be treated with Bordeaux paste (10%) and the plants are sprayed with Bordeaux mixture (1%).

The stem borer grubs are to be identified and killed by inserting a gear wire / any other bending metal wire and poking into the tunnel till a slushy sound is heard or white fluid flows out (post-grub extraction prophylactic treatment). The excavated portion of the trunk should be swabbed with fipronil (2.0 ml per lit.), and imidacloprid (2.0 ml per lit.). Pruning of trees may be carried out during September/ October months in the scion bank (Fig. 2).



Fig. 2: Scion Bank Maintained at ICAR-DCR, Puttur

Table 1: Cashew Varieties Recommended for Growing in Different States

State	Varieties recommended
Karnataka (Coastal area)	NRCC Selection-2; Bhaskara, Ullal-1; Ullal-3; Ullal-4; UN-50; Vengurla-1; Vengurla-4; Vengurla-7
Karnataka (Plain area)	Chintamani-1; Chintamani-2 and Dhana
Kerala	Madakkathara-1 (BLA 39-4); Madakkathara-2 (NDR2-1); K-22-1; Dhana; Priyanka; Kanaka; Amrutha and VRI-3
Maharashtra	Vengurla-1; Vengurla-4; Vengurla-6; Vengurla-7
Goa	Goa-1; Goa-2; Vengurla-1; Vengurla-4; Vengurla-6 and Vengurla-7
Tamil Nadu	VRI-3 and VRI (CW)-5
Andhra Pradesh	BPP-4; BPP-6; and BPP-8
Orissa	Bhubaneshwar-1; BPP_8 and Dhana
West Bengal	Jhargram-1 and BPP-8

RAISING OF ROOTSTOCK SEEDLINGS

Selection of Seed Nuts

- Collect the freshly harvested seed nuts (February-April) preferably VTH-174, V-4, MDK-2.
- The seed nuts should be sun-dried for 2-3 days.
- Select medium size nuts (6-7g)
- Every year required to collect the seed nut freshly for raising rootstock
- The seeds gradually lose viability after 8-10 months of storage.



Preparation of Potting Mixture and Filling of Polythene Bags

- The potting mixture should be prepared in the proportion of 1:1:1 (red soil; coarse river sand: compost) in heavy rainfall areas and 1:1 (red soil: Compost) in low rainfall areas. Rock Phosphate @ 5g/kg of the potting mixture may also be added for getting good root growth of seedlings.
- Polythene bags of 25 cm x 15 cm size and 300 gauge thickness should be used for filling potting mixture.
- In heavy rainfall areas, 30-40 drainage holes of 0.5 cm diameter may be punched uniformly on the polythene bags. In low rainfall areas, the number of drainage holes can be few.
- Potting mixture should be filled up to the brim level (Fig. 3).
- The filled bags should be arranged in beds of 1000 numbers each (100x10).



Fig. 3: Preparation of Polybags Filled with Media and Arranged in Beds

Sowing of Seed Nuts

- The cashew seeds should be soaked in water for 12-24 hours before sowing. Seeds need not be pre-soaked during the rainy season.
- The seeds should be dibbled in the center of the polythene bags, stalk-end upwards, and covered with little soil (Fig. 4).
- The depth of the sowing should be not more than 2.5 cm.
- Immediately after sowing and every day after sowing the seedbeds should be watered depending upon the weather conditions.
- During rainy days, if water stagnation is observed, excess water should be removed by pressing the sides of bags.
- During dry months seedbeds may be mulched with paddy straw till the germination takes place. Agro shade nets may also be used for this purpose.
- The seeds will germinate 10-15 days after sowing depending on the weather condition (Fig.5).
- Seeds should be sown at regular intervals (weekly/fortnightly) to get a continuous supply of desired rootstock seedlings for grafting depending upon the number of grafters available.



Fig. 4: Seed Sowing and Mulching

Maintenance of Seedlings in the Nursery

- The seedlings should be watered daily depending upon the weather conditions.
- During monsoon season, if water stagnation is observed, the polythene bags may be pressed from sides, so that the excess water drains out of the bags. This reduces the incidence of collar rot/damping-off of seedlings.
- During the rainy season, the seedlings should be sprayed with Bordeaux mixture (1%) at 10 days intervals to control collar rot/damping-off of seedlings.
- The seedlings may be sprayed with systemic insecticides such as acetamiprid (0.5 g per lit.) or λ -cyhalothrin (0.003%) or thiamethoxam (0.2g per lit.) to control tea mosquitoes and other pests at regular intervals.
- The side shoots arising from the axils of leaves should be removed frequently in order to get vigorous seedlings with a single main stem.



Fig. 5: Germinated Seedlings

SOFTWOOD GRAFTING TECHNIQUE

Selection of Scion Sticks and Precuring

- Avoid selection of thin and short scion sticks
- Scion shoots free from pest damage should be selected
- Avoid collection of scions from shade areas/canopy
- Select non-flowered lateral shoots of the current season's growth (3-5 months old)
- The leaves are to be removed using a secateur (precuring or defoliation) 10 days in advance of grafting (Fig. 6).
- The selected shoots should be 10-12 cm long, straight, uniform round with brown coloration, and of pencil thickness.
- The precured scions should be separated from the mother tree well before they sprout.



Fig. 6: Process of Precuring Scion

Collection of Scions

- The scion sticks should be separated from the mother tree preferably during morning hours.
- The precured scion sticks should be collected from the mother trees before the terminal buds sprout.
- The length of the scion should be 10-12cm.
- The detached scion sticks may be dipped in cold water and then placed in a polythene bag of 100-gauge thickness and brought to the grafting shed and utilized for grafting.
- For distance transport of scion requires the use of sphagnum mass for packing the scions and an icebox for transport is desired during hot days.



PREPARING THE ROOTSTOCK SEEDLING FOR GRAFTING

- The grafting operation should be carried out under the shade either in a grafting shed or makeshift shelters.
- About two-month-old seedlings (25-30 cm height) are selected as rootstocks. The girth of the seedling should be about 1cm at the place of grafting.
- On selected rootstock seedlings, two pairs of bottom leaves are retained and the other leaves are removed with a sharp grafting knife.
- Then the terminal shoot is decapitated at a height of 15 cm (where the softwood portion is available for grafting).
- A cleft of 6-7 cm deep is made on the decapitated stem.
- From the inner sides of the cleft a little portion of the wood is removed at the tip.
- Preparing the scion stick for grafting
- If the scion stick is longer, then it should be reduced to a length of 10-12 cm by cutting off the excess portion at the bottom.
- Very short scion sticks should be discarded.
- The scion stick should be carefully mended into a wedge shape of 6-7 cm long. However, care must be taken to retain the bark on either side of the wedge.
- The cut surface should be smooth and it should not be soiled at the time of preparing the wedge.



GRAFTING TECHNIQUE

- The wedge of the scion is inserted carefully into the cleft of the rootstock. If the scion is thicker in girth, then care must be taken to match the cambial layers of both rootstock and scion at least on one side with the help of a finger.
- Then the graft joint is secured firmly with a polythene strip (2.0 cm wide, 30 cm long, and 100-gauge thickness).
- Then a long and narrow white polythene cap (20 cm x 4 cm size and 200-gauge thickness) is inserted into the grafted plant.
- After 3 weeks, the polythene caps are removed gently and the grafts are shifted to an open area in the nursery.
- At the time of removing the caps, about 70-80 percent of the grafts show sprouting.



SEASON OF GRAFTING:

The grafts in cashew can be produced almost throughout the year with a mean graft success of 65-70 percent. Grafting may be suspended from December to January as there will be poor graft success in winter.

MANAGEMENT OF GRAFTS IN THE NURSERY:

The Cashew grafts produced in the monsoon season (June- November) are to be maintained at the nursery till the next planting season (July-August). Consequently, the following points should be considered:

- In the nursery, the grafts should be arranged in beds after spreading black polythene sheets on the ground to prevent the grafts from striking roots into the ground. Otherwise, frequent shifting of grafts from one place to another place is required which is labour-intensive.
- The grafts should be watered daily depending upon the prevailing weather conditions. During the heavy rainy season, if water stagnation is observed in the polybags, then the excess water must be removed by pressing the sides of the bags.
- During the summer months, the grafts should be provided with partial shade by erecting pandal and covering them with agro shade nets (35-50% shading). As soon as the monsoon starts, the shade should be removed. Complete shading should be avoided as it results in lanky and weak growth of grafts. Laminated shade nets (35% shading) can also be used.
- During the rainy season, the grafts may be sprayed with Bordeaux mixture (1%) at 10-15 days intervals. Spraying should be done when the weather is clear.
- The grafts may be sprayed with systemic insecticides such as monocrotophos (1.5 ml/liter) acetamiprid (0.5 g per lit.) or λ -cyhalothrin (0.003%) or thiamethoxam (0.2g per lit.) to control insect pests such as tea mosquitoes, leaf minor, leaf-eating caterpillars, etc.
- Frequent removal of side shoots arising from the rootstock portion of the grafts should be carried out. The flower panicles if any from the grafts in the nursery should be removed frequently.
- Practice of removing polythene strip should be followed from the graft joint after 4-5 months of grafting. If not, there will be girdling at the graft joint. However, the polythene strip should be removed before selling the grafts.
- After three months of grafting, the bottom leaves on the rootstock portion of the graft should be removed.

GRAFT PRODUCTION UNDER LOW-COST POLYHOUSES

- By employing low-cost polyhouses, softwood grafts can be produced almost throughout the year. Low-cost poly houses prepared from casuarina poles/areca reapers etc. and covered with Silpaulin brand plastic film (natural color) of convenient dimensions (preferably 11 m long and 6 m wide sheets with eyelets at a regular distance) may be utilized for grafts production. The height of the poly house in the centre should be 2.0-2.25 m and the height on the sides should be 1.0 m. Depending upon the cost of material (Silpaulin sheet, poles, GI wire, etc.) and labour, each poly house may cost about Rs. 3000/-. Each poly house may accommodate about 4000 filled bags of 25 cm x 15 cm size and about 6000 filled bags of 20 cm x 12.5 cm size.
- Raising of rootstock seedlings, grafting of rootstocks, and further maintenance of grafts can be done inside the poly house. This will save the labour required for supplying rootstock seedlings from the nursery area to the grafting shed and the shifting of grafts from the grafting shed to the nursery area. The polyhouses will also give protection to the seedlings and grafts during the heavy rainy season and reduce mortality due to fungal diseases. The plants may be watered using a hosepipe fitted with a fine rose. Misting units may also be fitted at suitable points and switched on for about 5-10 min at an interval of 2 hours from 10 AM to 6 PM during the summer months. This reduces the temperature build-up inside the poly houses. During the summer months, the Silpaulin sheet must be removed and a shade net (35-50% shade) is to be used.

MANAGEMENT OF CARRY-OVER GRAFTS IN THE NURSERY (ADVANCED NURSERY)

- The unsold grafts in the nursery require maintenance and need to adopt regular nursery practices, unlike the fresh grafts.
- Grafts should be arranged in beds after spreading black polythene sheets on the ground to prevent the grafts from striking roots into the ground.
- Partial shade (35-50%) should be provided in the summer months
- The grafts are to be watered daily
- Rebagging is essential and should be carried out carefully without disturbing the ball of earth with polybags (26cm x16cm).
- Rebagging must be done well before the onset of severe summer.
- Before rebagging, the grafts should be watered to ensure the ball of earth is wet and the root systems are not disturbed.

SEASONAL INFLUENCE ON GRAFT SUCCESS

Higher success in the case of softwood grafting is achieved in the seasons in which fluctuation in the day and night temperatures are minimal and high humidity is prevalent throughout the day. This type of weather condition is prevalent during the monsoon season (June-November) on the West Coast. During other seasons, graft success is slightly reduced due to the non-availability of proper scion sticks and unfavorable weather conditions. However, grafts can be produced almost throughout the year with a mean success of 65-70 percent.

GRAFT STANDARDS FOR SALE

- More than 5-month-old grafts are ideal for planting in the field.
- The height of the grafted plant should be more than 30cm.
- The grafted plant should have at least 4-5 fully matured leaves.
- The graft joint should be at a height of 15-20cm from the collar region.
- The graft should be healthy and erect growing.
- The graft joint should be perfect without any girdling or constriction.
- The polythene strip should be removed from the graft joint before the sale.
- Side shoots arising from the rootstock portion should be removed before sale.
- The polythene bag should be intact, not a tome.

IMPORTANT DO'S AND DON'TS

- The length of the scion should be 10-12 cm with pencil thickness.
- Very short scions and very thin scions should not be collected for grafting.
- For raising uniform and vigorous rootstocks, always collect seeds from a single variety block and use graded seeds (medium size and dense seeds).
- Application of good quality compost/cattle manure is a must to raise healthy and vigorous seedlings with proper stem girth.
- Pre-soaking of seeds for 12-24 hours helps in quicker and good germination.
- Seeds should be sown at weekly/fortnightly intervals to get a continuous supply of desired rootstock seedlings.
- To control the collar rot incidence in the germinating seeds and young seedlings of less than one month old, spraying of Bordeaux mixture (1%) during the rainy season at 10-15 days intervals is to be done.
- At the time of grafting two pairs of the bottom, leaves should be retained on the rootstock and a cleft of 6-7 cm deep is to be made at a height of 15-20 cm.
- The scion should be mended into a wedge shape of 6-7 cm in length.
- The cut surfaces of the wedge should be smooth and they should not be soiled or disturbed by touching with fingers.

- At the time of grafting, the cambial layers of both rootstock and scion should be aligned at least on one side with the help of a finger.
- The graft joint should be secured firmly with a polythene strip of 2.0 cm width 30 cm length and 100 gauge thickness. Thicker gauge strips should not be used, as this results in loose tying and failure of graft joint to heal. Moisture may also enter through the graft joint resulting in rotting at the graft joint.
- The grafted plants should not be allowed to strike their roots into the ground. To overcome this problem, arrange the grafts on a black polythene sheet (300-gauge thickness) in the nursery.
- During summer months the grafts should be provided with partial shade (< 50% shade) using agro shade nets/coconut fronds. Complete shading should be avoided. Shade nets should be removed when once the monsoon sets in.
- The suckers arising from the rootstock portion of the graft, and flower panicles arising from scion should be removed.
- The polythene strip from the graft joint should be removed after five months of grafting, before girdling takes place at the graft joint.
- Before sale, the grafts in the nursery are to be hardened by withholding water or watering on alternate days.

GUIDELINES FOR NURSERY ACCREDITATION AND RATING OF CASHEW NURSERY

- Availability of true-to-type, quality planting material is crucial for the success of commercial horticulture. This necessitates having a network of horticulture nurseries that confirm model nursery standards in terms of infrastructure, quality of seed and planting materials, and adoption of nursery management practices. The state government ensures the supply of quality planting materials for fruit crops by enacting the fruit nursery (Regulation) Act and enforcement of its provisions through licensing of horticulture nurseries.
- As per the information available in the report of the working group on horticulture for XI's five-year plan, at present only 8 states have adopted the Nursery Act and in 9 states system of registration/monitoring exists for nurseries. Whereas in 13 states there is no Nursery Act present.
- National Horticulture Mission has taken the initiative to specify the nursery standards by specifying the infrastructure, required for setting up of model horticulture nurseries, etc. ICAR has recently come out with technical specifications of horticulture planting material and its production procedure.
- A recognized model horticulture nursery should function as a reliable source of supply of quality planting materials.



SCOPE

- To establish a network of quality nurseries across the country for the purpose of propagation and distribution of quality planting materials.
- The recognition shall be accorded to the nurseries for;
- Production of quality planting material of one or more specified crops by adopting good nursery management practices.
- Nursery premise only where the sale of specific quality planting material of recognized source is being carried out by creating necessary infrastructure facilities and proper record keeping.
- The recognition shall be accorded to the nurseries for the crops specified in the document of recognition.
- Recognition shall be granted as such after up-gradation as per the requirement.
- Nursery farms licensed under the state act by the competent authority shall be given provisional recognition for a period of one year under the purview of this scheme but their financial recognition will be subjected to assessment by a technical committee.
- Recognition of the nursery with NHB shall be period specific

Procedure for Nursery Recognition and Renewal of Recognition

- The nursery seeking NHB recognition shall apply in form-1 to NHB HQ at Gurgaon. Each such application shall be accompanied by the layout of the nursery showing location of infrastructure components and land utilization plan, details of technically qualified staff in the nursery, major farm pieces of machinery, and operational manual prepared by the nursery for selection and maintenance of mother plants, a process followed for the production of planting material and management of the inventory of planting material.
- The nursery shall submit the details regarding the source of mother plants used for propagation of horticulture plants in a prescribed form (FORM-1) and also maintain the register for the sale of plants.
- The application form duly filled and completed along with necessary enclosures shall be submitted to NHB, Head Office at Gurgaon.
- Each application will be considered by NHB based on the criteria specified for recognition of nursery
- The recognition of nursery by NHB shall generally be considered product wise/aspect-wise.
- On receipt of an application for recognition assessment would be done by the agency identified by NHB with the help of the technical committee.
- Agency shall submit its assessment report to NHB along with recommendations.
- On the basis of the assessment report, NHB shall decide whether to register the nursery with or without up-gradation
- The decision of NHB shall be conveyed to the concerned nursery. In the case of recognition, the period of validity of recognition with other terms and conditions shall be indicated. In case of any deficiency, the nursery shall be given a time frame for compliance failing which the application shall be rejected. In case of requiring additional assessment, visits may be undertaken.

Criteria for Nursery Assessment

- The criteria have been aligned with the infrastructural requirement of the model nursery and product-specific technical requirements and adoption of good nursery practices for propagation of good quality planting material as detailed below:
- Product-specific criteria to assess the capability and competence of nursery follow technical program for specific crop as laid down in Handbook of seed and planting material testing manual for horticulture crops prepared by ICAR.
- Prescribed Nursery management practices and adoption of the Model layout plan.

Assessment Criteria: A System of Graded Certification

- It is essentially different from licensing of horticulture nurseries under the provision of some act or administrative orders. It is based on continuous evaluation of the source of parent material propagation in disease-free conditions by the adoption of technically prescribed method, adoption of good nursery management practices, reliable record-keeping, and training of staff.

Each parameter will be critically examined by the assessment team as per the laid down criteria.

Score	Stars	Recommendations
Up to 40	No star	Not eligible for accreditation
41 to 60	*	Good
61 to 80	**	Very Good
81 and above	***	Excellent

Processing Fee

- Processing fee of Rs 5000/- (non-refundable) shall be submitted in the form of a demand draft payable at NHB Gurgaon along with the application for recognition
- In case of renewal of recognition processing fee of Rs 3000/- (Non-refundable) shall be submitted in the form of a demand draft payable at NHB Gurgaon along with the renewal application.
- Government/ SAUs/ICAR nurseries are exempted from the processing fee
- **Note:** Visit the NHB website for regular updates and the fee structure.

Assessment

The members of the assessment committee shall be nominated by NHB in consultation with the agencies concerned. Assessment will be conducted as a pre-assessment, final assessment, and periodic / surveillance of nurseries. The committee will submit a report on their recommendations to the agency designated by NHB for this purpose.

The Validity Period of Recognition

- After approval initially, the recognition shall be granted for two years.
- The effective fate of recognition shall be considered from the date of issuance of the certificate.

CASHEW GRAFT SALES

Cashew grafts can be booked in advance from our Directorate either through e-mail or an android mobile application (Cashew India) developed from our Directorate available on the Play Store and website <https://cashew.icar.gov.in/>.



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Climate Requirements, Soil, Water and Nutrient Management in Cashew

Dr. M.S. Venkatesh and Dr. Aswathy. C.

Cashew is grown in the coastal west/ east indian states with poor soil fertility. Portuguese travelers Introduced it to India in 12th century. National average of cashew is around 835 kg per ha (i.e., around 5.50 kg per tree) and this is far less than the achievable level of 2000 kg per ha (i.e., around 12.50 kg per tree). Maharashtra state is having highest productivity of about 1500kg per ha (Mainly due to adoption of drip irrigation and mulching techniques). Almost all soils are suitable but the best is red sandy loam soil. An elevation of 600- 700 feet is suitable for cashew cultivation, However, up to 1200 m also it can be grown.

The climatic requirement of cashew can be highlighted as below:

- Tropical crop
- Warm , moist and tropical climate is best
- Dry season of 4-5 months followed by rainy season of 4-5 months
- Sensitive to cold and can't withstand even slightest frost
- Cashew distribution extends from 27°N to 28°S

Temperature requirement of cashew crop is as below:

The ideal temperature range for cashew is 20-30°C, and the distribution of cashew cultivation is restricted to areas where temperatures do not fall below 20°C for prolonged periods. Young plants are particularly sensitive to frost, and even mature trees suffer if exposed to extended cold spells.

- Climate for cashew: Cashew is essentially a crop of tropics cultivated between 31°N and 31°S latitude.
- Major production areas appear to be confined to 27°N (South Florida) up to 28°S latitude (South Africa).
- It can be grown up to 1,000 m above mean sea level.
- It is a sun loving tree and does not tolerate excessive shade.
- It cannot tolerate temperature above 45°C during fruit set and development stage. Ideal temperature range is 15 to 35°C, though it tolerates a temperature of 5°- 45°C.
- Rain during flowering and harvesting is not desirable and causes tea mosquito and *Colletotrichum* infection.
- Average sunshine of nine hours per day was optimum for the best production.
- Note: Overall cashew is tropical crop loving warm and humid climate of tropics

The Cashew area in India is about 12.04 L. Ha with Production of 8.02 L. Mt and with Productivity of 678 kg/ha (2024-25). The major reasons for low cashew productivity in India are:

- Poor soil fertility
- Soil acidity
- Micronutrient deficiency and also

The soils under cashew are normally sandy to sandy loam or they are laterite soils or red latosols which are normally poor in fertility status. Out of 17 essential nutrients required for completion of life cycle of any plant's cashew soils are found to be low in Nitrogen, organic carbon, bases (Ca, Mg, K etc. and deficiency of micronutrients is also reported in Zn and B. The soil testing is the primary step in any nutrient management programme. Soil sampling is important step in soil testing. Only a small fraction of soil in field is tested to get fertility status of entire field. So, representative sample of the area need to be tested. Periodic assessment of soil fertility is also important. Selection of sampling unit: On reaching the site visual survey for observing variation in slope, colour, texture, crop pattern, management etc If all these are similar entire field is taken as one unit. Separate sample is taken if area is differing in each of this character. To assess suitability – before establishing plantation.

The following area should be avoided for taking the soil samples in field for testing:

Recently fertilized plot, Bund area, Channel, Near well, Near compost pits, Use of fertiliser bags to store soil samples.

The depth and method of taking of soil sample for testing is as below: Preferably 3 depths 0-30, 30-60, 60-90 cm, Half way between trunk and fertilizer application zone, 4 sample in 4 direction and make one composite, Before fertiliser application, sampling should be completed before cessation of heavy rains

The optimum soil test level for different parameters of soil fertility are as below:

Organic carbon(%)	< > 0.5% - 0.75
Av. N	280 – 560
Av.P(kg/ha) :	9 – 12
Av.P ₂ O ₅	20-50
Av.K Kg/ha	120-280
Av.K ₂ O(kg/ha)	140 – 340



The recommended dose of NPK for cashew is given below:

State	Nutrient dose for mature cashew plantations (5 th years of planting) (g/tree/year)		
	N	P ₂ O ₅	K ₂ O
Kerala	500	125	125
	750	325	750
Karnataka	500	250	250
	750	125	125
Tamil Nadu	500	200	300
Andhra Pradesh	500	125	125
	1000	125	125
Maharashtra	1000	250	250
Odisha	500	250	250
West Bengal	1000	250	250

The recommended quantity of fertilizers to be applied to cashew in different years after planting is as below:

Year after planting	Urea (g/plant)	Rock phosphate (g/plant)	Muriate of Potash (g/plant)
I	220	280	85
II	440	560	170
III	660	840	255
IV	880	1120	340
V and onward	1100	1400	425



Method for taking the leaf samples of cashew for analysis of nutrients is as below:

4th leaf from petiole from tip of matured branches, just prior to flowering, 10 leaf required from all sides of tree. But avoid. Soiled or dusted leaf, Insect or disease damaged leaf and mechanically injured leaf for sampling purposes. Index leaf for cashew plant sampling is 4th or 5th leaf from tip just before flowering

Optimum Leaf Nutrient Status (%) in Cashew

Nutrient	% or PPM
Major	
N	2.23 - 2.82
P	0.130.18
K	0.91 - 1.47
Secondary	
Ca	0.92 - 1.39
Mg	0.46 - 0.7
S	0.78 - 1.14
Micro-Nutrients (PPM)	
Fe	285 - 398
Mn	200 - 409
Zn	54 - 74
Cu	47 - 60
B	22 - 46
Mo	3 - 4.4

A nutrient mixture product (Patented) developed at ICAR-DCR-Puttur is as below:

Cashew special:

- Mixture of K/Ca/Mg/S/Zn/B
- Foliar spray during Flushing/flowering @ 5 g/lit
- Winter/ Post rainy period
- Cost is 180/- per Kg
- Easily compatible with RDF (NPKS)
- 20-30 % increase in Fruit/ nut yield is reported in research / farmers field.



Importance and method of liming to correct soil acidity is as below:

- Acidity causes P,Ca,Mg,B,Mo leading to their deficiency.
- Lime should always be applied after cessation of Rain or before onset of rain
- LR- 0.5-5 t/ha based on soil type and acidity, Light soil less/ Heavy soil more
- Lime 20 cm depth mix well with soil

The quality of liming materials a farmer should know while it is purchased from market is as below:

- Neutralizing Value (NV)
- Calcium Carbonate Equivalence (CCE): Compares the material's acid-neutralizing capacity to pure calcium carbonate, which is assigned an NV of 100%. Pure oxides and hydroxides can exceed 100% NV,
- Particle Size (Fineness): The finer the grind, the faster the material dissolves and reacts with the soil. Coarse particles (larger than 8-mesh or 2 mm) offer little to no immediate benefit, while very fine particles (passing through a 60-mesh screen or 0.25 mm) are 100% effective within the first year.

The quantity of lime to be applied is: 1 TO 4 KG / TREE) B.O. SOIL PH/SOIL TYPE]

The difference between lime and dolomite which a farmer should know is mentioned below:

Feature 	Calcitic Lime (Garden Lime)	Dolomitic Lime
Composition	Primarily calcium carbonate	Calcium carbonate + Magnesium carbonate
Primary Use	Raises soil pH and provides calcium	Raises pH, provides calcium, and fixes magnesium deficiency
Best For	Soils with balanced or high magnesium levels	Sandy soils, high-leach environments, or Mg-deficient soil
Risk of Overuse	Can induce magnesium deficiencies if overused	Can compact soil or lock out other nutrients if magnesium becomes too high

About Organic farming / Integrated Nutrient management a farmer should know that:

- Farm Yard Manure (FYM) should be applied @ 10 -15 Kg/ tree in Aug –sept, Circular trench along with RDF.
- FYM or Compost or poultry manure, Green manure , neem cake, Horsegram/ greengram/ Blackgram should be included.

Soil conservation and irrigation management is also important for cashew:

- Although cashew is grown in high rainfall environment, it experiences severe moisture stress during Jan-May with the highest water deficit from March- May months.
- Critical growth phases like flushing, flowering and cashew formation occur during this period. (Problem of premature nut drop)
- Supplementary irrigation can improve productivity and yield.
- Cashew plantation is raised on undulating terrain where irrigation is costly and difficult

Adoption of proper SWC techniques in-situ in such slopy and degraded landscape play important role in preventing soil degradation like erosion, conserve soil moisture and improving tree growth and productivity in a sustainable manner

Different soil conservation structures for cashew under undulating soil terrain are as below:

- Continuous bench terrace
- Continuous contour trench
- Modified crescent bund
- Staggered trench
- Reverse terraces
- Catch pits
- Tree base terrace
- Coconut husk burial
- Bigger pits and mulching
- Trenches with vegetative barriers
- Green manuring and mulching.



At DCR, Puttur forming terrace at 2m radius around the plant at the base with in three years of planting has been found to be beneficial in conserving soil moisture

Terracing (2m radius) should be taken up around each plant by cutting soil from the upper portion of the slope and filling the lower portion so that the soil around the plant is flattened. Terrace should be in such a way that upper side of the slope should have a depression with a crescent bund measuring 6.2 M length, 1 M width at the base and 0.5M height. Depression with bund not only help in harvesting, retaining and making the water available to the plant for a prolonged period but also cuts the velocity of the running water in the slopes there by arresting soil erosion.

Top soil eroded from the exposed portion of the hillocks also gets trapped in the depression. The studies indicated the advantage of coconut husk burial in cashew plantation for better soil and water conservation. Coconut husks are buried in trenches of 1M width, 0.5M depth and 3.5 M length /plant opened across the slope between two rows of cashew. Generally three to four layers of coconut husks are buried one above the other with convex side of the first layer of the husks touching the ground.

Cost – Rs.150/tree.

Irrigation management in cashew: : Supplementary irrigation with limited source of water protective irrigation @ 200 lit/tree once in fortnight from January to March, totalling about 1000 l/tree year is recommended.

If sufficient water source and drip irrigation facilities are provided, irrigating 80 l/tree once in four days or irrigating daily @20 l/tree through drippers. Irrigations to be given from December to end of March (30 irrigations, 2400 l/tree/year). Fertilizer mixture used for application of 50 % of recommended doses of fertilizers (500 g N and 125 g each of P_2O_5 and K_2O per tree/year). The fertilisers like Urea, DAP and MOP (20 kg Urea, 6 kg DAP and 4 kg MOP) are dissolved in water by continuous stirring and applied to 200 plants (1 ha) through drip irrigation system per month through venturi (Fig.). Like this 5 applications are given for one season. Each split dose is given once in each month starting from October to December and from January onwards the monthly-allotted dosage is further split into four doses and given once in a week up to February through drip irrigation system. The rate of drip irrigation is to be given for normal density planting system is meet 60% of CPE. This is equal to 36 L for 1.5 hours/day from December to January and 48 L for 2 hrs /day from February to March. Totally six drippers of 4 L /hr capacity should be installed at the base of the tree located at 1 m equidistance from base of the tree.

CONCLUSION:

Cashew is a rainfed horticultural crop which is cultivated on poorly fertile soils. With proper and scientific management of soil like liming, Integrated nutrient management, soil and plant leaf test based nutrient application a farmer can definitely get more yield and at the same time while maintaining the soil health and economy of his horticultural enterprises.

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High Density and Ultra-High-Density Planting in Cashew

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Introduction

High density planting (HDP) or Ultra high density planting (UHDP) is a system of planting in a lesser space than traditional spacing to accommodate a greater number of plants per unit area to increase the productivity in any kind of horticultural crops preferably with little modification in their packaging practices especially canopy management, nutrient and irrigation requirements. The concept of HDP is always associated with training and pruning operations, where the initial frame work of the plants is to be strengthen with the earlier and excessive vegetative growth are controlled with the later.

Concept of HDP and UHDP

- Maximum utilization of natural resources like solar radiation and land
- To increase the productivity and quality of the produce
- To avoid congenial micro-climate suitable for survival or breeding of pest and disease inoculum by proper pruning operation

Land Preparation

The planting pits are prepared with 1 m³ size at a distance of 4 × 4 m (HDP) 3 × 3m (UHDP) in plains. In case the land is slope, pits are preferably taken up by making contiguous reverse terraces against the slope. The 2/3rd depth of the pits are filled with friable and fertile soil and remaining 1/3rd can be applied with 5 kg of well decomposed farm yard manure (FYM).



Season and Method of Planting

Grafts of selected cashew variety are planted right at the centre of the pit preferably during the monsoon season (August - September). Planting can be done throughout the year if irrigation facilities are available. The soil should be compacted without air pockets around the root zone followed by life irrigation. Staking should be provided to the grafts to support straight growth and mulching with green manures can be made to retain adequate moisture for longer period especially during summer and water scarcity regions. This will help to reduce the number of irrigations.

Plant Spacing

The plant spacing for conventional method, high and ultra-density planting system for cashew has been furnished here.

Table 1. Comparison of Planting Density at Different Methods of Planting

Sl. No	Method of Planting	Recommended spacing	Accommodation of number of plants per hectare
1	Conventional method/low density planting	8 X 8 m or 7 X 7m	156 or 204
2	High density planting	4 X 4m	625
3	Ultra-Density planting	3 X 3 m	1111

Varieties Suitable for HDP and UHDP

All the available varieties are not suitable for high and ultra-density planting. The variety which responds well for pruning is to be selected. Therefore, selection of variety is very important aspect in high and ultra-density planting systems. The cashew varieties having precocious flowering and positive response to pruning are VRI-3, Bhidhan Bonsai kaju, NRCC Sel-2, Ullal-1, Ullal-4 and K-22-1 are most suitable for this kind of planting. The recent hybrid H-130 is also suitable for the purpose having high precocity and good response to pruning. Among the above mentioned VRI - 3 a bhidhan bonsai kaju highly recommended

The complete allotted space can be covered in 3rd year of planting and potential yield of the unit land can be realized from 3rd to 4th year of orchard life onwards. The yield in the farmer's plot harvested in this method was up to 2-3 kg/plant in the third year of planting. Even if a yield of 2 kg per plant can bring more than 3 tonnes per ha area which will be much superior over existing orchards having National average yield less than 750 kg/ha.

Training and Pruning

The cashew grafts are allowed to grow without side sprouts in the main stem for upto 40-50 cm from the ground level to ensure the stronger trunk in later years. The growing tip are pinched or nipped off to promote side branches / primary branches and subsequent secondary branches and laterals. Symmetrical and wider-angle primary branches at the number of 3-4 are allowed in all four directions.

The flowering and fruiting may start from first or second year is depended on the precocious bearing nature of cashew varieties. Pruning is a year wise operation and required to be carried out immediately after harvest (June-July). The recommended height of pruning during first and subsequent years is 1.5 m from ground level, if spacing is 3 X 3m and 2m in 4 X 4 m spacing plantation.

Aftercare During Training and Pruning

- Training must be made in live tissue to facilitate good callus formation for rapid healing
- Sharp tools should be used for implementing training or pruning to avoid damage to bark/phloem
- After training or pruning, 10% Bordeaux mixture paste swabbing for large cut ends or 1% Bordeaux mixture spray for pruned shoots is recommended
- As a preventive measure, the pruned trees are to be sprayed with 0.2% λ -cyhalothrin twice or thrice in the initial 24 months of pruning
- The tender shoots should be protected against Tea mosquito bug attack by spraying λ -cyhalothrin 0.06% (6 ml in 10 L of water)

Manuring and Fertilizer Application

The annual dose of fertilizers to cashew is to be applied in to two split doses. First split dose at onset of monsoon period and second split dose during post monsoon period when the soil moisture condition is at optimum level. For HDP, recommended dosage is 160 g N:80g P and 80 g Kg/plant/year (Table 2) and for UHDP, recommended dosage of fertilizer given in Table 3. Fertilizers are to be applied 0.50 m, 0.75 m, and 1 meter away from the main stem by making 10-15 cm deep trenches during 1st, 2nd and 3rd years onwards respectively. The fertilizer dose can be modified depending on the soil type and crop requirement based on soil test results. The general recommendation for the crop is as follows.

Table 2. Fertilizer Recommendation for Different Aged Plants (HDP)

Sl. No.	Age of Plants	Urea	Rock Phosphate	Muriate of Potash (MOP)
1	I Year	70 g	80 g	30 g
2	II Year	140 g	160 g	60 g
3	III Year	210 g	240 g	90 g
4	IV Year	280 g	320 g	120 g
5	V Year and above	350 g	400 g	150 g

Table 3. Fertilizer Recommendation for Different aged Plants (UHDP)

Sl. No.	Age of Plants	Urea	Rock Phosphate	Muriate of Potash (MOP)	Organic Manure
1	I Year	100 g	150 g	50 g	4-5 kg
2	II Year	250 g	200 g	100 g	5-10 kg
3	III Year and above	400 g	300 g	200 g	10-20 kg

Plant Protection Measures

There are no major diseases in cashew but some pests cause severe infestation to the crop. Due to regular pruning operation Dieback incidence may be observed in the field. Timely pruning of diseased branches and application of 10% Bordeaux paste will reduce the incidence and avoid further spread in the field.

Tea Mosquito Bug (TMB), Cashew stem and Root Borer (CSRB), leaf eating caterpillar and leaf minor. The infestation of TMB is severe in ultra-density planting due to emergence of enormous new shoots and panicles and the infestation of CSRB was very less due to less bark growth and stem thickness due to frequent pruning of plants.

1. Tea Mosquito Bug (*Helopaltis Antonii*)

Tea mosquito bug is considered to be the most serious pest of cashew in India, and causes more economic loss to the crop than any other pest. It will cause damage to all the parts such as tender shoots, leaves, floral branches, developing nuts and apples. The TMB can be controlled by spraying 0.06% Lambda cyhalothrin, or 0.02% Thiamethoxam or 0.05 % Acetamiprid. For better management three sprays is required, one at the time of vegetative flush, second at the time of panicle emergence and third at the time of fruit setting.

2. Cashew Stem and Root Borer (*Plocaederus Ferrugineus*)

This is another major pest in normal density planting but in ultra-high-density orchards it was observed very low infestation may be due to less bark growth and stem thickness which is due to frequent pruning of plants. For the control of cashew stem and root borer early detection of incidence is very important. The affected bark should be removed along with the grubs and then swabbing affected area with Fipronil 2 ml/lit.

Harvesting and Yield

In high density and ultra-density planting, plants start flowering during first year of planting. If plants are healthy and vigorous harvesting can be done during first year otherwise panicles can be removed in first year for better growth of plant.

The 2nd year plants yield 1-1.5 kg nuts per plant and 2-3 kg per plant during 3rd year and above. Nuts are harvested from fully developed fruits or nuts are collected from the fallen fruits.



Conclusion

HDP and UHDP is beneficial in the initial 8-10 years as compared to normal density planting.

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Mechanization in Cashew Cultivation: Status and Technologies

Dr. K. Manjunatha and Dr. D. Balasubramanian

Abstract

Cashew (*Anacardium occidentale* L.) is an economically important plantation crop cultivated predominantly under rainfed conditions and have a high labor requirement for many operations in the field. The problem of labor shortage, increasing wage rates, and the need for timely farm operations have emphasized the importance of mechanization in cashew cultivation. Reducing drudgery through the use of suitable farm machinery and techniques can greatly benefit cashew farming. This chapter presents a concise overview of mechanization in cashew cultivation, covering land preparation, orchard establishment, intercultural operations, plant protection, harvesting, and post-harvest handling. Recent developments like UAV-based plant protection technologies, gadgets for cashew fruit harvesting, and various cashew fruit and nut separation machinery are highlighted. The chapter highlights the necessity for developing cost-effective, farmer-friendly mechanization solutions to support sustainable cashew production systems in India.

Keywords: Cashew cultivation; Farm mechanization; Orchard management; Harvesting machinery; UAV spraying

1. Introduction

Cashew (*Anacardium occidentale* L.) is a lucrative plantation crop that is widely cultivated in tropical and subtropical areas. Cashew makes a substantial contribution to export revenue, employment creation, and agricultural revenue in India. The crop is predominantly cultivated by small and marginal farmers under diverse agro-climatic conditions. Cashew cultivation still heavily relies on manual labor despite its economic significance, especially for activities like pruning, spraying, harvesting, and post-harvest handling. Acute labor shortages, rising wage rates, delayed farm operations, and decreased profitability are just a few of the difficulties facing the cashew production system.

The labor-intensive, time-consuming, and physically demanding nature of conventional methods of production leads to low operational efficiency and high levels of drudgery. These constraints necessitate the adoption of mechanization technologies suited to orchard conditions. In cashew farming, mechanization refers to the efficient and cost-effective use of mechanical, power-operated, and automated technologies for a variety of farm operations. Appropriate mechanization increases productivity, lowers production costs, and encourages sustainable farming methods in addition to improving timeliness and accuracy of operations.

2. Cashew Cultivation Practices and Scope for Mechanization

Cashew is cultivated under both rainfed and irrigated conditions, with orchards being notable for large spacing, perennial tree structure, and uneven terrain. The cultivation system comprises a series of operations such as land preparation, orchard establishment, interculture, pruning, nutrient management, plant protection, harvesting, and post, harvest handling. Most of these operations have traditionally been carried out manually using simple hand tools. Mechanization has been somewhat adopted for land preparation and weed management; however, operations like pruning, spraying, harvesting, fruit collection and fruit and nut separation are still largely manual. The crop being perennial, the canopy size variability, and the scattered fruit drop are the reasons for incomplete mechanization. There is a huge opportunity to introduce orchard friendly, compact, and power efficient machines that are capable of working under cashew field conditions. Mechanization should be aimed at labour reduction, efficiency improvement, and making it economically viable for small and medium farmers.

3. Mechanization of Land Preparation and Orchard Establishment

3.1 Land Preparation

Land preparation represents one of the most mechanized operations in cashew farming. It basically entails the removal of vegetation, primary tillage, secondary tillage, and levelling. Depending on the size of the land and its topography, tractors and power tillers are the most common means of land preparation. Implements like mouldboard ploughs, disc ploughs, disc harrows, and rotavators are employed in order to get the desired soil tilth. Mechanized land preparation improves soil structure, enhances moisture conservation, and ensures timely completion of operations, which are critical for successful orchard establishment.

3.2 Pit Digging and Planting

Pit digging is traditionally done by hand and is very labour and time intensive. Mechanised pit diggers, such as tractor-mounted and self-propelled auger type machines can produce uniform pit size and depth, greatly reduce labour requirements, and substantially increase field capacity. Mechanised planting helps to achieve the right orientation and spacing which is necessary for good canopy management and also for future mechanised operations.



4. Mechanization in Intercultural Operations and Orchard Management

4.1 Weed Management

Weed competition during the initial years of cashew plantation establishment adversely affects plant growth and yield. The use of hand hoes to weed manually is highly laborious and expensive. There are mechanized weed control options such as power weeders, brush cutters, and tractor, mounted inter-row weeders. Power weeders can be used either with rotary blades or sweep-type tools for inter-row weed spaces, whereas brush cutters are mostly used for cutting down weeds and grasses around tree basins. Mechanized weed management has the advantage of improving timeliness, lowering the labour input, and increasing the cleanliness of the orchard.

4.2 Pruning and Canopy Management

Pruning in the orchard is one of the most important management practices that is directly involved in the cashew cultivation. It is a process of maintaining the shape of the tree, improving the penetration of sunlight, and making the activities of pest and disease control easier. Manual pruning with the use of sickles and hand saws is slow and very tiring work. Machines pruning tools like battery operated secateurs, pole pruners, and lightweight chainsaws have made pruning more efficient and the operators less tired. In addition to that, these tools allow the operator to make precise cuts, and the overall environment is safer, especially when handling tall and thick trees.

4.3 Nutrient and Soil Management

Nutrient management in cashew orchards is typically done by manual fertilizer application. Mechanized fertilizer applicators having the advantages of uniform application, labour savings, and improved nutrient use efficiency are only very limited in adoption. A backpack type granule fertilizer applicator is a manually operated device worn on the operator's back for uniform application of granular fertilizers in horticultural crops. It consists of a hopper, metering mechanism, delivery tube, and adjustable outlet for controlling application rate. The unit ensures precise placement of fertilizer near the root zone, reducing wastage and improving nutrient use efficiency. It is lightweight, easy to operate, and suitable for small and medium landholdings.

5. Mechanization in Plant Protection

Plant protection plays a crucial role in successful cashew cultivation, as the crop is frequently affected by a range of insect pests and diseases. Traditionally, farmers depend on manual and power-operated sprayers to apply plant protection chemicals, making spraying an essential and routine field operation.

5.1 Conventional Spraying Equipment

Knapsack sprayers, rocker sprayers, and motorized power sprayers are the main tools/equipment's for spraying in cashew orchard. However, these sprayers lead to problems such as uneven coverage, high labour requirement, and the operator getting exposed to the use of chemicals. One can use tractor, mounted sprayers in big orchards, but face limitations due to terrain and canopy structure.

5.2 UAV-Based Spraying Technologies

Unmanned Aerial Vehicles (UAVs) have been emerged as a breakthrough technology in the protection of orchard crops from pests and diseases. Among the benefits of UAV spraying are quick coverage, even distribution of droplets, reduced use of chemicals and less exposure of the operator to the spray.

In a cashew farm, the use of UAV spraying is a smart choice, especially for those tall trees with dense foliage where traditional spraying methods hardly result in a good performance. Optimization of operational parameters such as flight height, speed, spray volume, and droplet size is essential for achieving effective deposition and penetration.



Fig. 1. UAV-based Spraying in Cashew Orchards

6. Mechanization in Harvesting

6.1 Cashew Harvesting Practices

Harvesting ranks the most labour consuming operation of cashew production. Cashew fruits drop naturally when mature and in the traditional way they are collected from the floor of the orchard manually. This method requires continuous bending, carries a lot of physical strain, and the fruits get contaminated with soil and debris. Manually operated hand held devices such as jaw type cashew fruit collector, roller type cashew fruit collector, and battery, operated cashew fruit harvesters have been developed to increase the efficiency of the harvest. The details of these devices/tools are provided below.



a) Battery Operated Telescopic Cashew Fruit Harvester



b) Roller Type Cashew Fruit Collector



c) Jaw Type Cashew Fruit Collector



Fig. 2. Gadgets for Cashew Fruit Harvesting and Collection

6.2 Cashew Apple and Nut Separation

The separation of Raw Cashew Nut (RCN) from cashew apples is traditionally a labour-intensive, time-consuming, and tedious task, as the process is carried out manually due to the lack of mechanized solutions. To address these challenges, efforts were made to develop machinery for separating nuts from cashew apples. With a focus on meeting the needs of small, marginal, and large-scale farmers, pedal-operated, semi-automatic, and fully automatic machines were designed and developed.

Pedal-operated Cashew Fruit and Nut Separator

A prototype pedal-operated cashew nut and fruit separator was designed and developed. The machine consists of a main frame, shear cutting blades, a spring-retractable mechanism, and separate outlets for nuts and apples. The overall length, width and height of the nut separator were 770, 771 and 1030 mm, respectively. Performance evaluations showed that the pedal-operated separator has an average separation capacity of 15.0 kg h^{-1} (RCN) with a separation efficiency of 82.74%. The nut damage was found to be less than 5%, making it an effective and farmer-friendly solution.



Fig. 3. Pedal-operated cashew apple and nut separator

Portable semi-automatic Cashew apple and Nut Separator



Fig. 4. Portable semi-automatic cashew apple and nut separator

A portable semi-automatic cashew apple and nut separator prototype was also developed, featuring a twisting mechanism. This machine comprises of main frame, a prime mover, a power transmission system, and a nut separating mechanism. The overall length, width and height of the semi-automatic cashew apple and nut separator were 1170, 705 and 925 mm, respectively. Performance evaluations revealed an average separation capacity of 29.48 kg h^{-1} with a separation efficiency of 91.45%.

Fully automatic 3-in-1 cashew nut separator

A versatile 3-in-1 machine was developed to perform three operations viz: nut separation, pulp extraction, and fibrous material separation. This fully automatic machine demonstrated exceptional performance during evaluations, achieving an average separation capacity up to 300 kg h⁻¹ (RCN) with a separation efficiency of 99.32%. Additionally, the nut damage was remarkably low (<1.0%), highlighting its suitability for large-scale cashew processing operations.



Fig. 5. 3-in-1 cashew nut separator, juice & pulp extractor, and fibrous material separator

These innovations represent significant advancements in cashew processing technology, providing scalable and efficient solutions to reduce labour requirements and improve productivity across different farming scales.



7. Economic, Social, and Environmental Impacts of Mechanization

Mechanization in cashew cultivation leads to substantial economic benefits by reducing labour costs, improving timeliness of operations, and enhancing productivity. Mechanized systems improve work efficiency and enable better management of large orchard areas.

From a social perspective, mechanization reduces physical strain and occupational hazards associated with manual operations. Adoption of modern machinery also encourages youth participation in cashew farming. Environmentally, precision mechanization technologies such as UAV-based spraying contribute to efficient input use, reduced chemical drift, and lower environmental contamination. However, adoption constraints such as high initial cost, limited technical skills, and lack of awareness need to be addressed through training, extension, and institutional support mechanisms.

8. Conclusion

Mechanization is a key driver for enhancing productivity, profitability, and sustainability in cashew cultivation. While significant progress has been made in land preparation and intercultural operations, greater emphasis is required on precision plant protection, mechanizing harvesting, and post-harvest handling.

Adoption of appropriate mechanization technologies can reduce labour dependency, minimize drudgery, and improve operational efficiency. Continued research, innovation, and effective extension support will play a vital role in realizing the full potential of mechanization in cashew cultivation.

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Management of Major Pests in Cashew

Dr. T.N. Raviprasad and Dr. K. Vanitha

Cashew, *Anacardium occidentale* L., which belongs to Anacardiaceae is a native of north-eastern Brazil. Its related wild species are recorded from the vast expanse around the Amazonian rainforest. Cashew mostly prefers a warm subtropical climate, however, it can perform equally well in tropical as well as semi-arid situations also. The Portuguese colonists introduced cashew into India around 5 centuries ago (Rao et al., 1998). Vietnam is presently reported as the largest producer of cashew in the world; India, Mozambique and Tanzania have been considered as the subsequent major cashew producing countries. Cashew was primarily introduced in Goa, from where it dispersed to various other parts of the country. Initially, cashew was mainly planted to check soil erosion in various states, and its commercial cultivation gained impetus during late 1960's. Presently, it has established itself in a significant position of an export-oriented commodity, earning considerable foreign exchange. India is one amongst the prominent producers, processors and exporters of cashew in the world. The global production of raw cashew nuts was 4.43 million MT during 2013, Vietnam being the largest producer with 1.11 million MT. Indian cashew nut production accounted for 16.89 per cent of the world cashew production during 2013. The production of cashew nut has shown an increasing trend in the last decade and accounted for 17.3 per cent of the total world cashew nut production during 2014-15.

Indian cashew kernels are exported to over 68 countries across the globe. In 2014-15, India's exports of cashew kernels and cashew-based products were valued at 0.82 billion US\$. Currently, India has approximately 1.02 million hectares under cashew cultivation with a total production of 0.73 million MT, with a mean productivity of 0.715 MT per hectare (2014 -15) (Hubballi, 2016). The major cashew nut producing states in India are Maharashtra, Odisha, Andhra Pradesh, Karnataka, Tamil Nadu, Kerala, Goa, Gujarat, Chhattisgarh and West Bengal. Maharashtra contributes 32.39 per cent of India's production and is the leading cashew nut producer (0.24 million MT/annum) in India (FAO, 2016).

Among the key factors which limit the remunerative cultivation of cashew, seedling populations of non-descript origin, poor soil nutrient levels, water stress during flowering and fruiting, conversion of area having cashew into other plantation / commercial crops and considerable yield losses due to insect pests and diseases are the most prominent. At different phenological stages of the crop, more than 180 insect pests have been reported to cause damage to different parts of cashew. Among these insect pests, tea mosquito bug (), cashew stem and root borer (CSRB) are at present considered as major pests which result in substantial loss in nut yield as well as, drastic reduction in population of yielding trees, respectively. Apart from these major pests, a few other regionally occurring /sporadic insect pests such as, leaf miners, leaf and blossom webbers, shoot tip caterpillars, leaf and flower thrips and apple and nut borers also inflict sizeable injury to the cashew crop during certain years. In order to minimize the yield losses induced due to infestation by these insect pests, effective pest management is of foremost importance, which will significantly increase the productivity of cashew plantations in India.

A. Major Insect Pests of Cashew

1. Tea Mosquito Bug (TMB), *Helopeltis* spp. (Heteroptera: Miridae)

Tea mosquito bug is a major insect pest which occurs during cropping season and can cause 36-75 per cent damage even at lower population levels of 0.15-0.36 nymphs/adults per shoot or inflorescence. Devasahayam and Nair (1986) and Stonedahl (1991) reviewed the distribution, nature and extent of damage due to TMB, its biology, seasonal abundance, natural enemies, alternate host plants as well as, management techniques for this pest. *Helopeltis* spp. have an extensive distribution ranging from West Africa to North Australia. Stonedahl (1991) mentioned about distribution of the 40 documented species of *Helopeltis*, across different continents.

Extensive surveys undertaken in coastal plains and surrounding areas of Tamil Nadu wherein, neem is an endemic species and also in Western Ghats of TamilNadu and Karnataka having negligible neem population revealed that *Helopeltis antonii* Signoret existed on varied host plants viz., neem, cashew, guava, ber, drumstick, Indian gooseberry, cotton, *Ailanthus excelsa* Roxb. and cowpea in neem endemic areas only; whereas in the Western Ghats, *H. antonii* was a dominant species co-existing along with *Helopeltis bradyi* Waterhouse and *Helopeltis theivora* Waterhouse on cashew and cocoa. *H. antonii* also co-exists as a dominant species on guava along with *H. bradyi*. It was reported that only *H. theivora* exists on *Chromolaena odorata* (L.) and tea *Camellia sinensis* (Sundararaju and Sundarababu, 1999; Srikumar and Bhat, 2013).

Among the several species of the genus *Helopeltis*; *H. antonii* is the most serious foliage and flower pest of cashew in India, Indonesia and other major cashew growing countries.

This species is also reported as a major pest on cocoa, tea and neem (Stonedahl, 1991; Sundararaju and Sundarababu, 1999) and is distributed in most of the cashew growing tracts of Kerala, Karnataka, Goa, Maharashtra, Tamil Nadu, Andhra Pradesh and Odisha causing yield loss of 30-50 per cent (Abraham and Nair, 1981).

In India, this pest regularly occurs in the cashew growing regions of Kerala, Goa, Maharashtra, Tamil Nadu, Goa, Andhra Pradesh, Odisha and Madhya Pradesh. Losses in nut yield to the tune of 25-50 per cent have been reported from Karnataka, Goa, Kerala and West Bengal. In India, in addition to the predominant species; *H. antonii*, three more species viz., *H. theivora*, *H. bradyi* and *Pachypeltis maesarum* Kirkaldy were also recorded on cashew causing similar damage in certain locations (Sundararaju and Sundara Babu, 1999).



Shoot drying in a cashew tree Severely Infested by TMB



a) *Helopeltis antonii*



b) *Helopeltis bradyi*

Different species of TMB infesting cashew



c) *Helopeltis Theivora*



d) *Pachypeltis Maesarum*



Henna



Guava

Host Range

Helopeltis species have been recorded to infest a vast number of plants both in the Oriental and Australasian regions. From an economic viewpoint, the primary host plants being infested are cashew, tea, cocoa and cinchona. Other economically important plants damaged by *Helopeltis* spp. include allspice (*Pimenta dioica*), black pepper (*Piper nigrum*) (Devasahayam and Nair, 1986), apple (*Malus* sp.), grapes (*Vitis* sp.) (Puttarudraiah and Appanna, 1955) and guava (*Psidium guajava*) (Gopalan and Perumal, 1973). Estimates of crop losses attributed to *Helopeltis* spp. are highly variable and depend on numerous local factors such as, horticultural practices, pest management approaches, location, climate and the host plant and insect species involved (Stonedahl, 1991).

A wide variety of host plants viz., mahogany, neem, cocoa, cinchona, annatto, red gram, apple, guava, grapevine, drumstick, mango, *Syzygium* sp., *Lawsonia alba*, black pepper and allspice, *Annona reticulata*, *Thespesia populnea*, *Solanum nigrum* and ornamental *Acalypha* have been reported for TMB (Sundararaju and Bhakthavatsalam, 1994).

Infestation symptoms of TMB on various alternate host plant parts



Neem



Singapore Cherry



Cocoa



Chromolena

Biology

The eggs of *Helopeltis antonii* are inserted into the mesophyll portion of tender parts of shoots, petioles and midribs of leaves (during flushing). Occasionally the eggs are laid on the flower buds, flowering inflorescences, peduncle, rachis and immature fruits as well as, nuts resulting in small raised brownish black pustules.

The total period of egg and nymphal stages of *Helopeltis* spp. (*H. antonii*, *H. bradyi* and *H. theivora*) lasted for 8 -10 days, 6-12 days and 7-14 days, respectively. The developmental period of eggs and nymphs depended mainly on temperature, wherein, it was longer during winter (December-January) and was shorter during summer (April-May). The adults could survive for more than a month and a female bug could lay up to 259 eggs during its life time (Sundararaju and Sundarababu, 1999).



Respiratory Tubes of TMB Eggs Seen Externally on Ventral Side of Midrib



Eggs Laid Below the Epidermis



Young 2nd Instar Nymph



Adult of Tea Mosquito Bug

Nature of Damage

The nymphs on hatching feed on tender portions of the plant by sucking the plant sap and the typical feeding damage symptoms occur as brownish or dark brown necrotic lesions. The lesions are striate on shoots and roundish on tender fruits. Both nymphs and adults suck sap from tender shoots, petioles, midribs and laminae of tender leaves, inflorescences, flower buds and immature fruits. The feeding activity results in drying up of new flushes and inflorescences leading to a scorched appearance of the trees; shriveling and abortion of immature nuts (Pillai *et al.*, 1984).

Being a low-density pest, a very small population of the pest is sufficient to cause conspicuous injury on the tender parts of cashew. Under vulnerable crop stages, the population spreads very rapidly and leading to severe yield losses within a month.

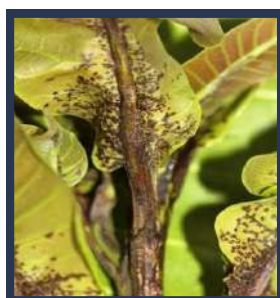
The fungi, *Gleosporium mangiferae* and *Phomopsis anacardii* in association with *H. antonii* infestation have been reported to induce blossom blight. The feeding injury by the bug was attributed as one of the causes of infection and manifestation of die-back disease caused by *Colletotrichum gloeosporoides* and *Botryodiplodia theobromae* (Nambiar *et al.*, 1973).



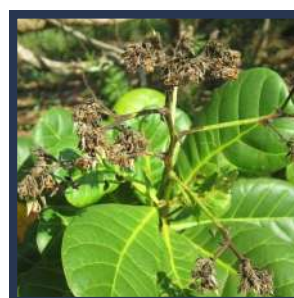
Coalesced Lesions on Tender Cashewnut



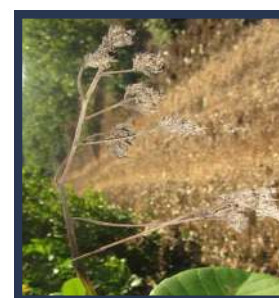
Dried Shoot Tip with New Side Flushes



Feeding Damage Symptoms due to *Pachypeltis Maesarum*



Symptoms of Blossom Blight



Symptoms of Die-back Disease

The life table analysis carried out in Indonesia (Siswanto *et al.*, 2008) and India (Sundararaju and Sundarababu, 1999) indicated that the survivorship of the *H. antonii* population on cashew shoots was of Type II; indicating a high hatchability and substantial death occurring during early nymphal stages followed with a relatively lower death throughout the older stages. Therefore, for effective management of this pest, initiating pesticide intervention during the early stages of pest incidence is absolutely necessary.

H. antonii populations were found to proliferate very rapidly under favourable conditions on neem and cashew, and also could sustain under unfavourable conditions on neem and guava. However, a sudden population decrease occurs during crop conditions unfavorable for feeding in cashew. This suggests that appropriate management measures should be taken especially during vulnerable stages of cashew crop (viz., flushing, flowering and fruiting period) prior to build-up of *H. antonii* population.

Seasonal Incidence of TMB

Initiation of population build-up of *H. antonii* and its damage symptoms commence during September–October onwards synchronizing with the emergence of new flushes/inflorescences after the cessation of monsoon rains. A maximum shoot damage of 49.5 per cent during November and high inflorescence damage of 72.1 - 73.9 per cent from December to February with a peak pest population during February has been reported by Sundararaju (1984). In young plantations, the pest is noticed continuously with a higher intensity during February and March (Sathiamma, 1977).

When the weather parameters were correlated with the weekly mean values of TMB population, only minimum temperature displayed a consistently negative relationship. Hence, occurrence of lower minimum temperature (i.e., below 18.0°C) continuously for more than a week during December-January provides a hint for starting pest surveillance to schedule the insecticidal interventions suitably. For decision making on insecticidal management, only farm based monitoring of TMB damage and its population from flushing to fruit set were found to be the most appropriate parameters (Sundararaju, 2004).



Seasonal Fluctuation in TMB Population and Mean Shoot Damaged on Cashew

Integrated Pest Management Techniques

a. Management on Alternate Hosts

In east coast of Tamil Nadu, Andhra Pradesh and in the plains region of Karnataka, neem trees are retained on the borders of cashew plantations. As neem trees serve as an important alternate host for TMB, raising neem trees in the vicinity of cashew plantations should be avoided. Taking up need based pesticide sprays on neem, prior to cashew cropping season can be followed prophylactically to prevent the migration of this pest from neem to cashew in endemic areas.

b. Varietal Resistance

Most of the crop improvement programs have mainly focused on enhancing yields and product quality. Hence, there has been only a slight progress on selection and breeding of pest-resistant cultivars, though importance of host plant resistance in cashew has been well deliberated. Histopathological studies of infested tender cashew shoots revealed that cashew has an innate active phenol-phenolase system (Sundararaju and Sundarababu, 1996).

Hence, any feeding injury leads to rapid hypersensitive reactions resulting in necrosis, (blighting and drying of affected parts) especially on tender shoots, inflorescences and developing fruits. Under natural and forced feeding trials, all recommended cultivars of cashew were established to be susceptible to TMB infestation which suggests a minor possibility of encountering a TMB resistant cultivar. Well matured shoots of cashew, exhibited highest feeding deterrence to the pest, irrespective of varieties. Consequently, this phenological stage checks any further build-up of pest population during non-flushing period (June-September).

Though most of the cashew varieties are highly susceptible to this pest, mid season or late season flowering varieties could escape from the severity of the pest infestation.

A cashew accession, Goa 11/6, exhibited consistently moderate level of pest incidence due to mid – late season flowering and also had a satisfactory nut yield of 2.0 t/ha. Hence, this accession has been later released as ‘Bhaskara’ from the ICAR-Directorate of Cashew Research, Puttur (Sundararaju *et al.*, 2006).

c. Natural Enemies

Certain egg parasitoids naturally regulate the build up of this pest in cashew ecosystem. They are *Erythmelus helopeltidis* Gahan (Hymenoptera: Mymaridae), *Telenomus* sp. (Laricis group) (Platygastridae), *Chaetostricha* sp. (Trichogrammatidae) and *Gonatocerus* sp. nr. *bialbifuniculatus* Subba Rao which have been reported from West Coast regions while, *Ufens* sp. is an egg parasitoid reported from East Coast (Vridhachalam, Tamilnadu).

These parasitoids are species-specific and were ascertained to be not amenable for mass multiplication due to their specific biotic requirements, ruling out the management of TMB by utilizing these parasitoids. However, the activity of the above mentioned parasitoids gets naturally enhanced, due to favourable weather conditions coinciding with the vulnerable cropping period (November-February) and exert natural biotic pressure on the pest population, considerably.

Several groups of predators were also recorded on this pest. The arboreal ant *Crematogaster wroughtoni* Forel and *Oecophylla smargdina* (Formicidae) have been recorded as regular predators on nymphs of the pest. Field observations revealed occurrence of 117 species of spiders belonging to 18 families viz., Araneidae, Clubionidae, Corinnidae, Gnaphosidae, Hersilidae, Linyphiidae, Lycosidae, Miturgidae, Nephilidae, Oxyopidae, Pholcidae, Pisauridae, Salticidae, Sparassidae, Tetragnathidae, Theridiidae, Thomisidae and Uloboridae in cashew ecosystem. Several species of reduviid bugs (*Sycanus collaris* (Fab), *S. galbanus*, *Sphedanolestes signatus* Dist.,

Endochus inornatus Stal., *Irantha armipes* Stal. and *Occamus typicus* Dist.) have also been recorded as predators of the tea mosquito bug in cashew ecosystem (Bhat *et al.*, 2013). The entomopathogenic fungi viz., *Aspergillus flavus* and *A. tamarii* have been confirmed to be pathogenic to *H. antonii*, however detailed reports on this aspect are lacking.

Reduviids



Cydnocoris Gilvus
Predating on TMB



Sphecanolestes Signatus
Predating on TMB

Egg parasitoids of TMB



Telenomus Cuspis



Chaetostricha sp.



Nymph of *Panthous Bimaculatus* Predating TMB

Important Predatory Groups on TMB in Cashew Ecosystem



Nymph of *Ephestiasula Pictipes* Predating a TMB



Nymph of *Euanthisa Pulchra*



Nymph of *Hestiasula Brunneriana*



Phintella Vittata



Camariacus Formosus



Telemonia Dimediate

d. Pest Management Using Insecticides

Various groups of insecticides and several plant products (botanicals) which were evaluated against this pest, did not exhibit any ovicidal action. L-cyhalothrin (0.003 per cent) prophenophos (0.05%), triazophos (0.05%) and carbaryl (0.1 per cent) displayed the longest residual action against nymphs and adults of TMB. Thus, in the endemic areas it is advisable to adopt need-based insecticidal sprays with any of these insecticides, alternatively during vulnerable stages of crop, i.e., flushing, flowering and fruiting.

Spraying of recommended insecticides will be remunerative only if the cashew trees provide economical yields. The recommended insecticides did not display any detrimental effect on emergence of egg parasitoids from already parasitized TMB eggs. Further, though cashew has substantial insect mediated pollination; application of insecticides during flowering did not noticeably reduce the fruit set.

e. Management Using Semio-chemicals :

The tea mosquito bug, *H.antonii* is a low density pest and causes serious losses even with a low population density. Investigations on the possibility of utilizing a semio-chemical based management approach was considered and the occurrence of sex pheromone system in TMB was investigated at ICAR-DCR,Puttur. It was observed that a live virgin female when used as bait could attract as many as 84 males / trap in 15 - 25 mins after trap installation. Further investigations on this aspect are being continued to identify the chemical compounds of the sex pheromone in TMB females for development of insect traps.



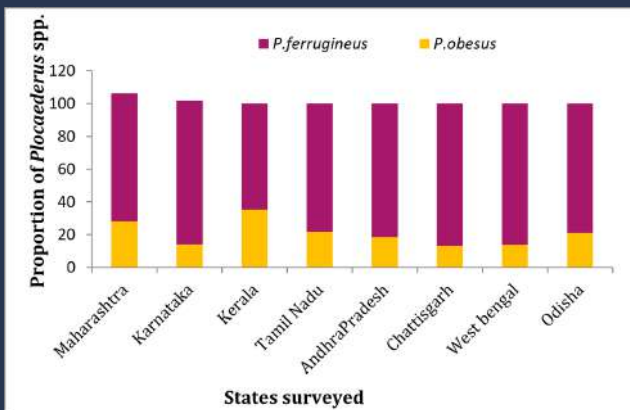
Males of TMB trapped in Sticky Trap with Live Virgin Female as Bait

2. Cashew Stem and Root Borers, (CSRB) *Plocaederus ferrugineus* L., *Plocaederus obesus* Gahan and *Batocera rufomaculata* De Geer (Coleoptera: Cerambycidae)

Presently, three species of cerambycids viz., *Plocaederus ferrugineus* L., *P. obesus* Gahan and *Batocera rufomaculata* De Geer, are reported as cashew stem and root borers (CSRB). *P. ferrugineus* L., is the most destructive pest species that infests cashew in all the cashew growing tracts in India along with two other species, viz., *P. obesus* and *B. rufomaculata* (Abraham, 1958; Rai, 1984). The preliminary report of CSRB damage was made by Ayyar (1932, 1942) from Travancore (Kerala). Both species of *Plocaederus* infest healthy cashew trees while, *B. rufomaculata* in general, infests only the already infested cashew trees.

The grubs of CSRB immediately after emergence bore into the bark tissue and feed on the phloem and xylem tissues of the trunk and root by irregular tunneling (Sathiamma, 1978). The extent of damage estimated in different cashew plantations owned by forest corporations of Kerala and Tamilnadu showed that cashew stem and root borers (CSRB) cause 7-20 per cent and 30-35 per cent loss, respectively (Misra and Basuchoudhary, 1985, David and Ananthakrishnan, 2004). In Guntur and Prakasam districts of Andhra Pradesh, CSRB infestation reaching up to 40 per cent was recorded (Arjuna Rao, 1978; Ayyanna and Rama Devi, 1986). The incidence and status of various insect pests of cashew have been reported from Goa (Sundararaju, 1984), Maharashtra as well as from coastal and interior Karnataka (Rai, 1983).

The prevalence of *P. ferrugineus* in infested cashew trees was higher than *P. obesus*. Among the cashew growing states of India, the ratio of *P. ferrugineus* to *P. obesus* was 64.8 : 35.2 in Kerala; 72.0 : 28.0 in Maharashtra; 79.0 : 21.0 in Odisha; 78.0 : 22.0 in Tamil Nadu; 87.0 : 13.0 in Karnataka; 87.0 : 13.0 in West Bengal; 86.0 : 14.0 in Chhattisgarh and 82.0 : 18.0 in Andhra Pradesh (Vasanthi, 2013).



Mohapatra and Mohapatra (2004) recorded the level of CSRB infestation in several cashew cultivars and concluded that none of these cashew cultivars were either resistant or tolerant to the infestation by CSRB. They reported highest infestation of *P. ferrugineus* in Ganjam (20.8%) in Odisha.

Distribution of CSRB in Bangladesh, Burma, Hawaii Islands, Hong Kong, India, Sri Lanka, Taiwan, Thailand and Vietnam has been recorded by Duffy (1968). The severe incidence of CSRB on cashew has been documented from various other countries such as, Sri Lanka and Tanzania (Gerini, 1976), China (Kangde Liu, *et al.*, 1998) and Nigeria (Asogwa, *et al.* 2008).



Typical Canopy Yellowing in CSRB Infested Cashew Tree

Host Range:

Though regular and preferred incidence of this pest is mainly noticed on cashew, its incidence has also been recorded on *Bombax malabaricum*, *Boswellia serrata*, *Buchanania latifolia*, *Buchanania lanzan*, *Diospyros melanoxylon*, *Hardwickia binata*, *Lannea grandis*, and *Holigarna* spp. Likewise, *P. obesus* was recorded also on *Shorea robusta* and infestation of *B. rufomaculata* has been reported on mango, silk cotton, jackfruit, rubber, fig, guava and pomegranate.

Biology:

The adults of *P. ferrugineus* are reddish dark brown, medium sized beetles (25 to 40 mm in length). Adults of *P. obesus* are chestnut coloured, longicorn beetles, measuring about 40 cm in length and have slight pubescence on elytra. The adult beetles are sluggish on the day of emergence, mating starts on the second day and repeated matings occur during the life time of the adults. Adults of *Batocera rufomaculata* are greyish, measuring 50 mm in length and have yellowish or orange spots on the elytra and on the pronotum.



CSRB Eggs Laid in Soil Near Collar Zone

CSRB Eggs Laid on the Tree Bark



Eggs are generally laid in the bark crevices of the main trunk up to one meter from ground level and also on the exposed roots as well as, in the soil close to the collar region of the tree. Eggs are pale white, ovoid and smooth measuring about 3.5 × 1.5 mm. The nascent first instar grubs feed on the tissue near the site of oviposition and extrusion of fine pinkish frass with or without gum exudation is noticed within few days of hatching. The grub duration in case of *P. ferrugineus* and *P. obesus* lasts for about 6-8 months. The grubs of *Plocaederus* spp. have 3 pairs of thoracic prolegs while, in case of *B. rufomaculata* the grubs are apodus. The fully grown grub measuring about 100-120mm in length bores into heartwood for pupation and makes a circular exit hole of 1.50 cm width for subsequent adult emergence.

The pupation takes place inside a calcareous cocoon in case of *P. ferrugineus* and *P. obesus* while, grubs of *B. rufomaculata* pupate without forming any cocoon. Though the adults develop fully within 45 to 60 days, they stay quiescent in the cocoon and emerge after 75-90 days. Under laboratory conditions, pupation occasionally occurs without calcareous cocoon (Pillai *et al.*, 1976 and Raviprasad and Bhat, 1998).

Pillai *et al.* (1976) reported incubation period of 4.0-6.0 days, and duration of 6-7 months for larval stages and 20 days (when pupal cocoon was not formed) and 60 days (inside cocoon) for pupal period in the laboratory cages for *P. ferrugineus*. Rai (1983, 1984) reported a total life cycle of 338 days with an egg period of 7.0-9.0 days, larval stage being 138-150 days and pupal period of 108-166 days.

Sexual dimorphism was observed in adult beetles wherein, the males had antennal length greater than the body length while in females it was equal or shorter to the body length. A laboratory rearing technique for the field collected *P. ferrugineus* and *P. obesus* larvae was standardized by Raviprasad and Bhat (2000) on cashew bark. Further, they reported that, younger larvae of CSRB displayed cannibalistic behaviour and hence had to be reared in separate rearing bottles. A novel egg collection technique using cotton tape wound onto a cashew twig was developed by Raviprasad and Bhat (2007). Mohapatra and Jena (2007) reported that the cashew stem and root borer, *P. ferrugineus* could successfully complete its life cycle on three host plants, viz., cashew (*Anacardium occidentale* Linn.), drumstick (*Moringa oleifera* Lam.) and silk cotton (*Ceiba pentandra* (L.) Gaertn.).

Survival to adults on these hosts was 80.9, 58.6 and 57.5 percent, respectively. Senguttuvan (2000) reported that the larvae consumed only 12.5 percent of the bark material which they tunneled. The total larval period differed for both the sexes and averaged 169.7 days for female and 145.8 days for males



CSRB Eggs Laid Below Cotton Tape Wound on Cashew Twig.



Eggs of *P. ferrugineus* (L) and *P. obesus* (R)



15 days Old Larvae of CSRB

Adult beetles of CSRB and Calcareous Cocoon Formed Below the Bark



P. ferrugineus



P. obesus



Calcareous cocoon

Nature of Damage

The symptoms of infestation by CSRB on cashew were earlier recorded by Pillai *et al.* (1976) and Misra and Basuchoudhary (1985) such as the presence of small holes in the collar region and main stem with gummosis, extrusion of frass, pre-mature yellowing and shedding of leaves, drying of twigs and final death of the tree.

Grubs feed extensively below the bark resulting in arrest of flow of sap; the leaves become yellow and are shed prematurely. The infested cashew trees succumb to pest incidence within one to three years depending on pest intensity, bark circumference damaged and age of the trees (Misra and Basuchoudhary, 1985). The pest is capable of causing death of 6-10 per cent of the productive trees annually if they are left untreated (Ramadevi and Krishna Murthy, 1983; Jena *et al.*, 1985a; Samiayyan *et al.*, 1991, Mohapatra and Mohapatra, 2004 and Mohapatra *et al.*, 2007).

The symptoms of damage include the presence of small holes in the collar region, having gummosis and extrusion of frass through these holes. The subsequent stages of infestation lead to gradual yellowing and premature shedding of leaves and drying of twigs and finally, the death of the CSRB infested cashew tree. The larval period is quite prolonged and usually extends for 6-8 months based on availability of feed. Abundant food availability extends the larval period while shortage of food leads to early pupation. The grubs tunnel inside the bark extensively in the collar region, progressively increasing in body size. The tunnels extend from 65 to 185 cm in length, based on the direction and nature of tunneling. The tunneling in several cases extends deep below the soil, completely damaging lateral and taproots up to below the ground level. These tunnels are tightly plugged with chewed fibers, frass and excreta and an air pocket occurs only at the spot where the grub feeds.

At later stages of pest infestation, extrusion of white powdery frass due to tunneling into the xylem (heartwood) is generally noticeable at the base of the tree trunk. As a result of damage by numerous grubs in a single tree, the bark of the collar region withers away and shows severe splitting. Occurrence of termite galleries can be seen at this stage wherein, they feed on the old frass and dead bark.

External Symptoms of Infestation by CSRB on Cashew Trees



Gummosis in Fork
Region



Initial Frass Exudation from
Main Stem



Frass and Gum Exuded
from Infested Trunk

Canopy Symptoms in Advanced Stages of CSRB Infestation in Cashew Tree



Premature Yellowing of Leaves



Premature Defoliation and Twig Drying

P. ferrugineus, by and large prefers cashew trees aged more than ten years as they possess thicker bark, which facilitates the tunneling by the CSRB larvae. Though the pest generally infests older cashew trees beyond 10 years of age, young cashew grafts of 1-2 years have been recorded to be killed by a single grub during its course of development though the grub cannot complete its lifecycle. As many as 260 grubs in different stages of development were extracted from infested cashew trees aged 15-20 years old trees (Bhat *et al.*, 2002). Infestation levels varied widely in different cashew plantations based on the local maintenance situations, recording 7-20 per cent and 30-35 per cent damaged trees from Kerala and Tamil Nadu, respectively. The pest infestation is extensive in neglected and unkempt cashew plantations and the pest infested trees act as a main source of inoculum (Jena *et al.*, 1985b).

Seasonal Abundance

Even though occurrence of the pest is noticed throughout year in both East and West Coast, relatively large population of CSRB grubs and severe infestation could be seen in the coastal Karnataka and Andhra Pradesh during February-May and March-July, respectively (Ramadevi and KrishnaMurthy, 1983 and Jena *et al.*, 1985a). The intensity of attack and abundance of *P. ferrugineus* was reported from Calicut, Kerala and the CSRB was reported to have an annual life cycle (Mariamma Daniel, 1991). The maximum occurrence of CSRB eggs was during March-May, the early larvae were seen from March-July and old larvae from June - October while, the pupal stages were prevalent from October – December (NRCC, 1999).

Extensive observations in the cashew plantations in Karnataka to identify the pre-disposing factors for CSRB incidence indicated that infestation was higher in trees aged above 10 years, having rough and fissured bark, with a stem circumference exceeding 60 cm. It was also concluded that the preferred zone of pest attack was the collar region and pest incidence occurred within 8.0 m distance from a severely infested tree (NRCC, 1999). The larvae of CSRB are inconspicuous and hence their age cannot be directly recorded. However, in order to obtain a reliable estimate the pro-thoracic shield (PTS) width was used as an indicator of age, and the measurements of PTS width of the laboratory reared larvae of CSRB were recorded using digital vernier calipers and standardized for various age class intervals. By measuring the prothoracic shield (PTS) width (in case of *Placaederus species*) an estimated age of the larva was arrived at and by backdating; the period of egg laying could be

obtained to determine the seasonality of the pest in a given locality (Raviprasad and Bhat, 2010).

The adults are highly nocturnal and adult beetles are seldom observed in the cashew plots. Hence, in order to confirm the actual adult emergence period, back-dating of age of the field collected grubs can be adopted, and the egg laying period is estimated which can be an indicator period of adult emergence. In this connection, PTS width observations of field collected CSRB grubs indicated that maximum egg laying occurred between February to May; which indicates maximum adult emergence during these months. However, there is a meager and random adult emergence extending from September to June. Age estimation of field collected CSRB grubs from different locations revealed that there was no adult emergence during the monsoon season (June to August) in any of the cashew growing states.



Measuring PTS Width of Field Collected *Placaederus* Larva to Estimate Age and Egg Laying Period by Back-dating.

Field Occurrence of Various Stages of CSRB in Infested Cashew Trees During Different Months.

Stage	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Quiescent Adults in cocoons	←→					←→						
Eggs			←→									
Young larvae												
Older larvae					←→							
Pupae	←→											

Integrated Pest Management Techniques

1. Insecticidal Intervention and Phytosanitation Approach:

Several pest management strategies including chemical, mechanical, cultural and biological methods were evaluated against CSRB, by different researchers from various institutes. Management of these pest species on cashew was achieved by post extraction prophylaxis after mechanical removal of the immature stages of the pest and later by swabbing and drenching the infested portions with chlorpyrifos (0.2%) as well as the remaining zone of pest incidence (NRCC, 2004). Pillai *et al.* (1976) reported based on their trials on management of *P. ferrugineus* that mechanical removal of pest stages and maintaining field hygiene could facilitate reduction of the pest incidence. Misra and Basuchoudhary (1985) reported considerable reduction of *P. ferrugineus* infestation through field hygiene, by removing dead and severely damaged cashew trees.

Post extraction prophylaxis (PEP) trials for management of CSRB were conducted in cashew plantations of DCR, Puttur using chlorpyrifos (0.2%), lindane (0.2%) and monocrotophos (0.2%) along with entomopathogenic fungal spore suspensions of *Metarhizium anisopliae* (250g spawn /tree base). The results indicated that chlorpyrifos (0.2%) was the most effective pesticide in aiding recovery of trees infested by CSRB (NRCC, 1998). Trials taken up at the ICAR-Directorate of Cashew Research, Puttur indicated that adoption of phytosanitation could not only reduce the number of freshly infested cashew trees in the subsequent year, but also significantly reduced the mean number of CSRB grubs encountered in each infested cashew tree (NRCC, 2004).

It was confirmed that the trees in initial stages of infestation only could recover while those in moderate and later stages of damage having more than half (>50 %) of bark circumference damaged showed very low levels of recovery when treated by adopting PEP approach.

Sundararaju (1985), Bhat *et al.* (2002) reported the effective management of CSRB by adopting IPM like phytosanitation, surveillance, mechanical control followed by post treatment prophylaxis (PEP) with carbaryl (1.0%). Treatment with mud slurry having carbaryl (0.2%) resulted in lowest mean cumulative percentage of infested cashew trees (6.0) and highest recovery (38.4%) of treated trees after 4 rounds of treatment (Mohapatra, 2004).

Adopting phytosanitation by uprooting the trees beyond recovery (i.e., >50% bark circumference damaged and/or having yellowing of leaf canopy), followed by post extraction prophylaxis (PEP) with chlorpyrifos (0.2%) indicated that, only the trees with initial stages of infestation (<25 per cent bark circumference damage) could recover fully by adoption of timely treatment. (NRCC, 2004)

Hence, it is vital to implement surveillance activity for early detection of pest infestation symptoms and adopt timely insecticidal intervention at the initial stages of pest infestation and also take up phytosanitation measures as suggested above, to reduce the intensity and spread of pest infestation.

For effective reduction of cashew stem and root borer infestation in cashew plantations, it is very essential to adopt two important pest management approaches viz.,

(a) saving the infested trees in initial stages of infestation and

(b) phytosanitation activity to achieve reduction of pest population in a given location.

To achieve effective management of the pest, dead cashew trees and trees which are beyond recovery (those having more than 50 per cent of bark circumference damaged and/or showing yellowing of the canopy) should be uprooted and removed from the plantation before and after monsoon, since they serve as continuous source of inoculum for multiplication of the pest (Raviprasad *et al.*, 2009; Bhat *et al.*, 2012).

All the trees in the plantation need to be checked for initial symptoms of infestation by CSRB at their tree bases, at monthly intervals, especially during nut collection period (January- May) as field workers repeatedly visit the tree bases for gathering the produce. In cases where external infestation symptoms are noticed, the CSRB grubs should be mechanically removed by careful chipping of the bark. The injured portion as well as base of the tree and exposed root should be swabbed / drenched with chlorpyrifos (0.2 per cent). In case the damage symptoms viz., frass extrusion and gummosis reappear it is necessary to repeat the treatment for such trees after tracing out and physically removing the CSRB grubs.

2. Biological Management Approaches :

(a) Entomopathogenic Fungi :

Two entomopathogenic fungi *Metarhizium anisopliae* (Metsch) Sorkin (Deuteromycotina: Moniliales) and *Beauveria bassiana* (Bals.) Vuill, have been successfully utilized in management of many insect pests (Gupta *et al.*, 2003; Bhattacharya *et al.*, 2008). Application of *M. anisopliae* spawn 250g/tree along with neem cake 500g was most effective with least infested trees (7.40 per cent) followed by application of *B. bassiana* spawn 250g/tree along with neem cake 500 g with 11.11 per cent infested trees (Sahu and Sharma, 2008).

Bhat and Raviprasad (1994) reported the pathogenicity of three species of entomopathogenic fungi, *B. bassiana*, *B. brongniartii*, and *M. anisopliae* against CSRB. *B. bassiana* induced 90 percent mortality on direct topical application while, *B. brongniartii* and *M. anisopliae* induced about 50 percent and 40 percent mortality of the CSRB larvae. The spores of *M. anisopliae* could survive for three months and retain virulence under field conditions. Mixing the fungal spawn with organic substrates like FYM, neem cake and cashew apple could considerably enhance the survival and duration of virulence of spores under field conditions. Ambethgar (2001) tested the pathogenicity of indigenous entomopathogenic fungi for their efficacy as biological control agents against CSRB larvae.

The CSRB larvae collected from field showed mortality to the tune of 23.7 - 86.6 percent in case of various entomopathogenic fungi such as *Aspergillus flavus*, *A. niger*, *B. bassiana* and *M. anisopliae*.

Extensive field surveys for indigenous natural enemies of CSRB, confirmed the occurrence of an egg parasitoid, *Avetianella batocerae* (Hymenoptera : Encyrtidae) on eggs of *P. ferrugineus* and an indigenous field strain of *M. anisopliae* collected from cashew plantations of Karnataka which induced high mortality (85.0%) of CSRB larvae. The laboratory evaluations confirmed its parasitism to larvae of CSRB. Unfortunately, the laboratory cultures of *A. batocerae* could not be sustained for further trials (NRCC, 1999).

Infection of CSRB Grubs by Indigenous Strain of *M. anisopliae*



Natural Infection of CSRB Grub by *M. anisopliae*



Sporulation of *M. anisopliae* on CSRB Grub.

(b) Entomopathogenic Nematodes :

Among the three species of coleopteran infecting strains of EPN tested viz., *Steinernema abbasi*, *S. bicornutum* and *Heterorhabditis indica*, it was noticed that all the EPN species caused cent per cent mortality of laboratory reared CSRB larvae in a short spell of 5.25 - 5.75 days. However, the field collected larvae were less susceptible and total mortality occurred in 14.11 days, 12.88 days and 12.37 days after treatment with the infective juveniles (IJs) of *H. indica*, *S. abbasi* and *S. bicornutum*, respectively for *Plocaederus spp.* and in 17.42, 18.25 and 17.94 days, respectively for field collected larvae of *Batocera rufomaculata*.

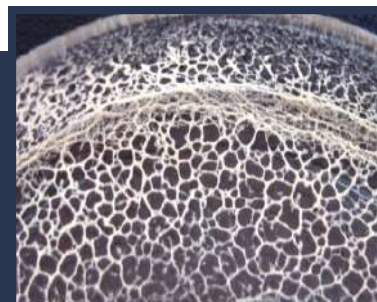
Thus, a differential susceptibility of CSRB to EPN could be established wherein, *Steinernema* species displayed higher virulence on *Plocaederus* spp., while *H. indica* indicated a higher virulence on *B. rufomaculata*.



Plocaederus Grubs Infected by EPN
(*Steinernema* spp)



Plocaederus Cadavers Placed for
Emergence of IJs



Net Formation in Petri Dish by the
IJs Emerging from CSRB Cadavers

The infective juveniles (IJs) of entomopathogenic nematodes of the genus *Steinernema* and *Heterorhabditis*, which were found to be pathogenic to grubs of CSRB under laboratory conditions, had a long survival in field situations. They could survive for up to 150 days in cashew ecosystem under shaded conditions (Vasanthi and Raviprasad, 2012).

3. Management Using Semio-chemicals :

The pest stages are concealed below the cashew bark, tracking and removal of these stages involves skill and drudgery. The complete removal of all the pest stages is seldom achieved during mechanical removal. In certain cases the farmers inflict more damage by unskillful removal of bark than the damage caused by the pest itself. Further, usage of several chemicals either as prophylactic or curative treatment was found to be partially effective and recovery was not consistent.

In order to avoid any insecticidal residues in the end product, the management of the pest using the novel approach of semio-chemicals is being investigated at ICAR-DCR, Puttur. The volatile concentrates and extracts of frass were found to elicit positive response from the female beetles under electro-antennogram (EAG) trials. The compounds in the response inducing fractions have been synthesized and are being evaluated using bucket traps and cross- vane traps installed in CSRB infested plots (DCR, 2015).



Bucket Trap Containing Synthetic Bait for CSRB



Cross-vane Sticky Trap Containing Synthetic Bait for CSRB

For further information and assistance, please contact us at the email address mentioned below:

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Management of Minor Pests and the Importance of Pollinators

Dr. K. Vanitha, Dr. T.N. Raviprasad and Dr. H. Rajashekara

Introduction

Apart from the two important insects viz. cashew stem and root borer (CSRB) and tea mosquito bug (TMB), cashew is also infested by other damaging pests namely, shoot tip caterpillars, thrips, leaf miner, leaf and blossom webbers, apple and nut borers, inflorescence caterpillars, mealybugs etc. These pests are sporadic in nature and occasionally occur as problematic in certain regions. It is known that cashew depends on insects for pollination and fruit set, as it is cross-pollinated. This chapter covers details of important minor pests and pollinators of cashew.

Minor pests of cashew

(a). Shoot Tip Caterpillar

During active flushing period, damage to shoot tips of cashew trees can occur due to shoot tip caterpillars. This pest is seen in the east coast cashew growing tracts. The pale yellowish green caterpillar (*Anarsia epotias* Meyr., F: Gelechiidae) webs together the tender leaves and feed within it at the early stage. Later, they bore into the terminal shoots and tunnel inside up to 2-3 cm. A gummy substance oozes out from the infected tips, and finally the attacked shoots dry up. Similarly, the tiny, yellowish to greenish-brown larvae of *Hypotima haligramma* M. (Lepidoptera: Gelechiidae) also damage shoot tips by folding the fresh leaves and feed within. Tender shoot tips are bored occasionally up to 25-35 mm, leading to drying up of shoot tips. The larva damages the inflorescences also in the subsequent period.

(b). Leaf Miner

The leaf miner, *Acrocercops syngramma* M. (Lepidoptera: Gracillariidae) is a common pest of cashew during post monsoon period all over the country. Young plants are more prone to attack. Caterpillars mine and feed below the epidermal layer of the tender leaves and tender shoots causing extensive leaf blisters which later dry up causing distortion, browning and curling of the leaves. As the attacked leaf ages, holes develop due to drying out of the damaged portion. Larval parasitoids viz., *Chelonus* sp. (Braconidae), *Sympiesis* sp. (Eulophidae), *Chrysocharis* sp. (Eulophidae) were reported and parasitism up to 40 % has been recorded in field conditions at Puttur, Karnataka.

(c). Thrips

Thrips are minute, fragile, slender, active insects, and adults have fringed wings. Foliage thrips infesting cashew are *Selenothrips rubrocinctus* (Giard), *Rhipiphorothrips cruentatus* Hood and *Retithrips syriacus* (Mayet) (Thysanoptera: Thripidae). The adults and immature stages of thrips colonise the lower surface of leaves. The infested leaves become pale brown and crinkle with roughening of the upper surface.

Honeydew excreted from thrips gives rise to the growth of black sooty mould. Under severe infestation, shedding of leaves and stunting of growth results. If infestation occurs on cashew seedlings, whole seedling may dry up.

Flower thrips reported on cashew include *Rhynchothrips raoensis* G., *Haplothrips ganglbaueri* (Schmutz), *H. ceylonicus* Schmutz, (Thysanoptera: Phlaeothripidae), *Thrips hawaiiensis* (Morgan), *Frankliniella schultzei* (Trybom) and *Scirtothrips dorsalis* H., (Thysanoptera: Thripidae).

A recent study at ICAR-DCR, Puttur has documented a total of 19 species of thrips on cashew flowers. *Thrips subnudula* has been noticed as dominant species followed by *Haplothrips ganglbaueri*, *H. gowdeyi* and *Scirtothrips dorsalis*. Flower thrips attack buds, flowers, immature apples and also nuts. Thrips infestation causes shedding of flowers, immature fruit drop, formation of scabby as well as, malformed apples and nuts. Up to 15-25 per cent fruit drop is noticed due to thrips damage.

A large number of predatory insects like anthocorid bugs, geocorid bugs, lace wing bugs, coccinellids etc feed on thrips and bring down their population.

(d) Leaf Folder and Leaf Rollers

Several caterpillars fold and/or roll the tender cashew leaves emerging after post monsoon and feed within. Light yellowish larvae of *Caloptilia tiselaea* M. cause damage by folding the tender leaves terminally. Larvae of *Anigraea albomaculata* damage tender leaves by making spindle shaped folds. While larvae of *Macalla albifusa* Hamp. join the leaves one above the other by silken threads and feed on them. Larvae are very active and wriggle out when disturbed and the damaged portion dries up gradually. In few places, larvae of *Sylepta auranticollis* F. during their early stages roll the tender leaves and scrape the green matter, later they defoliate the entire leaves.

(e) Inflorescence Caterpillars

A complex of webbers, loopers, bud worms, caterpillars etc occur on cashew flowers. Important species include, *Hypatima haligramma* M., *Anarsia* sp., *Lamida moncusalis* W., *Nanaguna* sp., *Thylacoptila paurosema* M., *Archips* sp., *Euproctis* sp., *Aetholix flavibasalis* G. Other caterpillars are *Dudua aprobola*, *Oenospila flavifusata*, *Tinolius* sp., *Perixera* sp., *Bombotelia jocosatrix* etc. Infestation by lepidopterans especially by *H. haligramma* and *Anarsia* sp. starts soon after the emergence of inflorescences and panicle/bud expansion stage. The infestation by lepidopterans gradually increases from December first week reaching a peak during the last week of December or first fortnight of January. But the population of most of the lepidopteran species decreases drastically during March. Incidence of certain leaf feeding caterpillars like *B. jocosatrix*, *O. flavifusata*, *Pingasa ruginaria*, *Perixera* sp., *Hyposidra* spp., *Euproctis* sp. and *A. flavibasalis* can also be noticed on cashew flowers between December and January especially during delayed flushing and early flowering seasons. Damaged portions of buds, flowers, rachis, drying of flowers, webbing of flower clumps and reduced nut set. Studies indicate that timely application of insecticides against lepidopteran flower pests can minimize the yield loss by 20-50 per cent depending on the nature of pest infestations and damage intensity.

(f). Apple and Nut Borer

Several lepidopteran, coleopteran, dipteran and hemipteran pests damage apples and nuts of cashew during different developmental stages. Among them, *Thylocoptila paurosema* M. and *Hyalospila leuconeurella* R. (Lepidoptera: Pyralidae) are important. Dark pink larvae initially damage flowers and later bore inside the tender nuts and developing apples resulting in shrivelling and premature fall. In the developed green nuts and apples, caterpillars tunnel near the junction of apple and nut and the boreholes are plugged with frass and excreta.

The fully grown larvae drop to the ground for pupation and emerge as moths. The larvae of *H. leuconeurella* bore through the apple from one end to the other end and remain inside the apple till the fruit drops and when nuts are attacked, they get deformed. Recently, infestation of apples and nuts by *Citripestis* sp. has also been reported in Karnataka. On *H. leuconeurella*, a chalcid, *Brachymeria* sp. and an Ichneumonid *Cremastus* sp. have been recorded as parasitoids. Besides, *Lamida moncusalis* Wlk., *Orthaga exvinacea* Hamps and *Euproctis* spp. occurs as external feeders on tender fruits and apples.

(g). Leaf and Blossom Webber

Cashew shoots bearing fresh flushes and flowers are attacked by *Lamida* (= *Macalla*) *moncusalis* Wlk. (Lepidoptera: Pyralidae) and *Orthaga exvinaceae* Hamps. (Lepidoptera: Noctuidae). Of these, *L. moncusalis* is an important pest in East Coast tracts. Symptoms of infestation are presence of webs on terminal portions, with clumped appearance, and drying of webbed shoot/ inflorescences.

(h). Mealy Bugs and Scale Insects

Mealy bugs, *Ferrisia virgata*, *Planococcus lilacinus*, *Planococcus citri* and *Phenococcus solenopsis* are serious in certain cashew pockets. They are soft bodied, having milky white coating on the body. The nymphs and adults suck sap from the tender plant parts results in withering of growing shoots, inflorescence and developing fruits. Due to honey dew secretion by mealy bugs, sooty mould develops on the affected portions. Two parasitoids viz., *Aenasius advena* Campere (Encyrtidae) and *Blepyrus insularis* Cameron were recorded on *F. virgata*. Besides mealy bugs, scale insects also occur on cashew, becoming problematic especially in net house conditions where natural enemies are not present. Recently, two new species of scales *Lepidosaphes laterochitinsa* Green and *Ceroplastes ceriferus* (Fabricius) (Hemiptera: Coccoomorpha) have been reported on cashew from Karnataka, India.



Leaf miner



Thrips



Inflorescence Caterpillars



Apple and Nut Borers

Fig. Damage by Minor Pests of Cashew

Other Minor Pests

Apart from these pests, there are several chrysomelid beetles (importantly *Monolepta longitarsus* Jacoby, *Neculla pollinaria* Baly), lepidopteran caterpillars (*Lymantria* sp. (Lymantridae), *Metanastria hyrtaca* Cram. (Lasiocampidae), *Euproctis* spp. (Lymantridae) defoliate cashew mostly during post monsoon flushing period. In few regions, leaf folders, leaf rollers, aphids cause damage to tender cashew shoots. Besides, there are several other minor pests damaging flower buds and flowers. Most of these pests occur at very low population level, for which, management measures are generally not required.

Management of Minor Insect Pests of Cashew

- Generally, the plant protection measures taken up against tea mosquito bug manages most of the minor pests, hence spraying for these pests is required only under severe infestation.
- Removal and destruction of mealy bug, scales and aphid infested plant parts help to minimize their infestation and spread.
- Under unsprayed conditions, an array of predators viz., spiders, ants, reduviids, coccinellids, neuropterans, hemipteran bugs and praying mantises predate on many of the minor pests of cashew. Red ants (*Oecophylla smaragdina*) are the potential biocontrol agents in cashew plantations that feed on bugs, caterpillars, hoppers, moths etc. Red ant colonized old cashew trees are generally free from pests. Trees harbouring ant nests especially red ants should be spared of spraying to allow them to take care of pests naturally.
- Neem (*Azadirachta indica*) oil @ 3-5%, Karanj (*Pongamia pinnata*) oil @ 2%, Fish Oil Rosin Soap and neem seed kernel extract @ 1% are some of the botanical preparations effective against many of the foliage pests of cashew like leaf miners and leaf feeding caterpillars. While using botanicals, emulsifiers (soap water/ bar soap 0.5 % @ 5g/lit or teepol @ 0.1 %) should be mixed in the spray fluid for thorough mixing, if needed.

II. Importance of Pollinators in Cashew

As cashew is a cross-pollinated crop, fruit set is mainly influenced by the activity of pollinators. In general, cashew flowers are visited by diverse group of insects like ants, bees, thrips, butterflies, flies, wasps etc. Insect visitors documented on cashew flowers at ICAR-DCR include 40 species belonging to 13 families of three insect orders. Many of the dipterans are just visitors of cashew flowers, and not pollinators. Similarly, wasps like sphecids and vespids move among cashew flowers frequently which might be for nectar as well as prey insects. Similarly, several ant species move over the cashew inflorescence throughout the day period, but they forage mostly on EFN.

Based on the abundance and foraging activity, eight bee species are considered as pollinators of cashew, viz. *Apis cerana*, *Apis florea*, *Braunsapis* spp., *Ceratina hieroglyphica*, *Tetragonula* sp., *Lasioglossum* sp., *Pseudapis oxybeloides* and *Seledonia* sp. Bees of different species visit the flowers simultaneously, and activities of *A. cerana*, *A. florea* and *Tetragonula* sp. are noticed throughout the observation period. Peak foraging period of pollinators (11.00 - 03.00 h) coincides with peak anthesis of hermaphrodite flowers and high pollen build-up in male flowers, which is very much advantageous for effective pollination in cashew.

Since pollen is the foraging reward for most of the bee species, fresh male flowers are mostly preferred. Most bees collect pollen followed by nectar in the same male flower or nectar followed by pollen. Nevertheless, it is observed that the same hermaphrodite flower is visited by multiple bee species consequently, thus effecting pollination.



Fig. Pollinators of Cashew. From left: *Pseudapis Oxybeloides*, *Ceratina Hieroglyphica*, *Braunsapis* sp.

Pollinator exclusion studies by bagging experiments indicated that bees are necessary for increasing the fruit set in cashew. Thus, sufficient pollinator population is required to realize good yield, as hermaphrodite flowers need to be pollinated within 4 hours of peak stigma receptivity. Encouraging bees especially the native bees by means of their conservation and identifying cashew genotypes with high pollinator attraction are important to enhance the productivity of cashew. Artificial bee nests designed at ICAR-DCR, Puttur having wooden blocks with drilled dead-end tunnels at 1 x 1 cm (6 cm deep and inner diameter of

3.00 mm and 2.5 mm) and sticks of bamboo, lantana, Johnson's grass, cashew etc were successfully occupied by *Braunsapis* spp., which are the important and abundant native bee species found in the region. These trap nests can be used for conservation of this bee species and pollination. Keeping *A. cerana* colonies @ 8/ha resulted in yield increase by 15 % in the cashew plantations at ICAR-DCR, Puttur, however, up to 200 % yield increase has been reported in few African countries through bee keeping. Thus, the flora in the surroundings influence the bee visits on cashew.



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Diseases Management in Cashew

Dr. H.Rajashekara

Introduction

Cashew (*Anacardium occidentale* L.) is an important commercial plantation crop supporting livelihood of farmers and grown in warm and humid tropical and subtropical regions. India is a major key player in cashew processing and exporter of cashew kernels in the international market leading to more foreign exchange. In India, information available on the incidence, nature of occurrence, yield loss and its economic importance by different pathogens in cashew plantations as well as cashew nurseries and their management strategies is very less.

However, in other major cashew growing countries, many diseases are found to be infected by different pathogens in cashew starting from seedling to harvesting of cashew nuts with economic importance. This chapter highlights the important diseases occurring in cashew plantations and nurseries with special emphasis on disease symptoms, causal organism and management approaches.

1. Anthracnose Disease

Symptoms

Initially elongated dark brown to black water-soaked lesions on shoots later it will dry up and leaves which become crinkled, dry up and fall off. Small dark spots are formed on main stalk and lateral branches of the panicle; the flowers eventually wither and drop down and floral branches show drying symptom. Immature fruits turn black and fall prematurely. On mature fruits black irregular or roundish spots develop those are often sunken and gradually start rotting. The disease is more severe when rainfall coincides with flowering season. Small black spots appear on nuts and apples and it becomes mummified

Causal Organism: *Colletotrichum gloeosporioides* (Penz.) Penz. & Sacc.), the telomorph *Glomerella cingulata* (Ston.) Spauld. & Schrenk.

Pathogen Survival and Spread

The pathogen survives on dead plant debris after the tissues are killed and it becomes active to produce abundant conidia during rainy season. When the humidity starts increasing and new flushes emerge, the disease spreads in plantations through conidia which are easily carried by air current and rain splashes. High rain and temperature around 22-28 °C favor fast spread of disease in cashew plantations.

Management

The anthracnose disease can be effectively managed by spraying plants and seedlings with the help of protective and curative fungicides. The affected plant parts should be pruned and burnt to prevent the spread of the disease. Spraying with 1 % Bordeaux mixture or Mancozeb 0.25% or copper oxychloride 0.3%.

2. Gummosis Disease

This disease was described by Freire (1991) in cashew plantations of Ceara State (Brazil). In Ghana, the incidence of gummosis was reported 7%-14% (Muntala et al 2020). *Botryodiplodia theobromae* was reported in causing die-back, inflorescence-blight and gummosis disease (Khatoon et al., 2017). In Nigeria, twig dieback disease caused by *Lasiodiplodia theobromae* is a major yield limiting factor for decades (Olunloyo, 1983; Hammed and Adedeji, 2008). Inflorescence blight/ floral shoot and twig die back reported as serious disease and causes nut yield loss by 70% and it also causes complete drying of vegetative shoots by 50% (Olunloyo1979).

Lasiodiplodia theobromae has been described as a causal agent of cashew gummosis, which has become the most important disease impacting cashew orchards in the semi-arid conditions of northeastern Brazil. This disease causes damage of up to 30% stand losses in localized orchards in the states of Ceara and Piaui (Cardoso et al., 2002), infecting commercial clones of cashew trees and causing nut decay (Freire, 2014)

Symptoms

Initially the symptom will exhibit as gum oozing from small cracks of the infected parts and reddish-brown liquid from the main stem and branches which later turn black in color giving tree bleeding appearance. The most diagnostic symptom is gum exudation followed by leaf yellowing and leaf drop. Longitudinal cracks also appear on the affected region from which gum exudes. The inner tissues of the affected portions turn reddish brown having small cavities filled with reddish fluid and the affected branches dry gradually.

Management

Monitor the cashew plantations regularly and keep clean, prune the unproductive, dry and disease/ insect infected branches. Chiseling out the affected plant portions and applying Bordeaux paste (10 %) or swabbing the cut portion with suspension of copper oxychloride (0.3 %). Spraying of mancozeb (0.2 %) or Bordeaux mixture (1 %) is found effective. Spray Bordeaux mixture 1% thoroughly on the whole plant after harvest and repeat again at fruit setting. If the bark is cracking or has mechanical injury, use Bordeaux paste 10% immediately. Likewise, if there is gum secretion on any part of the tree, clean it off and use Bordeaux-pest as mentioned before.

3. Powdery Mildew Disease

The disease is first reported from Sao Paulo Brazil by Noack in 1898. It is an important disease in Brazil and African countries. In India, it is noticed in west coast regions of Maharashtra state (Phadnis and Eliah, 1968). The yield loss from 50 to 70 per cent has been reported from Tanzania (Sijaona and Shomari, 1987). In east Africa, its damage can lead to over 60% yield loss (Agboton *et al.*, 2013). In Tanzania, the cashew crop is severely affected by powdery mildew, it is causing yield loss ranging from 70% to 100% (Sijaona, 1984)

Symptoms

The disease occurs as sporulating whitish or grayish white mycelial growth on the upper surface of leaves and occasionally on inflorescence. Infection will affect the fruit set resulting in small, crunched and cracked cashew nuts. Severe infection may lead to shriveling and complete drying up of leaves and twigs.

Management

Regular maintenance of field sanitation by the removal of infected plant parts before flowering can delay in disease development and reduce disease severity. Adoption of appropriate spacing and regular pruning during establishment can reduce the carryover of inoculum to next season. In Brazil, disease could be controlled by fortnightly dusting or spraying with sulphur products and benomyl (Cardosa et al., 1995; Menezes, 1997). In Tanzania also successful control of the disease was obtained by five to six applications of sulphur dust during flowering period (Waller et al., 1992). It is also observed that spraying of organic

sulphur 30-50% is superior to sulphur dusting 20% (Smith et al., 1997). Spraying of the inflorescence with triadimenol 250g a.i. per litre reduced mildew infection to less than 9 per cent in highly susceptible genotypes (Sijaona and Mansfield, 2001). Three sprays of triadimenol 250EC (Bayfidan) and triademefon 25WP (Bayleton) at 14 days interval starting at the onset of flowering showed effective control of the disease in Kenya. Systemic fungicides like triadimenol, hexaconazole (50g a.i. per liter) and penconazole (100g a.i. per liter) have been recommended with higher efficiency in Tanzania and Mosambique (Topper et al., 1997; Smith et al., 1997).

A hyperparasitic fungus, *Cicinnobolus cesatii* is found in association with *O. anacardii* (Casulli, 1979). In an in vivo screening of 72 isolates of bacteria and fungi from cashew leaves and florets, none of them showed inhibitory effect, but the commercial bioagents, *Bacillus subtilis*, *B. licheniformis* and *Candida saitoana* were antagonistic to the pathogen. The inhibitory effect of *B. licheniformis* was on par with triadimenol fungicide (Uaciquete, 2006).

4. Black Spot Disease

Black mold is considered the most important foliar disease of cashew in Brazil. The disease epidemic has caused a nut yield loss of 33 per cent (Cardoso et al., 2000). The disease is caused by the obligate parasitic fungus *Pilgeriella anacardii* Arx and Miller which infects only cashew plants. Initial symptoms are chlorotic spots on the upper surface of leaves which later spread to lower surface and the pathogen forms black colonies giving velvet like appearance. Severely infected leaves become shriveled and fall prematurely. Symptoms are seen on old mature leaves and young leaves are not susceptible to the pathogen.

The effective control of black mold by copper oxychloride (3g/lit) has been reported by Freire (1991a). Spraying of protective and curative fungicide can control this disease (Cardoso et al., 1995). Two applications of plant activator, acibenzolar-S-methyl (ASM) at 30 days interval are sufficient to reduce the disease incidence (Viana et al., 2012).

5. Inflorescence Blight Disease

It is a common disease during flowering season caused by *Colletotrichum gloeosporioides* and *Phomopsis anacardii* in possible association with Tea Mosquito Bug (TMB). The disease is characterized by drying up of floral branches. Reddish- brown, shiny, minute water-soaked lesions develop on the main and secondary rachis. The lesions turn pinkish brown, enlarge and soon turn scabby. Gummy exudation can be seen on the affected regions. The adjoining lesions coalesce resulting in drying- up of inflorescences with a scorched appearance. The nuts and apples of the affected inflorescences show rotting and shrinking. During cloudy weather, incidence of this disease is aggravated. The combined application of copper oxychloride 0.2 per cent and any insecticide that control TMB such as lambda-cyhalothrin 0.003 % is recommended.

6. Sooty Mold Disease

Sooty mold is the most common fungal disease. It is caused by *Capnodium* spp. on majority of plantation crops including cashew trees. The fungus does not enter into the tissues of their hosts but grow rapidly on the honeydew excreted by various insects. The fungus forms a superficial thick black coating on leaves (usually on upper side), twigs and even fruits, wherever the honeydew excreted by the insects falls. Though there is no direct damage or injury caused by the fungus to cashew trees the very presence of sooty mold interferes seriously with photosynthetic activity of the plant, resulting in stunted growth and poor fruit setting. Control of insect pests that exude honeydew will prevent the occurrence of this disease. The disease can be controlled by spraying fish oil resin soap (1.5 kg in 1000 liter of water) followed by starch solution 2 per cent.

7. Red Rust Disease

Red rust is an algal disease caused by *Cephaleuros* spp. especially in close planted orchards. This disease is prevalent in almost all cashew growing regions of India. The symptoms can be observed as small, circular, greenish-grey raised spots appear on leaves, petioles and tender twigs. The spots gradually turn reddish brown and coalesce to form large irregular and slightly raised patches. It will reduce the photosynthetic area.

Nursery Diseases and their Management

Cashew seedlings are succumbing to many nursery diseases. It has now become a serious concern in cashew nurseries with the development of new varieties and with adaptations of scientific technologies. The nursery diseases are not studied in depth for its pathogen confirmation and for adoption of suitable management practices for effective control. The important nursery diseases include seedling die back, damping off, foot and root rot, seedling blight and leaf blight. Damping off and leaf spot are discussed in detail.





8. Damping Off Disease

Damping off is caused by a different seed and soil borne pathogens, majority of which are soil borne in nature. The disease occurs in nurseries where drainage conditions are poor. This disease is reported from India in 1962 from Vengurla, Maharashtra state and it was also noticed in Kerala, Karnataka and Andhra Pradesh cashew growing nurseries. *Phytophthora palmivora*, *Pythium* sp. are found associated with both pre- emergence and post-emergence damping off (Kumara Raj and Bhide, 1962). Symptoms consist of two types, i) pre-emergence and ii) post emergence. In pre-emergence, rotting of seed nut before emerging out of soil and appearance of water-soaked lesions at the collar region.

The affected plants turn pale and show water-soaked girdle of darkened tissues around the stem and such seedlings eventually topple over and show rotting symptoms. In severe cases, the leaves also show water-soaked areas which enlarge and coalesce. Close spacing, continuous nursery growing, cool and wet conditions are highly congenial for damping off diseases. Optimum levels of irrigation combined with proper drainage in nurseries, and periodical nursery inspection will give good control. Soil drenching with 1% Bordeaux mixture reduced the infection.

9. Leaf Spot and Leaf Blight Disease

In majority of cashew growing countries, leaf spot diseases caused by different fungi are a serious problem in nurseries. Among these, leaf spots caused by *Colletotricum gloeosporioides* and *Pestalotia* spp. are the most common and serious ones. Leaf spot caused by *C. gloeosporioides* appears as light brown spots with reddish brown margin, which later coalesces and lead to blighting symptom. *Pestalotia* spp. shows irregular brick red necrotic lesion on leaf lamina mainly along the midrib, which enlarge and cause leaf blighting. This disease can devastate nursery if proper control measures are not adopted. Initial symptom appears as water-soaked lesions which lead to rotting, yellowing and defoliation of leaves. The leaf blight disease caused by *Pestalotia heterocornis*, Guba was ranged from 18 to 32 percent in Maharashtra state (Joshi 2005)

Spraying with metalaxyl (1g/lit) controls the infection (Freire, 2002). Spraying of 1% Bordeaux mixture/ copper oxychloride/mancozeb/ zineb @ 2g/lit can effectively control all leaf infection in cashew nursery. Spraying of carbendazim 1g/lit is also effective against *Colletotrichum* spp. and *Pestalotia* leaf blights (Mathew, 2007). Cashew shell extract has got tremendous effect in suppressing the growth of pathogenic fungi like *Fusarium* sp., *Rhizoctonia bataticola*, *Sclerotium rolfsii*, *Pellicularia filamentosa*, *Phomopsis* sp. especially *P. palmivora* which showed 70 per cent inhibition. Thus, the use of cashew shell extract as a potential antifungal botanical can be exploited in eco-friendly disease management practices. Spraying with copper oxychloride (3g/lit) or benomyl (1g/lit) can effectively control the disease (Freire et al., 2002).

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Raw Cashewnut Processing – Status and Technological Advancement in the Era of Changing Economy

Dr D Balasubramanian

Cashewnut processing is a sun rising sector and has been evolved as a significant driving force of growth and development of the agrarian economy for many states in India. The sector also contributes a significant amount to the foreign exchange earnings through export. The rising population and the increase in purchasing power means that the demand for cashew will continue its robust growth. The vertical linkages by way of value addition and post-harvest processing of cashewnut increases the significance of this crop sector, both in terms of employment generation and livelihood security.

Global Perspective of Cashew:

Although cashew is native to Brazil, now it is grown in many other tropical countries. It suits very well to relatively poor soils wherein many others crop find difficult to grow. Cashew is primarily grown in the continents of Asia, Africa and South America. Asiatic zones mainly include India, Vietnam and Indonesia as the major cashew producing countries followed by Philippines, Malaysia, Thailand and Sri-Lanka. African countries producing cashew are Côte d'Ivoire, Nigeria, Tanzania, Mozambique, Kenya, Benin,

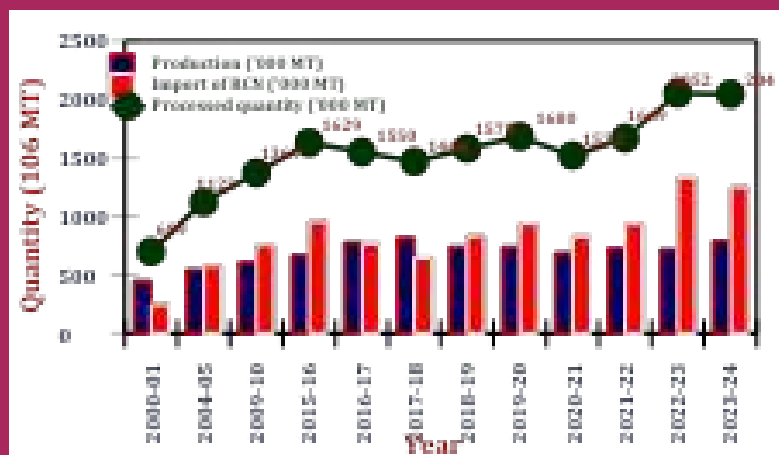
Guinea- Bissau, Mozambique, Ghana, Senegal and Madagascar.

The primary producers in the Latin American zone are Brazil, besides Columbia, Costa Rica, Honduras and Salvador. Vietnam and India are the leaders in processing cashewnut and earn more foreign exchange through value addition. Although, African zone recorded the highest production of raw cashewnuts, due to improper mechanism in place, majority of harvested nuts are exported to other countries losing additional value.



Production and Processing of Cashew in India:

Cashew cultivation was very much confined to the western and eastern coastal areas of the peninsular region after its introduction in India during the sixteenth century. Presently, it is more concentrated in the Maharashtra, Goa, Karnataka and Kerala all along west coast and Tamil Nadu, Andhra Pradesh, Orissa and West Bengal in the east coast. Besides, it is expanding in non-traditional regions viz., Chhattisgarh, Jharkhand, Gujarat, Assam, and Northeast Hill Regions and also in Andaman and Nicobar Islands.



In India, cashew is grown in an area of 12.05 lakh ha with the annual production of 8.02 lakh MT of raw nut and its average productivity centres around 678 kg ha⁻¹ during the year 2024-25. At present Maharashtra state ranks first in production with a total production of 1.92 lakh MT with productivity of 1099 kg ha⁻¹ in the country.

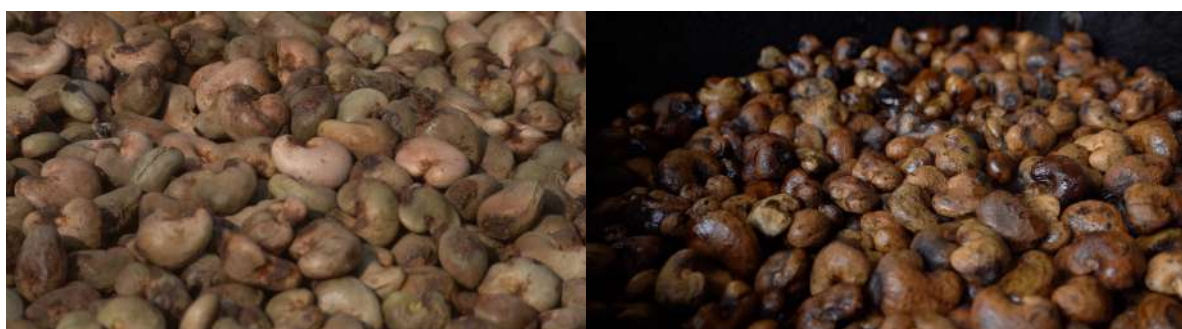
The pioneering spirit of the early entrepreneurs and the unsurpassed skills of Indian women in extracting whole kernels from the nuts were the major factors influencing the birth and growth of cashew industry in India and for her preeminence as the world's largest processor and exporter of cashew kernel. A record quantity of 20.46 lakh MT of raw cashewnuts were processed during the year 2023-24, equivalent to 43 % of the global production.

Indian cashew is renowned worldwide for its superior quality, taste and appearance. The demand is ever increasing for kernels in domestic and international markets. About 0.45 lakh MT of cashew kernels was exported, earning a foreign exchange to the tune of Rs 5433 crores during 2023-24.

Quality Standards for Raw Cashewnut:

Cashew processing is relatively labour and energy intensive industry wherein raw material accounts for a large proportion of the processing cost (70%). The relative importance of these quality factors and their contribution to the suitability vary depending on the material, the process applied to it and the end product made from it.

Certain factors followed to assess the quality of raw cashewnuts are Nut count (Number of nuts / kg); Moisture content (% d.b) and Outturn (Quantity of edible kernels per kg of nuts). This also aids in fixing the price of the nuts.



Mode of Cashewnut Processing in India:

India is the foremost in processing cashewnuts and majority of processing facilities are located in the east and west coast region of this country. These units are categorized under medium to large scale industries based on the capital investment and installed capacity. In early methods, the dried nuts are shelled manually after open pan roasting. The kernels extracted by this process had scorched tip. Oil bath method is a semi-mechanized one and requires huge investment for machinery and infrastructure development. In drum roasting process, the nuts are fed into an inclined rotary drum, wherein the exuding oil ignites and burns, thus charring the shell. The total loss of the shell liquid and exposure of workers to heat and acrid fumes are the major shortcomings of this method. Steam boiling is a cost-effective process wherein raw nuts are subjected to regulated pressure and comparatively low temperature sufficient enough to bring out the shell liquid.

Cashew processing involves multiple interlinked stages, each requiring specific techniques and machinery to ensure yield optimization, product quality, and food safety.

Cleaning and Drying :

Raw cashew nuts arrival at the processing unit involves: i) Removal of dirt, stones, and foreign matter and ii) Drying to reduce moisture content (typically to 8–10%) for effective shelling. Various machinery involved for cleaning and drying are Vibratory cleaners, air blowers, drying trays, and mechanical dryers.

Raw cashewnuts could be exposed to sun by uniformly spreading in thin layer on either semi-finished floor or over polythene sheets and the quantity of nuts to be dried shall not exceed 20 kg m^{-2} . Uniform drying can be achieved by constantly turning nuts over to prevent partial drying or non-uniform heating. Irrespective of drying methods, moisture content of raw nuts should be brought down to $\leq 8\% \text{ d.b}$ for safe storage.

Storage:

Gunny bag storage of 80 kg capacity is the most common practice all over the world and it is shown that storage of raw nuts with a moisture content of $< 8\%$ for a period of 12 months at ambient temperature (25 to 30°C) did not affect either processing or biochemical quality. Recent studies on effect of maturity on the processing quality have clearly indicated that shelling percentage, peeling outturn, whole kernel recovery increases while kernel rejects decrease with maturity. Application of insecticides or pesticides is prohibited to improve shelf life of raw cashewnuts in warehouses.



Conditioning :

Steam boiling mode of conditioning raw cashewnuts is considered to be cost effective system and gaining importance all over the world. As CNSL is preserved in the shell after conditioning, it can be extracted adding revenue to the processor, it is quite advantageous. During steaming process, nut expands and become soft due to infusion of moisture. Rate of moisture infusion should be controlled in order to prevent the transfer of pigment from testa to kernel surface. Therefore, steam pressure and duration of exposure are the decisive factors during steaming operation which are influenced by size, dryness and storage time. After steaming, the nuts are air-cured by spreading out on the floor in the ambient environment. These ultimately harden the shell and make it amenable for subsequent kernel extraction process.

De-shelling :

De-shelling is the removal of the hard outer shell to access the kernel. Kernel with surface skin can be removed both manually and mechanically. In manual shelling, each nut is individually cracked using hand-operated tools such as wooden mallets, hand knives, or pedal-operated shelling devices. The operator applies controlled force along the natural suture of the shell to split it open and extract the kernel with minimal breakage. Mechanical shelling involves the use of power-driven shelling machines designed to crack cashew shells in bulk. Modern mechanical shellers incorporate size grading mechanisms to reduce kernel breakage and improve efficiency. However, complete automation is challenging due to the non-uniform shape and size of cashew nuts.



Drying and Peeling :



Shelled kernels are exposed to controlled environment to facilitate the removal of skin adhering to edible kernel. In the commonly used 'Borma', drying chamber is indirectly heated by flue gases from the furnace at the bottom wherein spent cashew shells or cashew shell cake are used as fuel. This conventional dryer is presently replaced by more efficient electrical/diesel/de-oiled shell cake or wood operated tray driers. This system ensures uniform heating of kernels for a pre-set temperature [$80 \pm 2^\circ\text{C}$] and time [4-6 h] by means of reliable electronic digital controller and timer. Peeling is the process of removing outer skin called testa. Specially designed stainless-steel knife is used to scrap adhering testa without damaging the edible kernel.

Average peeling capacity ranges between 4-12 kg and peeling efficiency or whole kernel recovery observed to be 65-72%. Mechanical peelers working on the principle of impact or abrasion or both are employed to overcome the problem of scanty labourers.



Grading and Packaging :

Kernel grading is primarily based on wholesomeness, size and surface colour and manually segregated in processing units located in many countries. Mechanical graders with fluted rollers and colour sorters are also utilized for grading kernels based on size and surface colour respectively. Grading standards developed in India refer to number of kernels in a pound weight, for example, WW320 indicates 320 numbers of white whole kernels in a pound (lbs) weight. Broken kernels are either butts or splits depending on whether they are broken across or along the cleavage and graded size grading is based on sieve through which it passes through.

Vita packing is the process of vacuumizing and injecting inert gas viz. Carbon-di-oxide or Nitrogen into the cashew kernel filled tins. The gas infused tins are hand-soldered hermetically using lead free solder. Such tins are packed in a carton (2 nos.) and strapped and stencil marked for shipment. The consignment is shipped after per-shipment inspection formalities. Flushing with CO₂ avoids microbial spoilage during shipment or distant transport. Moulded vacuum packaging (MVP) replaced vita packing as it produces consistent rectangular blocks ranging in size from 500g to 25 kg of cashew kernels. Besides, MVP system has advantages during transport, handling, display, stock count etc. This also helps to save the total cost incurred on secondary packaging considerably. The vacuum barrier bag and the cardboard box are totally recyclable. The rectangular shape of primary packs ensures minimum movement during transport and handling ensuring maximum protection to kernels. The removal of air and gas flush reduce the incidence of rancidity and insect infestation.

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Value Addition of Cashew Nut

Dr. Jyoti Nishad and Dr. Veena G.L

Introduction

Cashew (*Anacardium occidentale*) is a highly valued tropical nut crop widely cultivated in countries like India, Vietnam, Brazil, and Africa. It is primarily grown for its edible kernels, which are rich in protein, healthy fats, and essential minerals. Apart from the nut, cashew also produces valuable by-products such as cashew apple, cashew nut shell liquid (CNSL), and cashew testa, which have applications in the food, pharmaceutical, and industrial sectors. The global cashew market has witnessed steady growth due to increasing demand for healthy snacks, plant-based products, and functional foods. The rising consumer preference for nutritious and natural ingredients has positioned cashew as a premium nut, competing with almonds, walnuts, and pistachios.

Additionally, cashew-based products like cashew butter, cashew milk, and vegan cashew cheese are gaining popularity in the health-conscious and plant-based food segments. Major cashew-producing countries such as India, Vietnam, and Côte d'Ivoire play a crucial role in supplying raw cashew nuts (RCN) and processed kernels to international markets, including the United States, Europe, and the Middle East. The increasing investment in cashew processing, value addition, and improved supply chain management is expected to further boost the market potential of cashew in the coming years. The adoption of sustainable practices and advanced technologies in the industry is opening new avenues for both startups and established players.

Cashew nuts are highly nutritious, containing 30.19% carbohydrates, 43.85% fats (including 54% monounsaturated fats, 18% polyunsaturated fats, and 16% saturated fats), 18.22% protein, 5.2% moisture, 0.00106% niacin, 0.86 mg/100g pantothenic acid, 0.037% calcium, 0.593% phosphorus, 0.66% potassium, and 0.29% magnesium (Blomhoff et al., 2006; Nwosu et al., 2014). These nutritional attributes highlight the richness of cashews in healthy fats, proteins, and essential minerals. Cashew kernels undergo value addition to enhance their quality, shelf life, and market appeal.

Value addition not only increases profitability but also provides consumers with a variety of cashew-based products. Below are key aspects of cashew kernel value addition and common value-added products. Expanding into diverse cashew nut processing methods can result in innovative products such as flavored, roasted, fried, or coated cashews, as well as cashew powder, cashew butter, and traditional items like kajukatlí. These strategies not only broaden the consumer base but also enhance the industry's market visibility and competitiveness.

Value-added Product

A value-added product can refer to “any product that has been subject to additional actions or combined with extra products to raise the overall value of the product.”

U.S. Department of Agriculture defines the value-added products as having:

- A change in the physical state or form of the product (such as making cashew butter from kernels).
- The production of a product in a manner that enhances its value (such as organically produced products).
- The physical segregation of an agricultural commodity or product in a manner that results in the enhancement of the value of that commodity or product (such as an identity-preserved marketing system)

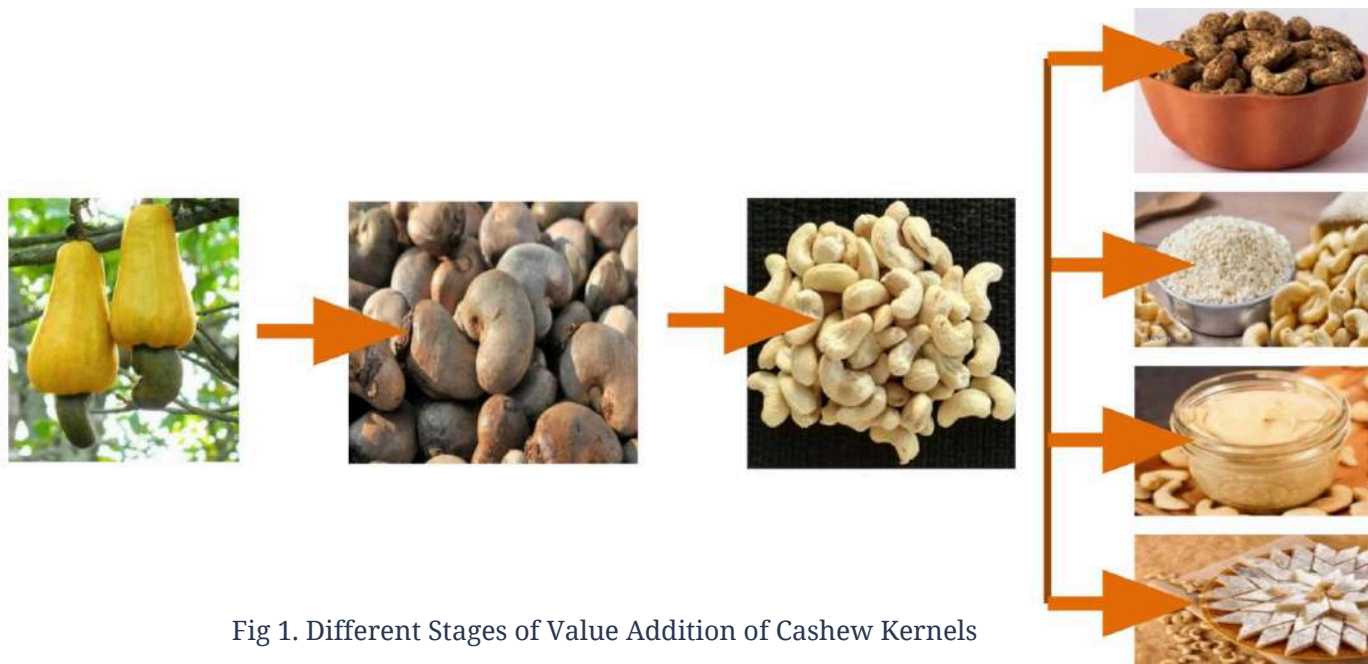


Fig 1. Different Stages of Value Addition of Cashew Kernels

Many research institutes such as Kerala State Cashew Development Corporation (KSCDC), the Directorate of Cashew Research have extensively worked on the utilization of cashew kernels for value-added products. KSCDC has launched cashew kernel products viz. Cashew Vita in four flavors that include pista, cardamom, vanilla and chocolate, cashew vanilla milkshake, chili-garlic cashew, salt and pepper-coated cashew, red chili-coated cashew, cashew powder, cashew soup, roasted and salted cashews in various grades.

Value addition is required to increase the revenue as it is estimated that mere roasting of cashew kernel and packing can double the market price of kernels. Also, with the availability of various options from a single raw material the market demand increases. Processing and packaging of cashew kernels also improve the keeping quality and facilitate the year-round availability of products. Figure 1 represents different stages of value addition of cashew kernels.



Value Addition of Cashew Kernels

1. Processing and Grading

Cashew kernels are processed by shelling, peeling, drying, and grading to ensure uniform quality. Grading is based on size, shape, and color, with whole, split, and broken kernels categorized accordingly. High-quality cashews are often roasted and packed for direct consumption.

3. Coating and Flavoring

Coated cashew products include honey-coated, caramelized, spiced, and chocolate-coated cashews. These products target premium markets and gourmet consumers.

2. Roasting and Seasoning

Roasted cashews are more flavorful and appealing. They can be oil-roasted or dry-roasted. Seasoning with salt, spices, honey, or chocolate enhances taste and market demand.

4. Packaging and Branding

Proper vacuum sealing and nitrogen flushing extend the shelf life. Attractive and hygienic packaging enhances marketability. Branding with organic, premium, or gourmet labels increases product appeal.

Fig 2. Cashew Kernel Products Available in Market



Plain Packed



Roasted



Roasted & Salted



Roasted and Seasoned with Different Spices



Cashew Powder



Cashew Butter



Cashew Milk



Kajukatli



Cashew Vita



Cashew Soup



Cashew Based Shakes

Roasted Cashew Kernel

It is a ready-to-eat snack and is popular for its ease of carrying and flavor. Roasting of kernel enhances its sensory and nutritional quality. In a study conducted by Famurewa et al. (2016) the effect of dietary consumption of roasted cashew kernel on lipid profile, and hepatic and renal status in rats. Studies showed that a supplemented diet significantly decreased the liver function parameters, and reduced serum creatinine and urea levels in rats. However, total cholesterol and low-density lipoprotein-cholesterol (LDL-C) were significantly increased, whereas oxidative stress markers and malondialdehyde were improved by the supplemented diet, although insignificantly, as compared with the control.

Roasted cashew kernels may be defined as “kernels which have been subjected to heat by either dry roasting or deep frying in a vegetable oil and to which salt (in form of powder or brine) and/or spices or food ingredients may have been added”. Roasted cashew kernel is prepared by roasting raw cashew kernels in the oven at 135 to 145°C for about 20-30 mins with intermediate turning or over low flame with sprinkling of a small quantity of edible oil with continuous stirring until kernels turn golden yellow (Olalekan-Adeniran & Ogunwolu, 2018).

The requirements of roasted cashew kernels are as follows (Northern Corridor Standard NC 3:2018):

Characteristic	Limit	Test Method
Moisture, %, m/m, max	2.0	ISO 1026
Peroxide value, max., meq/kg	3.0	ISO 3960
Acid insoluble ash on dry weight basis, %, m/m, max	2.0	ISO 735

Roasted Salted Kernel

For salting cashew kernels are sprayed with brine solution while continuously stirring over the flame. Then these kernels are dry-roasted until they become crisp and develop a desirable color. Care should be taken to avoid over-roasting and burning. The product is then cooled and pack (CFTRI method).

Alternative Method of Kernel Roasting

In this method, a brine solution is prepared in boiling water and cashew nuts are added to the brine while continuously stirring. Then these kernels are dry-roasted until they become crisp and develop a desirable color. (CFTRI method)

Roasted Seasoned Kernels

Cashew nuts are regarded as a healthier substitute for other savory snacks like crisps and extruded snacks, often deemed more advantageous for health than peanuts in many major consumer markets. They are available in various forms, including raw, roasted, or seasoned with a variety of savory or sweet flavorings such as chili, paprika, honey, and combinations of spicy and sweet. Seasoning of cashew kernels can be done using spice mix such as chili, cumin, chat masala, black pepper powder or with herbs like oregano, garlic powder, mint powder etc. Raw cashew kernels are roasted as described earlier with the addition of oil or butter. Sprinkle the desired over the surface and saute the kernels till a uniform coating is obtained.

Honey Coated Cashew Kernel

Honey, a natural sweet substance produced by honey bees from plant flower nectars and honeydew, is a supersaturated solution of sugars, with fructose (38%) and glucose (31%) being the primary contributors. Rich in phytochemicals, including polyphenols with antioxidant properties, honey encompasses a diverse array of minor constituents that also possess antioxidant qualities. Remarkably, honey is virtually non-allergenic and is easily assimilated by the body, serving as a potent energy provider (Rahman et al., 2010). Comprising 80–85% high-energy carbohydrates, honey offers sugars that are easily digestible, akin to those found in many fruits. Scientists investigating ways to enhance antioxidant levels in individuals through diet and supplements are exploring honey's potential in combating free-radical activity. Honey acts as an antioxidant through various compounds such as glucose oxidase, catalase, ascorbic acid, flavonoids, phenolic acids, carotenoid derivatives, organic acids, Maillard reaction products, amino acids, and proteins (Beretta et al., 2005).

In the body, honey can neutralize free radicals, contributing to improved health. When incorporated into foods, the compounds produced during the heating of honey can also prevent rancidity in some products. The multifaceted antioxidant properties of honey make it a valuable addition to both the diet and food preservation processes. Therefore, coating of cashew kernels with honey will improve its nutritional quality as well as antioxidant properties. Raw or roasted kernels can be used for honey coating. Coating is done using dip method. The kernels are then air-dried, packed and stored (Olalekan-Adeniran & Ogunwolu, 2018).

Candied Cashew Kernels

Candied kernels are good alternatives for market-based candies with artificial flavorings. These can be prepared by cooking cashew kernels in sugar syrup till caramelization of sugar occurs. Other flavors may be added to the sugar syrup to enhance the sensory quality of the product. Raw cashew kernels are roasted for 10 min with continuous stirring. Prepare a thick sugar syrup and add hot roasted cashew kernels to it. Stir the solution to ensure uniform coating of the syrup. Continuous heating and stirring need to be done until sugar becomes caramelized and coats the kernels. The product is then cooled and packed.

Cashew Kernel Powder

Cashew powder has gained popularity in gluten-free cooking and baking as a versatile ingredient. It serves as a suitable substitute for almond flour and can be incorporated into recipes for cookies, muffins, and quick bread. Notably, cashew flour possesses a natural sweetness and lacks the bitterness that can be associated with almonds, enhancing the overall flavor profile of the baked goods. Raw and dried cashew kernels are ground with intermittent breaks. Sieve the powder and store it in an airtight container. It is very important to avoid very smooth grinding of kernels otherwise it will become paste due to high fat content. Continuous grinding should not be done.

Cashew butter

The rise and evolution of dairy-free butter have become increasingly prominent in recent years. The recognition of the elevated fat content in dairy butter has underscored the demand for alternative plant-based butter options. Nut butters have gained immense popularity due to their rich content of essential fatty acids, fiber, and protein. These plant-based spreads are particularly favored within the vegan community for their nutritional benefits and versatility in various culinary applications.

Cashews play a significant role both as an edible nut and a prominent industrial product among tropical nuts (Chandrasekara & Shahidi, 2011). In a study by Nagaraja (2003), a sweetened and flavored spread made from cashew kernel baby bits (CKBB) was prepared. Cashews are rich in various nutrients, including iron, copper, and phosphorus. Notably, all the fat in cashew butter consists of heart-healthy unsaturated fats, making it a favorable option for those who enjoy its smooth, rich taste as an alternative to peanut butter or traditional butter. Additionally, cashew butter tends to have fewer additives compared to other spreads.

Table 2: Nutritional composition of cashew butter
(Source: USDA)

Constituents	Cashew butter
Calories (cal)	167
Fat (g)	14
Protein (g)	5
Carbohydrates (g)	7.8
Sugar (g)	-
Fiber (g)	0.6
Cholesterol (mg)	0
Saturated Fats (g)	2.8
Trans Fatty Acids (g)	-
Calcium (mg)	12.2
Iron, Fe (mg)	1.4
Potassium, K (mg)	155.1
Magnesium (mg)	73.3
Phosphorus, P (mg)	129.8
Zinc, Zn (mg)	1.5
Manganese (mg)	0.2
Selenium, Se (µg)	3.3

Cashew butter, similar to peanut butter, is rich in healthy fats, particularly monounsaturated fat. It contains high concentrations of iron, magnesium, vitamin B6, and calcium (Table 2). The butter is typically crafted from either raw or baked cashews, offering a lusciously creamy flavor. Opting for raw cashew butter is advisable, as it tends to retain more of the nutritional properties of cashews after processing. For cashew butter raw cashew kernels are roasted with vegetable oil at 140 C for 3- 4 minutes. Lima et al. (2012) in their study on the standardization of cashew butter used cashew kernels (89.9%), refined cane sugar (8.0%), soybean lecithin (2.0%), and table salt (0.1%). The roasted kernels are then ground with other ingredients for 5 minutes in a food processor with the use of a stainless-steel cutter. The butter is then collected, packed and stored under cool conditions.



Kajukatli

Brahmbhatt et al. (2017) have standardized the process of kajukatli. The optimized methodology is: soaked cashew nut splits 250 g was ground for 1 min using a laboratory mixture grinder, then water was added at 28% of weight of soaked cashew splits. The sample was then further ground for a total desired grinding period of 12 min.

After that the cashew nut paste was transferred into the thick bottom stainless steel (SS) top and sugar was added and mixed manually with the help of a hand scraper. The S.S. top was then placed in a hot water bath for a desired temperature of 100°C. The mixture was stirred manually with the help of a scraper until it started leaving the surface of the vessel. The cooked mixture was then cooled in another vessel up to 45°C with continuous stirring for about 7-8 min. The cooked and tempered mass was then rolled using a hand roller to the thickness of 5 mm and cut by knife in a diamond shape with having size of 3×3 cm .

Cashew Sprout – A mineral-rich diet

Cashew nuts are consumed either in uncooked or cooked form and have conquered a solid position in everyone's diet due to its high nutritional quality. Cashew being rich in monosaturated fatty acids (38-47%) and protein (21-28%) supports the tissue build-up and strengthens the immune system. Apart from nutritional value, cashew nuts also contain an anti-nutritional factor called phytic acid, which is a natural anti-nutritional substance will block from absorbing many of the nuts minerals and possibly causes digestive issues. Cashew contains a considerable amount of phytic acid (190 - 4980 mg/100 g DW). In general, germination, soaking in water, steaming, frying, and fermentation are the common methods followed in many leguminous and cereals for the reduction of phytic acid. Among those, germination is the most effective method and is reported to reduce the phytic acid even upto 80% and consequently increase the bioavailability of minerals and other nutrients.

During cashew kernel processing, raw cashew nuts (RCN) undergo various steps, i.e., steaming, drying, and roasting in which the phytic acid is not found to be effectively reduced. Hence, to reduce the phytic acid to the maximum, RCN were raised in sterilised sand/coir beds under etiolated conditions for sprouting at ICAR-DCR, Puttur (Fig 1). Germination exerts a significant reduction in fat, calorific and protein content, an increase in amino acids, phenols, flavonoids, total antioxidants, minerals such as calcium, iron, manganese, zinc, and copper. In addition to the health benefits, the processing steps can be skipped, which is an added advantage of cashew sprouts (Preethi *et al.*, 2019).



Fig 1. Raising of cashew sprouts in sterile sand bed and coir



Fig 2. Cashew sprouts

Potential Cashew Sprout Products

Cashew Sprout Extrudates

Corn flour and rice flour are the major ingredients in extruded product preparation, which are poor in minerals, proteins, and fibre. Hence, to enrich the product with bio minerals, protein and fibre, the mineral-rich cashew sprout powder (CSP) was added as one of the ingredients along with commercially available corn flour and rice flour. Significant raise in nutritional and mineral content was observed with the increasing proportion of CSP (Preethi et al., 2019).



Fig 3. CSP extrudates prepared using different proportions of cashew sprout powder (CSP), rice flour (RF) and corn flour (CF)



Fig.4. Cashew Sprout-Based Energy Drink

Cashew Sprout-Based Energy Drink

The mineral-rich cashew sprout energy drink is prepared from fresh cashew sprouts. The fresh cashew sprouts are ground to fine paste by adding water at a ratio of 1:3. The liquid phase was separated. Sugar and cardamom powder were added for taste and flavour. The milk was pasteurised.

Cashew Sprouts Cookies:

Cashew sprout cookies are unique cookies, based on traditional knowledge; the formulation has been standardized. It is a blend of four different sprouts, which are highly nutritious and beneficial to health. Cashew sprouts cookies stand out with respect to their bioavailability of nutrients such as protein (12.10%), fibre (4.35 %), Carbohydrate (55.85%) and are embedded with a good amount of total flavonoids, phenols, and antioxidant activity. The bioavailability of minerals such as potassium (0.48%), phosphorus (0.19%), Calcium (2.87%), and Magnesium (0.98%) is comparatively higher compared to the other traditional cookies available in the market.





Nethra-Cashew Sprouts nutri-bar (Nethra-CSNB)

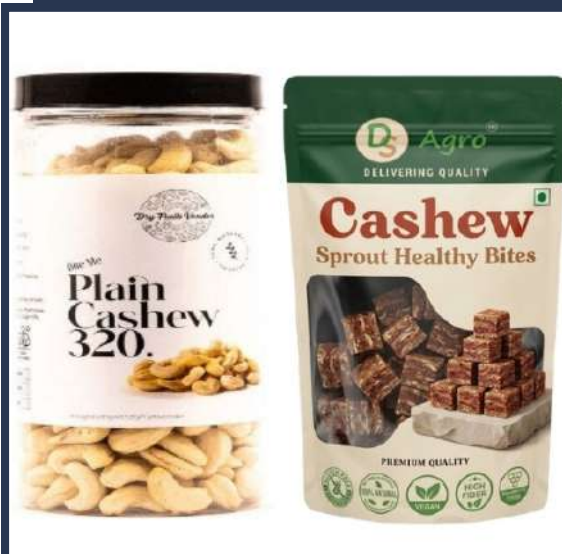
Cashew Sprouts Nutri bars are a healthy snack developed by fortifying cashew sprouts with nutrient dense blend of cereals and grains. This formulation is rich in high-quality plant-based protein and essential minerals with a very low concentration of phytic acid achieved through the sprouting process. Unlike traditional snack bars, CNSB offers a ready-to-eat nutritional supplement suitable for health-conscious consumers of all ages which is free from any of the preservatives and any added flavours.

Cashew Sprout Healthy Bites

Cashew nuts contain antinutritional factors such as phytic acid, which reduce mineral bioavailability and may cause gastrointestinal discomfort; however, sprouting enzymatically degrades these compounds and enhances nutrient availability. In parallel with growing demand for nutrient-dense, functional, and convenient foods, sprouted cashews present potential for incorporation into compact nutrition formats such as energy or health bars, which provide concentrated sources of energy, protein, fiber, and bioactive compounds across age groups. Cashew sprout healthy bites are rich source of protein (9.7%- 16% RDA), iron (8.6 mg- 41% RDA), calcium (85.88 mg-14% RDA) and fibre (7.93%- 26% RDA), it has no added sugar, and is completely vegan. It has goodness of cashew sprout and cashew nut butter and 14.22% moisture, 2.13% ash, 224.74 mg/100g total phenols and 14.55 $\mu\text{mol/g}$ antioxidant activity.



Packaging and Labelling of Cashew Kernels



Cashew kernels are packed in rigid materials like tin containers or flexible pouches. As the fat content is high in cashew kernels, modified gas packaging or inert gas packaging or vacuum packaging are the recommended methods. Earlier Vita packaging for cashews was most popular, where tin containers were vacuumized and injected with inert gases (nitrogen or carbon dioxide). This is very important in the case of cashew kernels due to high fat content. The presence of oxygen in the container may lead to rancidity of the product. Later, due to the bulkiness and high cost of tin containers, flexible materials were used for the packaging of cashew. The FSSAI specifications for cashew kernels are given in Table 3.

Table 3: FSSAI specifications for cashew kernels

Sl. No.	Parameter	Limit
1.	Moisture content, percent by mass (maximum)	5.0
2.	Acid-insoluble ash, percent by mass, on dry basis (Maximum)	0.1
3.	Total tolerances percent by mass (maximum)	5
	a. Superficial damage (Maximum)	2.0
	b. Immature or shrivelled (deformed) (Maximum)	2.0
	c. Speckled or spotted (black or brown) (Maximum)	0.5
	d. Presence of testa (Maximum)	2.0
	e. Insect damage (Maximum)	0.5
	g. Foreign matter (Maximum)	0.05
	f. Extraneous vegetable matter (Maximum)	1.0
4.	Free fatty acid (expressed as oleic acid percent (Maximum)	1.25 (for whole kernels) 2.0 (for cut/pieces)
5.	Peroxide value meq/kg ((Maximum)	10.0

For bulk packaging Agricultural Marketing Adviser has given following guidelines:

Method of Marking

- The grade designation mark shall be securely affixed to each container in a manner approved by the Agricultural Marketing Adviser and shall clearly show the serial number of the lot, date of packing; net weight, name of the packer, place of packing, any other particulars as may be specified by the agricultural marketing adviser.
- An authorized packer may after obtaining the prior approval of the agricultural marketing adviser, mark his private trademark on a container in a manner approved by the said officer; provided that, the private trademark does not represent quality or grade of Raw Cashewnut different from that indicated by the grade designation mark affixed to the container by these rules.

Method of Packing

- Raw Cashew nuts shall be packed in sound, clean and dry containers made of jute or any other material as may be approved by the Agricultural Marketing Adviser. They shall be free from any insect infestation of fungus contamination and also free from any undesirable smell.
- The containers shall be securely closed and sealed in a manner approved by the Agricultural Marketing Adviser.
- Each package shall contain Raw Cashew nuts of one grade designation only.

The following aspects are essential to effective cashew packing

- **Packaging Materials**

Cashews are typically packaged in materials that shield them from moisture, light, and physical damage. Common options include vacuum-sealed bags, which maintain freshness, polyethylene (PE) bags for cost-effectiveness and moisture resistance, and tin or metal containers for durability, particularly in premium or gift packaging.

- **Quality Control**

Before packing, cashews undergo thorough quality control, involving the removal of damaged or defective nuts, sorting based on size and color, and elimination of foreign objects or impurities.

- **Weighing and Labelling**

Cashew packs are labelled with key information such as weight, origin, production date, and nutritional content to assist consumers and comply with labelling regulations.

- **Sealing**

Different sealing methods, such as heat sealing, adhesive sealing, or zipper closures, are employed based on the packaging material to maintain cashew integrity and freshness.

- **Storage Conditions**

Proper storage conditions are crucial to maintaining packed cashew quality. Storage in a cool, dry place away from direct sunlight, moisture, and strong odors is recommended to prevent condensation within the packaging.

- **Packaging Design**

Cashew packaging often incorporates attractive designs, branding, and labeling to enhance product appeal and visibility on store shelves.

- **Moisture Control**

To prevent moisture absorption, packaging materials with moisture barriers or moisture-absorbing packets may be used, given the cashews' susceptibility to rancidity due to their high oil content.

- **Environmental Considerations**

Sustainable packaging options, such as biodegradable or compostable films, are gaining traction to reduce environmental impact.

- **Transportation and Shipping**

Cashew packs are designed to withstand transportation rigors, providing adequate protection against physical damage, crushing, and exposure to moisture or extreme temperatures.

- **Traceability and Batch Information**

Some cashew packaging may include batch numbers or QR codes for traceability back to the production batch, aiding quality control, recalls, or customer inquiries.

- **Regulatory Compliance**

Cashew packing must adhere to local and international regulations, including food safety, labelling requirements, and packaging material restrictions, to ensure consumer safety and build trust.

- **Shelf life and Expiry date**

Cashew packaging should indicate the product's shelf life or expiry date, aiding consumers in assessing freshness and retailers in managing stock rotation.

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Value Addition of Cashew Apple

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Cashew apple, the pseudo-fruit of *Anacardium occidentale* L., is an underutilized agricultural by-product generated during cashew nut processing. While cashew nuts hold substantial commercial importance globally, the cashew apple is largely discarded due to its high perishability, astringent nature, and limited post-harvest handling and processing facilities. This underutilization results in considerable post-harvest losses in major cashew-producing countries such as India, Brazil, and several African nations (FAO, 2019).

Nutritionally, cashew apple is a rich source of carbohydrates, dietary fiber, vitamins, minerals, organic acids, and bioactive compounds. It is particularly notable for its exceptionally high vitamin C content, which surpasses that of many commonly consumed fruits, including citrus. The fruit also contains significant amounts of phenolic compounds, flavonoids, and tannins, which contribute to its antioxidant potential and associated health benefits, such as protection against oxidative stress and inflammation.

Value addition of cashew apple through processing offers an effective strategy to reduce wastage and enhance economic returns for farmers and processors.

The fruit can be processed into a variety of products including juices, syrups, jams, candies, fermented beverages, vinegar, and dried products. Fermentation and fortification of cashew apple juice have also been shown to improve its nutritional quality and consumer acceptability. In addition to food applications, cashew apple has emerging potential in nutraceuticals, cosmetics, animal feed, and bioenergy production, such as bioethanol and biogas, supporting sustainable and circular bioeconomy approaches (Ribeiro et al., 2016).

Despite its significant nutritional and industrial potential, the commercial utilization of cashew apple remains limited due to technological constraints, short shelf life, and inadequate market awareness. Addressing these challenges through improved processing technologies, product diversification, and scientific validation of health benefits can significantly enhance the value addition and commercialization of cashew apple, thereby contributing to sustainable agricultural development and nutritional security (FAO, 2019).

Nutritional Value and Health Benefits of Cashew Apples :

Cashew apples, the fleshy pseudofruit of the cashew tree, are a rich source of nutrients and bioactive compounds. Though often overshadowed by the cashew nut, the cashew apple is gaining recognition for its significant health-promoting properties. Among its key nutritional strengths are its abundance of vitamins, minerals, phenolic compounds, and antioxidant activity (Ribeiro et al., 2016). It is a valuable source of vitamin C, sugars (primarily fructose and sucrose), dietary fiber, amino acids, polyphenols, flavonoids, carotenoids, volatile compounds, and essential minerals, particularly potassium (Assunção & Mercadante, 2003; Chandrasekara & Shahidi, 2011). The fruit is highly acidic (pH 3.5–4.8) and contains approximately 85% moisture, contributing to its rapid post-harvest deterioration.

Carbohydrates represent the major macronutrient fraction of cashew apple, mainly as glucose, fructose, and sucrose, supporting its suitability for energy-enhancing and functional beverages (Akinwale, 2000). Protein content ranges from 0.5 to 1.09% and includes amino acids such as alanine, glutamic acid, leucine, tyrosine, proline, and γ -aminobutyric acid (Ribeiro et al., 2016). Dietary fiber constitutes about 61.21% of the dry matter, comprising soluble (13.25%) and insoluble (47.96%) fractions, and has been effectively utilized as a functional ingredient and fat replacer in baked products, cereal extrudates, and meat analogues. In vitro digestion studies indicate higher nutrient bioaccessibility in cashew apple juice than in pulp, largely due to the presence of phytic acid in the fiber fraction, which may limit mineral absorption (Ribeiro et al., 2016). The ash content (1–1.5%) reflects its substantial mineral composition (Assunção & Mercadante, 2003).

Cashew apple is an exceptionally rich source of vitamin C (200–300 mg/100 g), exceeding that of most tropical fruits, including citrus and pineapple. The fruit also provides B-complex vitamins, including thiamine, riboflavin, niacin, pantothenic acid, pyridoxine, and folate. Its mineral profile is dominated by potassium, magnesium, and phosphorus, with lower levels of sodium, calcium, iron, copper, and zinc (Assunção & Mercadante, 2003). Cashew apple is rich in phytochemicals such as flavonoids, phenolic acids, tannins, carotenoids, and anacardic acids, which contribute to its antioxidant and functional properties (Chandrasekara & Shahidi, 2011; Ribeiro et al., 2016). Total carotenoid content ranges from 2.9 to 136 mg/100 g, with β -carotene, lutein, zeaxanthin, and cryptoxanthin as major components. Organic acids such as citric, malic, and acetic acids further influence metabolic and physiological functions (Talasila & Vechalapu, 2015). The nutritional and phytochemical composition varies with cultivar, soil, climate, maturity, agronomic practices, and processing conditions (FAO, 2019).

The aroma profile of cashew apple varies during ripening and spoilage. Freshly ripened fruit exhibits pleasant fruity notes primarily due to esters such as methyl and ethyl 3-methylbutanoate and methyl and ethyl butanoate (Ribeiro et al., 2016). Green or grassy notes arise from C5 and C6 aldehydes and alcohols, including cis-3-hexenol and hexanal. During spoilage, accumulation of short-chain fatty acids, particularly 2-methylbutanoic acid, leads to strong off-odors and reduced sensory acceptability.

The diverse nutrient and phytochemical profile of cashew apple supports its role in health promotion and disease prevention. Essential minerals contribute to immune function, electrolyte balance, neuromuscular activity, bone health, cardiovascular function, and metabolic regulation (FAO, 2019). Fructose aids glycemic regulation, while glucose provides rapid metabolic energy (Akinwale, 2000). Copper supports vascular elasticity and oxygen transport. According to the Indian Council of Medical Research, consumption of approximately 100 mL of cashew apple juice can meet the recommended daily intake of vitamin C (40–80 mg/day) for Indians.

Cashew apple has a long history of use in traditional medicine and demonstrates strong potential as a nutraceutical and pharmaceutical ingredient. Traditionally, its juice has been used to manage respiratory and gastrointestinal disorders (Talasila & Vechalapu, 2015). Both fresh and fermented beverages have been associated with the prevention of muscle cramps, macular degeneration, and age-related insomnia (Ribeiro et al., 2016). Anacardic acids present in cashew apple exhibit gastroprotective effects by inhibiting *Helicobacter pylori* (Chandrasekara & Shahidi, 2011). Additionally, antioxidant, anti-inflammatory, antimicrobial, and wound-healing properties have been reported, with experimental studies suggesting potential benefits in the management of obesity and diabetes. Overall, cashew apple represents a nutritionally rich and functionally valuable food with significant health-promoting potential.

Processing and Value Addition

Cashew apple is one of the emerging sources of nutraceuticals with limited availability in market due to short post-harvest shelf life. Limited research has been conducted on preservation of cashew apples during storage and transportation.

In light of previous reports, various preservation approaches viz. cold storage, modified atmosphere packaging, chemical preservatives, irradiation technique, oil coating etc. have been used for extending shelf life of cashew apples (Das & Arora, 2017; Kannan, 2002; Queiroz et al., 2011; Souza et al., 2009).

De-tannification of the juice is very imperative before the product preparation. Many strategies such as use of polyvinyl pyrrolidone (PVP), gelatin, rice gruel, sago, microfiltration, blanching, and enzyme like tannase are used for removal of tannins from the juice. Numerous processed products of cashew apples have been developed viz. non-alcoholic beverages and products, including cashew apple juice, squash, syrup, ready-to-serve beverages, and pickles. Additionally, alcoholic beverages like feni, wine, and vinegar have been produced using cashew apples (Deepak, 2022; Preethi et al., 2019; SR et al., 2024; Vermani et al., 2023). Confectionery products, such as nectar, syrup, jam, and candy, incorporating cashew apple pulp and juice, have demonstrated favorable sensory qualities and consumer acceptability.

The ICAR-Directorate of Cashew Research has developed various value added products viz. cashew apple liquid sweetener, cashew apple milk delight, cashew herbal tea, CashewPrash, cashew apple muffin, cashew apple RTS fortified with lemon juice, cashew apple cider, cashew apple jam, jelly, cashew apple squash, cashew apple chew, extrudates, cashew apple fig, cashew apple pomace powder cookies and cashew apple based fruit bar.

i. Cashew Apple Jaggery :

Cashew apple jaggery is a liquid sweetener from cashew apple developed with the aim of increasing the utilization of cashew apples with minimum inputs for production. It does not only imparts sweetness but also contains minerals and various polyphenols.

It has a glycemic index of 58.30 which comes under the moderate category, it is rich in nutrients such as potassium, magnesium, calcium, iron, phosphorus, and sodium, soluble fibre, phenols and anti-oxidant activity. It has high level of reducing sugars especially fructose and glucose, making it a good alternative to high fructose corn syrup and liquid glucose. It is a natural source of energy with no added preservatives and color and a shelf life of more than 1 year at room temperature.





ii. Cashew Apple Milk Delight :

Cashew apple milk delight is fruity and sweet confectionary product with creamy texture. It has a moisture content of 15.08%, ash content of 2.61%, 117.47 mg/100g vitamin C, 7.764 $\mu\text{mol/g}$ antioxidant and total phenolic content of 142.5 mg/100g. The sugar content of this delight is less than the market available confectionary products.

iii. Cashew Herbal Tea :

Cashew apples and leaves are a rich source of bioactive compounds such as polyphenols, vitamins, and antioxidants, making them ideal components for herbal tea. Cashew apples are rich in vitamin C and polyphenols, which help protect the body from oxidative stress caused by free radicals. .

Cashew leaves contain flavonoids and phenolic compounds that may help fight infections and reduce inflammation in the body. Therefore, a herbal tea from cashew apple and leaf would help to manage sore throats, minor wounds, and digestive discomfort.

Cashew herbal tea has good quantity of polyphenols (551.52-620.23 mgGAE/100g), ascorbic acid (0.3-0.75 mg/100g), flavonoid content (118.82- 125.83 mg/100g) and antioxidant activity of 28.20-32.16 ($\mu\text{mol trolox/g}$). This product not only addresses modern consumer demand for plant-based health solutions but also positions cashew as a powerhouse in promoting holistic well-being.\



iv. Diet Cashew Apple Muffin :

This product has no refined flour, no refined sugar and no eggs. It has low fat with polyphenolic content of 201 mg GAE/100g and antioxidant activity of 5.44 $\mu\text{mol trolox/g}$. This muffin has 6% to 67% less fat than the market samples. Total dietary fiber and ascorbic acid content of muffin is 1.33% and 99.6 mg/100g, respectively.

v. Cashew Prash :

CashewPrash is a cashew apple-based herbal supplement that supports immunity and vitality. It is rich in nutrients: energy (1% RDA), polyphenols (620.23 mg/100g), antioxidants (1236.43 μ mol trolox/g), dietary fibre (1.48%), and essential minerals (potassium, phosphorus, magnesium, iron (9% RDA), manganese, zinc) that support immune health. It has no added preservatives, flavors and colors with a shelf life of 6 months at room temperature.



vi. Cashew Apple Fruit Bar :

The cashew apple fruit bars are rich in total phenols (241 mg GAE/100g), total antioxidant activity (93.29 mg/100g), and other minerals like K, P, Ca, Na and Fe. It is chewy and flavorful, and naturally low in fat and high in fibre and carbohydrates. It is also lightweight and can be easily stored and packed. It has no added preservatives and colors.

vii. Cashew Apple Pomace Powder Cookies :

These cookies had a good amount of crude protein (6.84%), crude fat (13.3%), ash (92.30%) and higher fibre content. The cookies can further be fortified by incorporating 4 types of millets such as ragi, proso, little millet and jowar millet.

The protein content was high in ragi mixed cookies compared to other millets. The fat content was found to be high in prosomillet-based cookies. The ash content was highest in cashew apple pomace powder cookies compared to other combinations. It has no refined flour, sugar, preservatives and colors.



viii. Cash Lime :

Cash lime is a cashew apple and lemon juice blend RTS/Nectar prepared using cashew apple juice. The nutrient rich drink can be stored under refrigerated conditions for maximum of five months with maximum retention of nutrients and biochemical quality parameters compared to fresh one whereas the samples stored at room temperature began to lose its quality after two months of storage.

Lime possess bland taste and cashew apple can serve as the best functional food by blending with lemon as taste improver.

Cashlime has a TSS of 12° Brix, vitamin C of 86 mg/100 mL, total phenol of 72 mg/100 mL, antioxidant activity of 242 mg/100 mL. The product can be stored at room temperature for three months and for six months at refrigeration temperature with 70 ppm KMS. Presence of sufficient amount of ascorbic acid, and phenolics made the product more functional than the traditional one.



ix. Cashew Apple Cider :

Cashew apple cider is prepared from cashew apple juice through anaerobic fermentation at room temperature by yeast *Saccharomyces cerevisiae*. The alcohol content of the product is in the range of 3.5-6.0 % v/v. The product has antioxidant activity of 85-100 mg/100 mL trolox equivalent and vitamin C (150-200mg/100ml) and phenolic content (150-180mg/100ml). The cider is highly stable even at room temperature (>6 months), whereas at refrigeration temperature the product was found stable even for more than twelve months.

x. Cashew Apple Jam :

Cashew apple jam prepared with partial replacement of commercial pectin with natural pectin (dried orange peel powder). The product is made acceptable and rich in bioactives with no chemical additives. Cashew apple jam consists of functional nutrients and found rich in vitamin C (120mg/100g), total phenolics (134mg/100g), antioxidants (403mg/100g). It has a shelf life of 6 months at room temperature.





xi. Cashew Apple Jelly (65° Bx) :

Cashew apple jelly (65° Bx) is a value-added product, where the use of commercial pectin is reduced by using a natural source of pectin. The cooked guava (unripe/firm) pulp extract was used as natural pectin. It is rich in vitamin C (142 mg/100g), total phenolics (117 mg/100g), and antioxidants (316 mg/100g). It has a shelf life of 6 months at room temperature.

xii. Cashew Apple Crisp :

Cashew apple Crisp is an extruded product prepared out of cashew apple pomace powder. This is similar to crispy snacks available in the market but enriched with natural fibers, proteins, minerals and bioactive components which are beneficial to the human health. The methodology for preparation of cashew apple pomace powder extrudate with suitable puffiness and taste had been standardized. Moreover, converting the perishable cashew apple pomace to powder form helps in storing the raw material for diversified uses during off season.



xiii. Cashew Apple Fig :

Cashew apple fig is a whole apple osmo-dehydrated product (sugar based) rich in fiber, minerals, and bioactive compounds. The product retains maximum minerals and nutrients since this is whole apple product. This mimics the taste of dates and fig and thus can be consumed as a regular snack.

xiv. Cashew Apple Chew

Cashew chew is a spice mixture infused osmo-dehydrated product. It is rich in vitamin C, minerals, anti-oxidants and bioactive compounds. Compared to other cashew apple dehydrated products, chew retains 60% more ascorbic acid. This can be taken as such like a mouth freshener either alone or along with betel leaves.



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IT Initiatives at ICAR- Directorate of Cashew Research, Puttur, for management and dissemination of Cashew Information

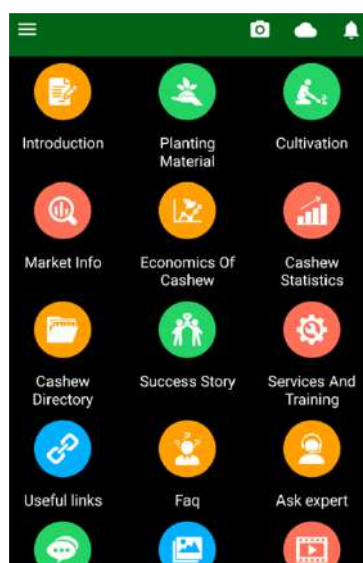
Dr. Mohana G. S. and Dr. Vanitha, K.

Adoption of agricultural/horticultural information heavily depends on its reliability, comprehensiveness and the mode of information exchange. The fruits of research can be realized only when the technologies are adopted by the farmers resulting in rich benefits. For this, dissemination of proper information through appropriate channels is very much necessary. Realising the current needs of information dissemination, ICAR- Directorate of Cashew Research, Puttur has developed the following apps and websites for management and dissemination of cashew information.

1. Cashew India App :

(https://play.google.com/store/apps/details?id=com.cashew.icar&hl=en_IN)

This app is developed with the principles of farmer friendliness, nationwide information, comprehensiveness and ease of use. Many crop based apps were reviewed before developing this unique app and attempts have been made in this app to overcome the deficiencies of existing apps. This app is expected to speed up the process of information exchange among the stakeholders in India leading to increased production and productivity. The app is made available through Google Play Store for public use.



Mode of Development:

The design and technical content of the app is developed by ICAR- DCR, Puttur in collaboration with AICRP-cashew centres spread across the country. The financial support was provided by Mission for Integrated Development of Horticulture, Ministry of Agriculture and Farmers Welfare, New Delhi through Directorate of Cashew and Cocoa Development, Cochin, Kerala.

Unique Features :



- 1.This app gives comprehensive information on cashew nursery, cultivation, plant protection, post harvest processing, market information, e-market, various stakeholders such as farmers, researchers, developmental agencies and processors at one place.
- 2.The app is developed for 10 cashew growing states in India i.e. Gujarat, Maharashtra, Karnataka, Kerala, Tamil Nadu, Andhra Pradesh, Chattisgarh, Orissa, West Bengal and Meghalaya.
- 3.The app is exclusively developed in 11 languages, i.e. Hindi, English, Gujarati, Marathi, Kannada, Malayalam, Tamil, Telugu, Oria, Garo and Bengali
- 4.Farmer/User can upload and store his own cashew images and videos in “My cashew” sub-section of “Cultivation” section. It is also possible to record the expenditure, observations and data of the cashew farm.
- 5.It is possible to order grafts online from the research stations in a particular state in “Planting Material” section
- 6.Farmers can give their buy/sell requirements in “Market info” section
- 7.Farmer/User can contact experts through “Ask Expert” section
- 8.Real time chatting is possible in ‘Chat Room’ with the users who are using app at a given point of time
- 9.E-speak button enables the app to read text for the user in different sections

Impact:

1. Downloaded 8210 times as of 18-05-2026
- 2.The rating of the app in the Google Play Store is 3.87
- 3.As many as 33,796 cashew grafts have booked online by farmers in Karnataka, Tamil Nadu, Andhra Pradesh, Maharashtra and Kerala using the mobile app.

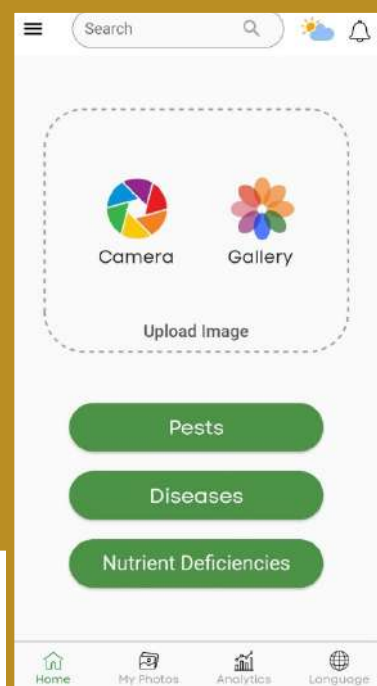
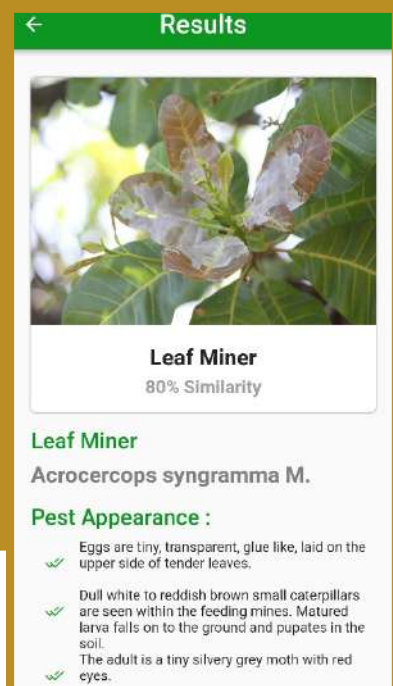
2. Cashew Protect: An artificial intelligence-based app for identification of pests, diseases and nutrient deficiencies

Cashew farmers often need expert advice for proper management of pests and diseases in addition to nutrient deficiencies. However, due to remote nature of villages and farms, advice is not easily available when it is most required. Recent advances in mobile technologies can help to a greater extent in this connection. Apps and websites based on technologies such as artificial intelligence, visual recognition and deep learning are being developed worldwide for identification of plants/animals/insects including pests/diseases/nutrient deficiencies. These tools have been found very useful and are regularly used by farmers in different parts of the world.



ICAR- Directorate of Cashew Research has developed the Cashew Protect website and app for identification of pests and diseases of cashew along with nutrient deficiencies (Website - <https://cashewresearch.in/cashewprotect>). The website/app is targeted to diagnose about 60 cashew pests, 20 diseases and 10 nutrient deficiencies instantly from the uploaded images. However, as of now, in the first phase of the work, it can detect 8 pests and 2 diseases and 1 nutrient deficiency. Artificial Intelligence (AI) and computer vision-based techniques are deployed here. The website/app is constantly being trained with additional data and gets more accurate with time.

In the backend application, PHP Laravel framework, MySQL, Windows OS, Apache/NGINX are deployed. React Native/Flutter is deployed in mobile phone application. The AI machine learning system included Python, Windows OS, Tensor Flow as AI framework and GPU server for training. This website/app is available in 11 languages i.e., English, Hindi, Kannada, Gujarati, Marathi, Malayalam, Tamil, Telugu, Bengali, Odia and Garo to cater to the needs of farmers in the local language. Options for contacting experts and sharing photos in social media have been provided in case of no detection or dissatisfactory results.



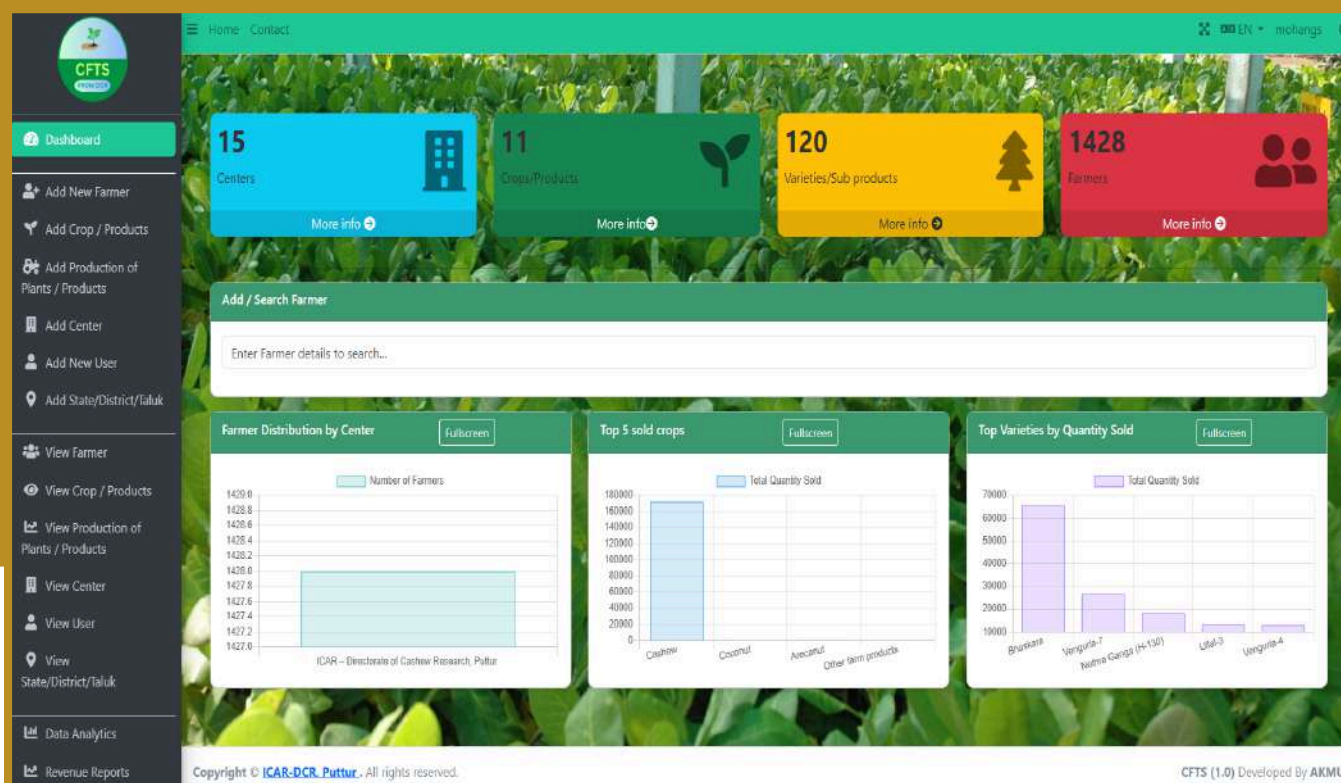
Most interestingly, it is possible to capture data via users on the number and type of pests, diseases and nutrient deficiencies observed in different countries/regions/districts/taluks during different time periods through this website/app. This will eventually help in early forecasting of these problems and alert farmers in time. Further, it also helps to channelize efforts and inputs required for management by the concerned agencies in an area/region of the country.

This is probably the first ever attempt of developing an AI based app/website in the world and in the ICAR system for cashew. The team behind developing this app/website included the scientists of ICAR-Directorate of Cashew Research, Puttur and the scientists of AICRP- Cashew centers spread across the country. This work is funded by the RKVY-RAFTAAR program of Government of Karnataka.

3. Cashew Farmers Tracking System (CFTS)

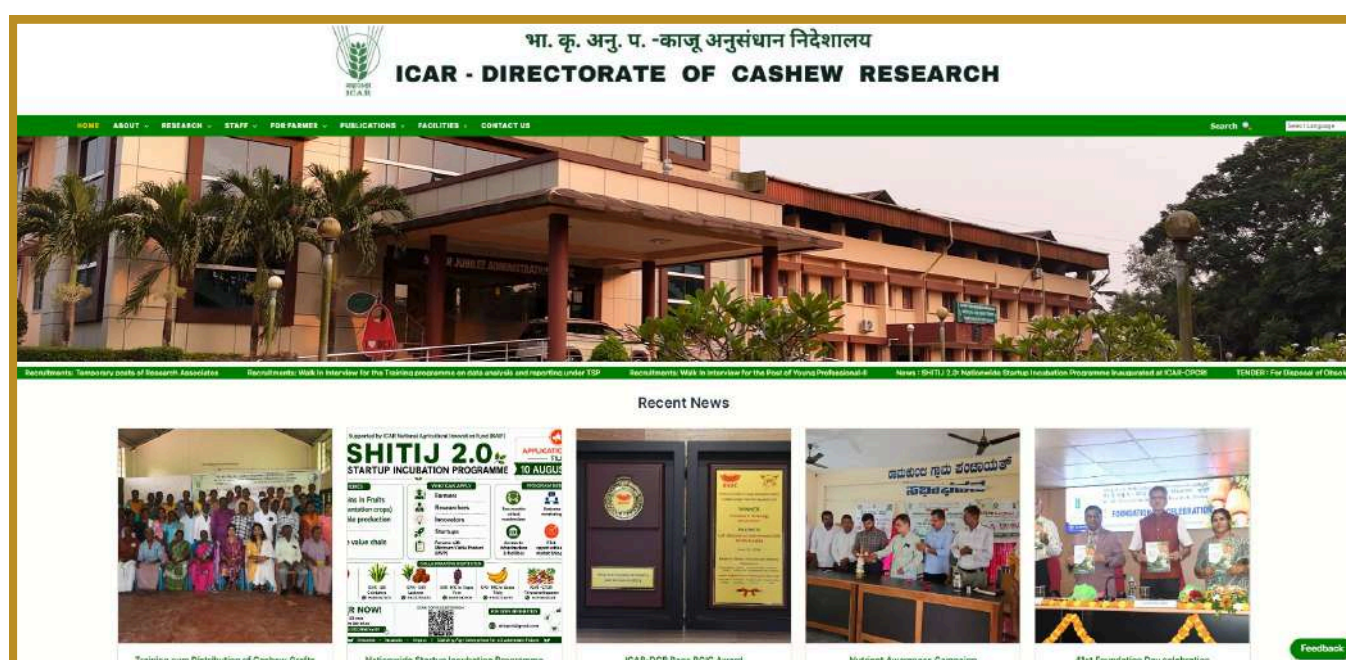
In Indian conditions, two problems encountered while selling indigenous/exotic planting material in any plant nursery are a) Farmers tend to forget the identity of varieties/plants they purchase from a nursery over a period of time and, b) Plant nurseries are not able to track their farmers/plants/varieties for a particular period and hence data is not available to assess their impact. This was also true for cashew plants sold at the cashew nursery of ICAR-Directorate of Cashew Research, Puttur, Karnataka, India.

Hence, a simple software, Cashew Farmers Tracking System (CFTS), was developed at the institute. This has a QR code system for farmers to access information on purchased varieties, and data analytics for tracking the location of planting, farmers, and varieties by the nursery. The data on the sale of cashew grafts for the years 2019 to 2025 was analyzed, and it was evident that more than three lakh plants have reached 9 states and 50 districts of India. Bhaskara, Vengurla-7, and Nethra Ganga are the most preferred cashew varieties by the farmers. A distribution map of farmers taking the Bhaskara variety was also prepared. The implications of QR code, tracking of farmers, and geo-tagged maps are discussed. The Implementation of such software in any government or private plant nursery can proximately offer diverse uses and facilitate policy decisions, and ultimately impact the production and productivity of different crops at the national and international levels.



4. Website of the ICAR- Directorate of Cashew Research, Puttur (<https://cashewresearch.in>)

A very comprehensive and user-friendly website providing all information about the institute, its vision and mission, objectives, facilities available, research programs, staff details, publications and links of many organisations related to cashew and horticulture has been developed, maintained and regularly updated. Most importantly, in the 'For Farmer' section, detailed information on cashew cultivation and related aspects such as cashew farmers, cashew grafts, brochures, cashew statistics, varieties, weather advisory, success stories etc have been given under different sections.

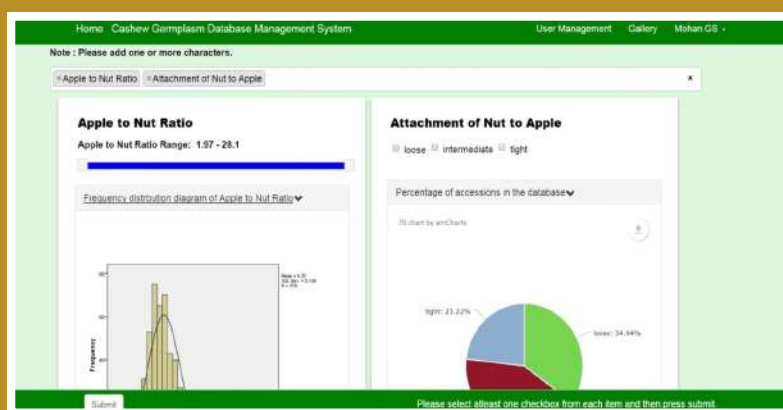


5. Cashew Germplasm Database (<https://cashewresearch.in/dcr>)

ICAR- Directorate of Cashew Research houses the largest germplasm repository consisting of 602 cashew accessions collected from different parts of the world in its National Cashew Field Gene Bank (NCFGB). So far, 5 germplasm catalogues containing evaluation data on 478 accessions for 68 characters following the cashew descriptor (published by Bioversity International, Italy) have been brought out.

To manage and better utilise these germplasm resources, a robust database has been developed. Currently, the database hosts data on 478 accessions with 68 evaluation characters (both vegetative and reproductive) in addition to 10 important fields from passport data. This sort of information is crucial in deciding the novelty/worth of germplasm accessions during survey and collection, and their subsequent inclusion in the gene bank.

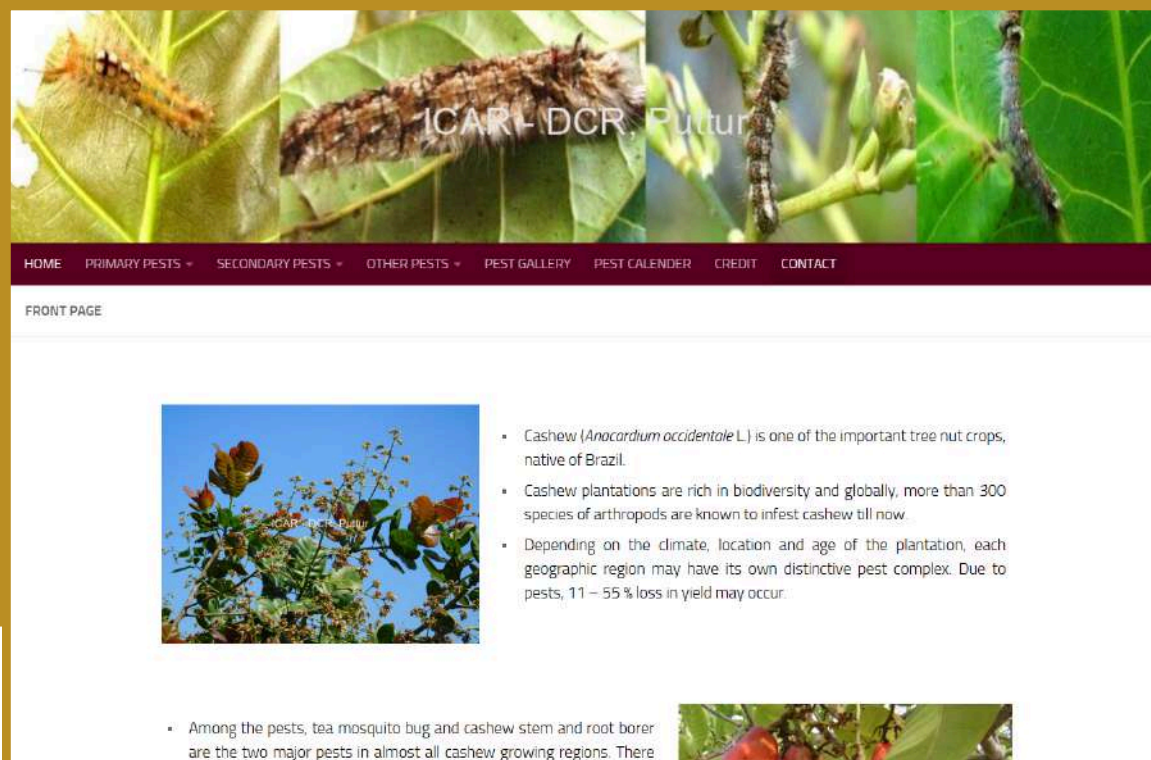
This easy-to-use interface and simple search facility will be immensely useful to researchers, students and other stakeholders. This module can be profitably emulated in other crops as well, where such options are not readily available.



6. Cashew Pest Database (<https://cashewresearch.in/pestsite>)

More than 250 insect species infest cashew worldwide, but not all are causing damage to the crop. Average loss of 10-50 % in yield has been recorded due to pests. Among the pests, tea mosquito bug and cashew stem and root borer are the two primary pests in almost all cashew growing regions. Apart from these, there are plenty of secondary and minor pests feed on cashew sporadically. The knowledge on insect pest species, season of occurrence, symptoms of pest damage helps to plan suitable management measures.

The 'Cashew Pest Database' developed at ICAR-DCR, Puttur provides details on primary, secondary and other minor insect pests of cashew. Symptoms of pest damage, seasonality, biology, alternate hosts and management measures are available in drop down menu for the important cashew pests. Photographs on pests and their symptoms of damage can be useful to farmers and other users to get an idea about the pest. Besides, the field 'Photo gallery' consists several images of pests and their damage with a short description. 'Pest Calendar' field provides pictorial information on period of pest occurrence of important pests. The users can contact scientists for any queries through the link provided in the web page of database.



7. Website on Beneficial Arthropods in Cashew Plantations (<https://cashewresearch.in/benificialinsect>)

In integrated pest management, a system-oriented approach is needed. A clear understanding of not only the target insect pests, but also other beneficial arthropods especially the associated natural enemies and their interaction with the pests is essential in devising an effective pest management module. In cashew plantations, several beneficial arthropods like predators, parasitoids and pollinators are commonly found and abundant. Conservation and utilization of these natural enemies in managing the insect-pests is one important component of an integrated pest management strategy. Apart from predatory insects, a lot of spiders can be seen in the cashew plantations. In general, the predatory arthropods found in the field conditions are generalist in nature and predate on different insect pests. In most circumstances, natural enemies manage the insect pests effectively, particularly the population of several minor pests of cashew is kept under control.

On the other hand, cashew is dependent on pollinators especially the bees for successful pollination and nut set. Honey bees as well as solitary bees are important to realize fruit set in cashew. It is interesting to note that, there are two species of wild silkworms occurring on cashew, which can be exploited for commercial silk production if suitable production strategies are devised. This webpage gives basic information on different beneficial arthropods present in the cashew plantations.



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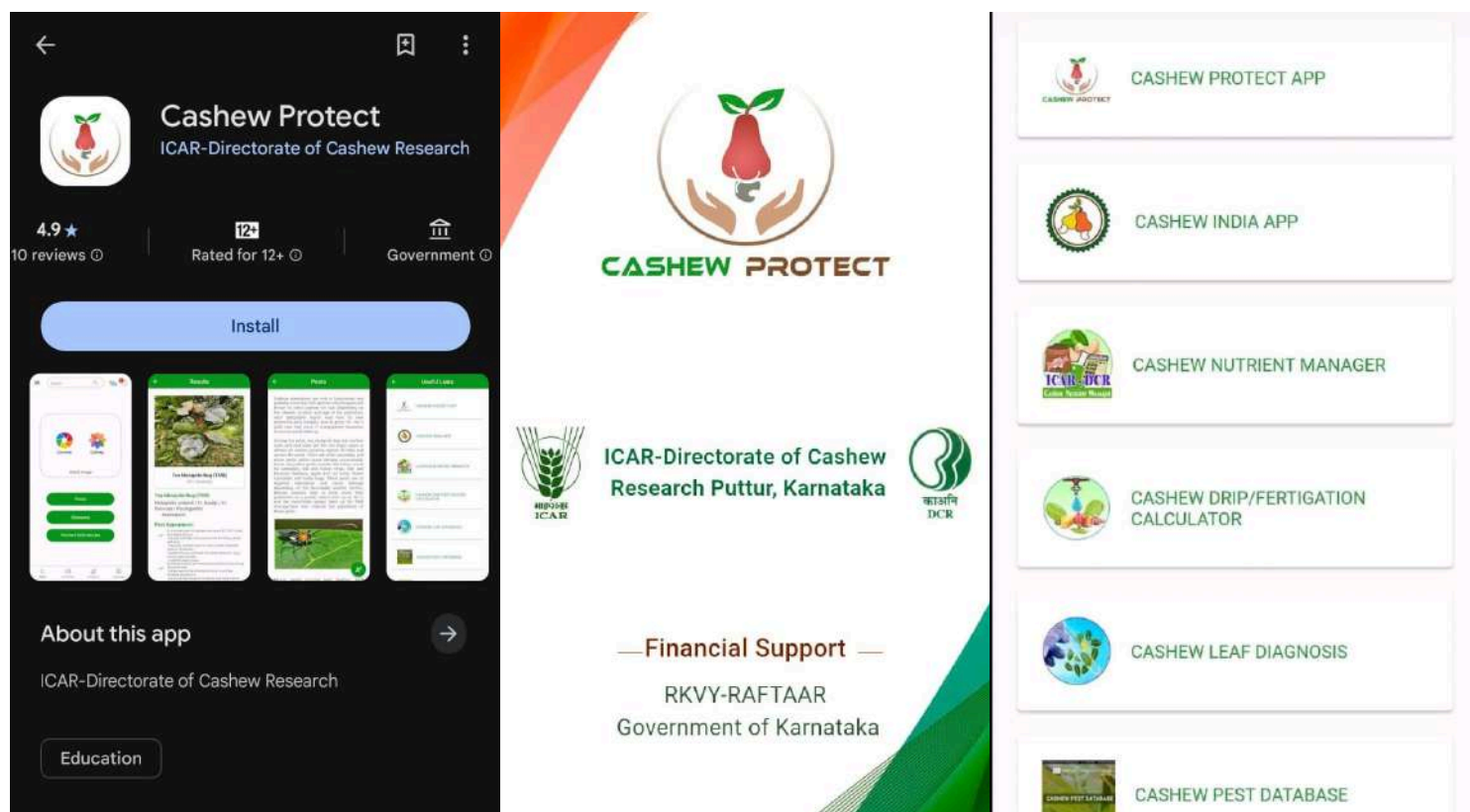
https://play.google.com/store/apps/details?id=com.cashew.icar&hl=en_IN&gl=US

Cashew Protect App :

<https://play.google.com/store/search?q=cashew%20protect&c=apps&hl=en-IN>

Plantix – Your crop doctor: <https://play.google.com/store/search?q=cashew%20protect&c=apps&hl=en-IN>

ICAR- Directorate of Cashew Research: <https://cashewresearch.in>



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Technology Incubation and Commercialisation at ICAR- DCR

Dr. Aswathy Chandrakumar, Dr. Thondaiman V and Dr. Manjunatha K

Introduction

Agricultural research is traditionally evaluated through scientific publications, varieties released, technologies developed and research outputs generated. However, for farmers and other stakeholders, the ultimate value of research is determined by a different question: Can the technology be used, adopted and converted into economic or livelihood benefits?

This distinction is particularly important in perennial horticultural crops such as cashew. Cashew is not simply a plantation crop producing raw nuts. It represents a complex value chain involving planting material, cultivation, harvesting, primary processing, kernel processing, and cashew apple utilization. Consequently, research interventions can create economic value at multiple points along the chain.

ICAR–Directorate of Cashew Research (ICAR-DCR), Puttur, Karnataka, is the national centre for cashew research in India. Its research portfolio covers crop improvement, crop management, crop protection, post-harvest technology, and technology transfer. The Directorate also houses an Institute Technology Management Unit (ITMU) and Agri-Business Incubation Centre (ABIC) to facilitate entrepreneurship development.

The evolution of ICAR-DCR demonstrates an important shift in the role of an agricultural research institution from being primarily a generator of technologies to becoming an innovation and enterprise ecosystem. Improved varieties can become nursery businesses; processing machinery can become manufacturing enterprises; cashew nut and cashew apple processing can become micro- and small-scale enterprises.

From an agricultural extension perspective, therefore, technology commercialisation should not be viewed as an activity that occurs after research is completed. It should be understood as a continuum connecting research, technology validation, intellectual property management, entrepreneurship, capacity building, market linkage and adoption.

1. Agri Business Opportunities Emerging from ICAR-DCR Technologies

Production of Quality Planting Material Through Nursery Establishment

One of the most direct commercial opportunities associated with cashew research is the production and marketing of quality planting material.

ICAR-DCR has standardised softwood grafting and nursery management techniques for commercial multiplication of cashew. The Directorate has also developed and released improved varieties, including NRCC Selection-2, Bhaskara, Nethra Ganga, Nethra Vaman, Nethra Jumbo-1, Nethra Jumbo-2, Nethra Ubhaya and Nethra Samrudhhi. From an agribusiness perspective, the availability of improved varieties creates opportunities for establishment of accredited nurseries, varietal demonstrations and supply of region specific planting material.

Mechanisation

Cashew processing is labour intensive and involves several operations in which mechanisation can improve efficiency, reduce drudgery and improve processing consistency.

ICAR-DCR has developed several machineries such as the radial arm type cashew kernel extracting machine, dual-mode dryer, rotating drum roasting machine, concentric drum rotary sieve grader, hydraulic cashew apple juice extractor, updraft gasifier for cashew shell cake, fully automatic 3-in-1 cashew apple and nut separator, portable semi-automatic cashew apple and nut separator and pedal operated cashew apple and nut separator. These technologies are available for licensing to manufacturers.

Cashew Apple Based Value Added Products

Historically, the cashew value chain has been heavily focused on the nut, while the cashew apple has often remained underutilised. From a circular bioeconomy perspective, this represents a significant opportunity loss. ICAR-DCR has developed technologies for converting cashew apple into a range of value-added products. The products available for commercialization include- Cashew Apple RTS (Cashlime), Cashew Apple Cider, Cashew Apple Jam, Jelly, Fruit Bar, Cashew Apple Pomace Powder Cookies, Cashew Sprout Cookies, Diet Cashew Apple Muffin, Cashew Prash, Cashew Apple Jaggery, Cashew Herbal tea, Cashew Sprout Healthy Bites, Cashew Apple Pomace Powder-based Rusk, Zingy Cashlime.

The commercial opportunity is particularly attractive because cashew apple processing can be undertaken at different scales.

Potential enterprise models

Enterprise Scale	Possible activities
Household	Fresh juice, syrup, preserves, dehydrated products
Self Help Groups (SHGs)	RTS beverages, sweetener, fruit products, bakery products
FPO/cooperative	Collection, primary processing and bulk product preparation
Micro-enterprise	Juice, beverages, concentrates and functional foods
SME	Standardised processing, packaging and branded products
Industry	Large-scale extraction, ingredient production and by-product utilisation

2. Technology Commercialisation at ICAR-DCR

The Institute Technology Management Unit (ITMU) is involved in technology commercialization. The ITMU manages institutional intellectual property portfolios, including patents, copyrights, trademarks and varietal registration, and facilitates technology licensing, public-private partnerships, industry-institute meetings and capacity-building programmes.

The commercialisation process at ICAR-DCR follows a defined pathway.

Step 1: Identification of Potentially Commercialisable Technologies

Technologies generated through research projects are presented before appropriate institutional research mechanisms. Technologies having commercial potential are identified.

Step 2: Technology Disclosure

The inventor submits a Technology Disclosure Form containing information such as description about the technology, protocol, cost, potential applications, Intellectual Property considerations, and the business potential.

Step 3: Assessment and Recognition

The ITMU undertakes prior-art assessment and evaluates potential duplication and market potential. The technology is then considered by the Institute Technology Management Committee (ITMC).

Step 4: Identification of Licensees

Potential entrepreneurs or companies are identified and invited to understand the technology. Demonstrations and technical interactions may be organised.

Step 5: Licensing

Once commercial terms are agreed, an agreement is executed and technical details are transferred to the licensee.

The current ICAR-DCR framework identifies both exclusive and non-exclusive licensing, with non-exclusive licensing being preferred within ICAR technology commercialisation. Depending on the technology, licensing may involve supplying planting material, providing food-processing protocols or transferring engineering drawings for machinery.

This structured process is important because it protects both the inventor and the institution while providing entrepreneurs with a formal mechanism to access publicly developed technologies.



3. Agri-Business Incubation Centre: From Technology to Entrepreneur

Technology licensing alone is insufficient when the prospective technology user is an inexperienced entrepreneur. This is where the Agri-Business Incubation Centre (ABIC) assumes importance. ICAR-DCR's ABIC is designed as a technology-led and knowledge-driven enterprise platform supporting start-ups, young entrepreneurs and individuals with innovative ideas in the cashew sector. Its activities include mentorship, technical and scientific guidance, technology awareness, entrepreneurship development programmes, business meetings, exhibitions and access to processing facilities.

The incubation approach can be understood through the following pathway:

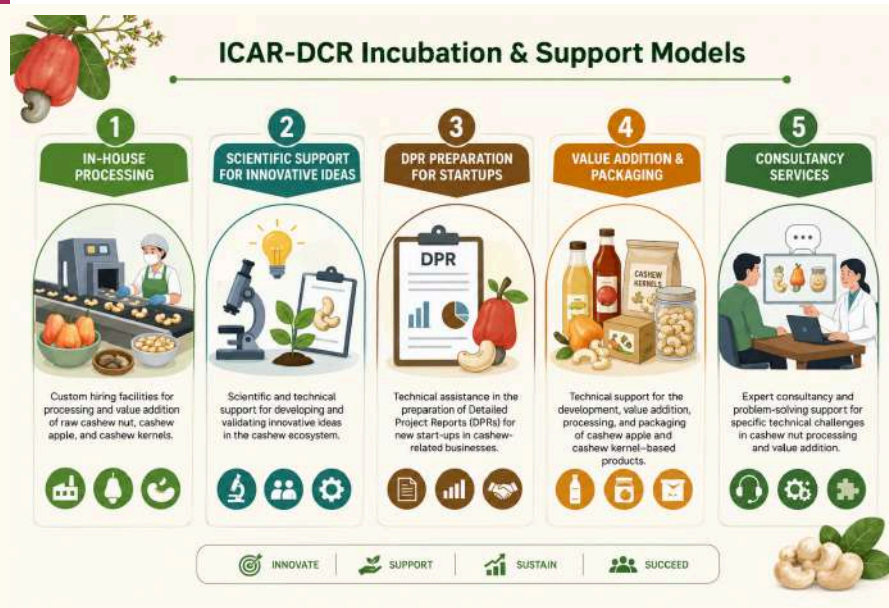
This model is particularly relevant for rural youth, women entrepreneurs, Self-Help Groups (SHGs), FPOs, Start-ups, existing food processing enterprises, cashew processors and nursery entrepreneurs. The Agri Business incubation centre is also involved in the following activities

- Creating technology awareness through business meetings and exhibitions.
- Facilitating skill development through training programs and Entrepreneurship Development Programs (EDP).
- Providing ABI workshop facilities for raw cashew nut, cashew apple, cashew kernels processing and Profiling of bioactive components for Incubatees.

The different incubation models available include

1. In-house processing – Custom hiring facilities for processing and value addition of raw cashew nut, cashew apple, and cashew kernels.
2. Scientific support for innovative ideas in the cashew ecosystem.
3. Preparation of Detailed Project Report (DPR) for new startup in cashew-related business.
4. Value addition and packaging of cashew apple and kernels.
5. Consultancy for specific problem in cashew nut processing and value addition.

Fig. 1: Different Incubation Models at ICAR-DCR, Puttur, Karnataka



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Schemes of DCCD for promotion of Cashew

Dr. Dadasaheb Desai

Introduction

The Directorate of Cashewnut and Cocoa Development (DCCD) in Kochi operates under the Union Ministry of Agriculture and Farmers Welfare, acting as the national nodal agency for the development of these crops. Following the 1997 incorporation of cocoa, the Directorate serves as a subordinate office responsible for promoting cultivation, increasing productivity, and implementing developmental schemes under the Mission for Integrated Development of Horticulture (MIDH). Through a robust network of state agencies, ICAR institutes, and local organizations, DCCD coordinates national efforts for capacity building, nursery accreditation, and technology transfer for holistic sector growth. This report covers the Directorate's strategic activities and achievements for the 2024–25 financial year, showcasing sustained expansion in production, infrastructure development, and improved planting material.

Cashew Scenario

Cashew crop is introduced to India in the 16th century, cashew has evolved into a vital commercial crop that supports the rural agrarian economy, sustaining half a million farmers and one million processing sector workers. Driven by the formulation and execution of development strategies by the Directorate of Cashewnut and Cocoa Development (DCCD) across 17 states, the crop now spans 12.05 lakh hectares, generating a production of 8.02 lakh metric tonnes with a productivity rate of 678 kg/ha. Recognized globally for its premium quality, the sector successfully overcame recent global disruptions to export cashew kernels and Cashew Nut Shell Liquid (CNSL) valued at ₹2,533 crore during the 2024–25 financial year.

Establishment of New Plantations in Farmers' Fields (Cashew)

The primary objective of the scheme is the expansion of area under cultivation through the establishment of new plantations utilizing elite clones of high-yielding cashew varieties in farmers' fields. The programme is implemented directly by the Directorate of Cashewnut and Cocoa Development (DCCD), Kochi, in active coordination with Local Panchayats, Krishi Vigyan Kendras (KVKs), State Agricultural Universities (SAUs), and State Departments. Under this intervention, 100% Central Assistance fixed at ₹30,000 per hectare is provided, subject to a maximum ceiling of 2 hectares per beneficiary. In accordance with the standard package of practices recommended by research institutes, cultivation must strictly adhere to a spacing of 7m × 7m, limiting the maximum planting density to 200 plants per hectare.

Quality planting material must be sourced exclusively from SAUs, ICAR research institutes, or DCCD-accredited nurseries, with applications routed through local grassroots institutions. The financial subsidy covers the cost of clonal planting materials and essential inputs for Integrated Nutrient Management (INM) and Integrated Pest Management (IPM). All financial assistance is disbursed to the beneficiaries solely through the Direct Benefit Transfer (DBT) mode, while the overseeing implementing institute is eligible for contingency charges calculated at 2.5% of the total project cost. For non-drip integrated production systems, the financial subsidy is released in two installments under a structured pattern. The release of consecutive instalments is strictly conditional upon mandatory joint field inspections by designated officials to verify a minimum crop survival rate of 80% in the second year.

Establishment of New Plantations by Replacing Senile Plantations and Replant with High Yielding Varieties

The primary objective of the scheme is the systematic removal of old, unproductive, and senile cashew plantations and their subsequent replacement with location-specific High Yielding Varieties (HYVs) to enhance crop productivity. Implemented directly by the Directorate of Cashewnut and Cocoa Development (DCCD), Kochi, across identified clusters on lands owned by State Farms, State Cashew Corporations, State Agricultural Universities (SAUs), and individual farmers' fields, the programme governs financial assistance under the Mission for Integrated Development of Horticulture (MIDH) framework.

The pattern of assistance is fixed at 40% of the cost, subject to a maximum ceiling of ₹24,000 per hectare, component-wise structured to allocate ₹4,000 per hectare for the physical removal of senile trees, ₹4,000 per hectare for subsequent replanting operations, and ₹16,000 per hectare for input components covering Integrated Nutrient Management (INM), Integrated Pest Management (IPM), and irrigation infrastructure. Quality planting materials must be sourced strictly from the respective corporations, SAUs, ICAR research institutes, or DCCD-accredited private nurseries to ensure genetic purity, with no area ceiling applicable for operations carried out on public sector farms, state-owned corporations, or agricultural university lands

Technology dissemination through front line demonstrations - Cashew

The objective of this programme is to demonstrate and convince the farmers, the benefits of various scientific production technologies. Each demonstration unit should not exceed 1ha. Four innovative programmes were done under FLTD programme.

a) Establishment of demonstration plots with high density planting

High Density Planting (HDP) is an innovative approach in cashew cultivation aimed at enhancing productivity by accommodating a greater number of plants per unit area. Conventionally, cashew is planted at a spacing of 8 m × 8 m or 7 m × 7 m, accommodating about 150 –200 plants per hectare. Under this system, trees generally take 7–8 years to fully occupy the allotted space and attain their potential yield. High density planting adopts closer spacing of 5m x 5m, resulting in a substantially higher plant population of 400 plants/ ha enabling efficient utilization of land, sunlight, moisture and nutrients. The success of HDP depends on optimizing growth parameters and minimizing unproductive vegetative growth without compromising tree health and nut quality. Regular pruning and canopy management are integral components of the system High density planting also facilitates early canopy coverage, thereby suppressing weed growth, reducing soil temperature, conserving soil moisture during summer months and providing a natural mulching effect.

To further enhance resource-use efficiency and ensure optimum growth of plants, the demonstration plots are integrated with drip irrigation systems, which provide water directly to the root zone in a precise and controlled manner. Drip irrigation improves water-use efficiency, reduces water losses through evaporation and runoff, supports uniform plant growth and is particularly beneficial in areas experiencing moisture stress.

The combined adoption of HDP and drip irrigation contributes to increased productivity, improved orchard management and enhanced resilience to climatic variability.

a. Establishment of Demonstration Plots with High Density Planting with Drip Irrigation:

Assistance will be limited to 75% of cost in farmers field and 100% in farms in public sector, ICAR, SAU's Deemed Universities having faculty in horticulture. Maximum assistance will not exceed Rs.25.00 lakhs per project. Rs.1.125 lakhs/ unit of 1 ha in farmers field for meeting the cost of inputs and Rs.1.50 lakhs/ unit of 1 ha in farms in public sector, ICAR, SAU's Deemed Universities having faculty in horticulture.

b. Establishment of Demonstration Plots with High Density Planting without Drip Irrigation:

Assistance will be limited to 75% of cost in farmer's field and 100% in farms in public sector, ICAR, SAU's Deemed Universities having faculty in horticulture. Maximum assistance will not exceed Rs.25.00 lakhs per project. Rs.45,000/ unit of 1 ha in farmers field for meeting the cost of inputs and Rs.60,000/ unit of 1 ha in farms in public sector, ICAR, SAU's Deemed Universities having faculty in horticulture.

b) Establishment of Demonstration Plots with High Yielding Varieties in Normal Density

The programme aims to demonstrate the performance of the latest cashew varieties along with the adoption of recommended production technologies under normal density planting systems. The demonstrations promote improved package of practices, including planting of quality cashew grafts, soil and water conservation measures, nutrient management and drip irrigation for efficient water use and enhanced crop productivity.

Under the programme, cashew is planted at a spacing of 7 m × 7 m, accommodating approximately 200 grafts per hectare, The integration of drip irrigation ensures efficient water application, improved moisture availability and better establishment and growth of plantations, particularly in water-scarce regions.

a. Establishment of Demonstration Plots with Normal Density Planting with Drip Irrigation :-

Assistance will be limited to 75% of cost in farmers field and 100% in farms in public sector, ICAR, SAU's Deemed Universities having faculty in horticulture. Maximum assistance will not exceed Rs.25.00 lakhs per project. Rs.75,000/ unit of 1 ha in farmers field for meeting the cost of and Rs.1,00,000/ unit of 1 ha in farms in public sector, ICAR, SAU's Deemed Universities having faculty in horticulture .

b. Establishment of Demonstration Plots with Normal Density Planting without Drip Irrigation :-

Assistance will be limited to 75% of cost in farmers field and 100% in farms in public sector, ICAR, SAU's Deemed Universities having faculty in horticulture. Maximum assistance will not exceed Rs.25.00 lakhs per project. Rs.30,000/ unit of 1 ha in farmers field for meeting the cost of inputs and Rs.40,000/ unit of 1 ha in farms in public sector, ICAR, SAU's Deemed Universities having faculty in horticulture.

c. Demonstration of Replanting Practices of Cashew with High Yielding Varieties Under Normal Density Planting

To demonstrate the latest replanting technologies in senile/unproductive plantations. Assistance will be limited to 100% in farms in public sector, ICAR, SAU's Deemed Universities having faculty in horticulture. Maximum assistance will not exceed Rs.25.00 lakhs per project. Rs.60,000/ unit of 1 ha in senile/unproductive farms in public sector, ICAR, SAU's Deemed Universities having faculty in horticulture.

d. Promotion of Integrated Nutrient Management/ Integrated Pest Management: Objective:

To improve the production and productivity of cashew plantations by promoting INM/IPM practices. Assistance @ Rs 1500/ ha for an area upto 2 ha per beneficiary or pro-rata basis for smaller areas

Nursery Programmes

The availability of quality planting material is a critical factor in improving the productivity and sustainability of the cashew sectors. The production and distribution of true-to-type, disease-free and healthy planting materials suitable for diverse agro-climatic conditions are essential for the successful implementation of developmental programmes under the Mission for Integrated Development of Horticulture (MIDH).

The objective of the programme is to establish hi-tech nursery, big cashew nursery and small cashew nurseries under MIDH as a credit linked back ended subsidy based on proposal received from needy states. In the first instance, necessary action will be initiated to explore the possibility of establishing nurseries in association with state developmental departments/private entrepreneurs.

However, the existing production of planting material through departmental progeny orchards and nurseries remains insufficient to meet the growing demand of farmers. Recognizing this gap, the production and distribution of quality cashew grafts have been identified as key thrust areas for enhancing crop productivity, expanding area under cultivation and ensuring the establishment of high-yielding plantations.

Assistance will be limited to Rs.10.00 lakhs/ ha @ 100% to public sector and 50% to private sector for an area from 0.40 ha to 1 ha as project based activity, on pro rata basis. Each nursery will produce a minimum of 50,000 planting materials per ha. Accreditation of each small nursery will be mandatory within 18 months from the date of release of last instalment.

a. Establishment/Up-gradation of Cashew Nurseries

The primary objective of this intervention is to establish new nurseries and upgrade the infrastructure of existing ones to ensure the mass production and distribution of high-quality, disease-free cashew planting materials required for area expansion and replanting across the country. Implemented directly by the Directorate of Cashewnut and Cocoa Development (DCCD), Kochi, the scheme provides financial assistance up to ₹4.00 lakh per hectare on a pro-rata basis for an area up to 2 hectares, with a funding pattern of 100% assistance to the public sector and 50% to the private sector.

This capital subsidy is strictly tied to the creation or modernization of essential infrastructure components, including hotbed media sterilization units, working sheds, net houses/hardening chambers, mist chambers, and integrated irrigation and fertigation facilities. To ensure strict quality control and standardization, the accreditation of each established or up-graded nursery is mandatory within 18 months from the date of release of the final financial installment.

Up-gradation of Cashew Nurseries through the Establishment of Cashew Mother Blocks with Drip Irrigation and Fertigation: This specialized program targets Research Stations, State Agricultural Universities (SAUs), ICAR Institutes, and qualified existing nurseries to maintain mother blocks of elite high-yielding clones under optimal resource management. The financial assistance is capped at a maximum of ₹1.50 lakh per unit of 1 hectare to meet input costs without licensing and ₹3.00 lakh per ha with licensing, adhering to the same pattern of 100% for the public sector and 50% for the private sector on a pro-rata basis up to 2 hectares. To qualify for this funding, eligible projects must maintain a minimum area of 1 hectare and ensure the mandatory establishment of at least five of the latest high-yielding cashew varieties within the mother block.

b. Accreditation of Nurseries

The DCCD acts as a nodal agency for accreditation of existing cashew nurseries based on the guidelines prepared by the DCCD and issue certificate of accreditation. This accreditation will ensure the quality of planting materials of cashew produced by the nurseries in private and public sector. The Nursery seeking DCCD Recognition shall apply in the prescribed form to DCCD Kochi. Each application will be considered by DCCD based on criteria specified for accreditation of nursery. On receipt of the application for recognition, a preliminary scrutiny would be done by DCCD .

A committee constituted by Director DCCD consisting of an expert from Cashew research, a senior Officer of DCCD and an officer from the Department of Horticulture/Agriculture will visit the nursery. On the basis of the assessment report, DCCD shall decide whether to accredit the nursery with or without up-gradation. It is proposed to earmark funds for meeting the contingency expenditure of the inspection team. The details of application and guidelines are available in the website www.dccd.gov.in of this Directorate.

Primary Processing Units in Cashew

Post-harvest management in cashew nut and cashew apple stimulates production by adding value to the raw commodities, preventing severe post-harvest losses, improving quality, and opening new market opportunities. This critical phase specifically involves the strategic sequence of movement and field operations that these commodities undergo from the immediate point of harvest up to final product preparation. The program focuses strictly on preserving both the raw nut and the highly perishable pseudo-fruit in an acceptable, premium state to ensure standard qualitative outturn and prevent economic losses. Primary processing in cashew, which includes the scientific drying of raw nuts to reduce moisture content and the immediate processing or de-tanning of the delicate cashew apple represents an indispensable practice that determines the final market value and prevents distress sales.

To address the vulnerabilities of improper post-harvest handling, this development programme prioritizes the creation of necessary infrastructure facilities for primary processing and safe storage.

Under this component, the Directorate of Cashewnut and Cocoa Development (DCCD) extends structured financial assistance to promote grassroots value addition and minimize field waste. Financial subsidies and project-based support are provided directly to individual farmers, registered farmers' groups, State Agricultural Universities (SAUs), and Local Panchayats to establish community drying yards, raw nut storage godowns, juice extraction units, and primary processing facilities. By mechanizing and standardizing these initial post-harvest steps for both the nut and the apple, the initiative effectively safeguards farmers' incomes and upgrades the overall cashew supply chain.

Strengthening of Database-Cashew Crop Cutting Survey

The primary objective of the programme is to formulate a realistic, data-driven assessment of cashew yield across consecutive cropping seasons utilizing precise morphological and productivity parameters, specifically the surface area of the tree canopy and the density count of nuts per square meter of canopy area. Implemented directly by the Directorate of Cashewnut and Cocoa Development (DCCD), Kochi, this scientific forecasting model is executed in formal collaboration with the research and economic wings of State Agricultural Universities (SAUs) and ICAR institutes. The geographic scope of the survey targets major cashew-growing districts across the country where the total crop coverage exceeds a threshold of 5,000 hectares.

Operational execution relies on field enumeration conducted across identified individual farms and clusters at the grassroots level. Enumerators utilize a specialized, standardized proforma developed by the Directorate to capture field parameters uniformly, and the aggregated data is compiled, statistically analyzed, and released as official crop forecasts by the DCCD. To ensure robust field implementation, the Directorate meets all associated contingent expenditures, which comprehensively cover allowances and training for enumerators, field movement expenses, and professional honorariums for collaborating scientists, and administrative contingencies including the printing of survey schedules.

Publicity on Crop Promotion - Cashew

The primary objective of the scheme is to undertake intensive publicity and extension measures for the cashew sector by disseminating the latest scientific production technologies to farmers, processors, marketers, and exporters. Implemented directly by the Directorate of Cashewnut and Cocoa Development (DCCD), Kochi, this initiative bridges the gap between research breakthroughs and field-level adoption to transform cashew cultivation into a highly profitable enterprise. The programme is executed in active collaboration with State Agricultural Universities (SAUs), ICAR Research Institutes, Krishi Vigyan Kendras (KVKs), State Development Departments, Registered Societies, Farmers' Associations, and Non-Governmental Organizations (NGOs.)

Under this promotional framework, the Directorate sponsors and coordinates structured field-level events, including District-Level Seminars, Horticulture Fairs, Krishi Melas, and Field Days across all major cashew-growing states to empower grassroots farming communities. For high-level policy and technical exchange, national and international seminars or conferences are organized directly by the DCCD in strategic association with the respective hosting State Development Departments. Through this multi-tiered dissemination network, the scheme ensures the widespread adoption of innovative orchard management and best practices, thereby driving national production, post-harvest quality, and rural farmers' income.

a. District-Level Seminar on Cashew

The Directorate provides a total financial assistance of ₹75,000 per event to organize a one-day District-Level Seminar, implemented through specialized ICAR Research Institutes, State Agricultural Universities (SAUs), Krishi Vigyan Kendras (KVKs), registered societies, and non-governmental organizations (NGOs). Designed as an intensive platform for knowledge exchange and technical technology transfer, each session targets a mandatory cohort of 150 participants, comprising cashew farmers, extension workers, field officials, processors, manufacturers, and development agencies directly associated with the crop. The comprehensive central grant is fully utilized to meet all logistical requirements, including venue hiring charges, audio-visual aids, field publicity materials, photography, participant refreshments, expert scientist honorariums, and institutional transportation costs.

b. Cashew Fair/Field Day:

The Cashew Fair and Field Day initiative is designed to raise widespread awareness among farmers and the general public regarding the commercial scope, significance, and latest technological advancements in cashew cultivation, transforming it into a highly profitable enterprise. Organized across various states, these events feature structured technical exhibitions and stalls from research institutions, development agencies, input-producing industries, and export consultancies to provide direct consultation on sector-specific issues and promote the field adoption of improved orchard techniques. The events are structured to accommodate a large cohort ranging from 100 to 2,000 participants per field day, with flexible central financial assistance earmarked between ₹50,000 and ₹3,00,000 per fair or field day scaled dynamically depending on the volume of farmer mobilization and institutional participation. For District level fair maximum assistance is upto Rs.1,00,000/- per day.

c. Publicity Activities (Exhibitions, Advertisements, Printing of Literature, Video Development, Workshops, Training on Processing, Documentation, and Publicity through AIR, Doordarshan, etc.) for the Promotion of Cashew Crops

Under the Mission for Integrated Development of Horticulture (MIDH) framework, the Directorate sponsors need-based exhibitions, field days, training workshops, and awareness campaigns across cashew-growing states to enhance direct farmer engagement and technology transfer. To support these field interventions, financial assistance and grant-in-aid are provided to implementing agencies for the preparation, printing, and dissemination of technical literature including detailed booklets, pamphlets, and folders in both English and regional languages tailored for farming communities and extension workers. Furthermore, the scheme provides financial support for the development of instructional videos covering advanced cultivation and processing methodologies for broadcast outreach, alongside the release of targeted advertisements in media platforms and horticultural societies to promote value addition, developmental activities, and the adoption of modern cashew technologies nationwide.



Human Resource Development (HRD) for Cashew :

The primary objective of the Human Resource Development (HRD) scheme under the Mission for Integrated Development of Horticulture (MIDH) framework is to systematically bridge the knowledge and skill gaps existing among field officers, extension workers, farmers, entrepreneurs, and unemployed women. Implemented directly by the Directorate of Cashewnut and Cocoa Development (DCCD), Kochi, the program accelerates sector growth by provisioning structured technical and managerial training models.

The capacity-building curriculum focuses on the entire value chain of cashew cultivation, equipping stakeholders with advanced expertise in scientific nursery management, phytosanitary disease control, canopy management, innovative production technologies, and post-harvest operations including standardized drying, safe storage, and the processing of primary and value-added consumer products.

Training Programme on Cashew Production Technologies

The primary objective of this component is to provide structured, one-day technical training to cashew farmers, self-help groups (SHGs), women entrepreneurs, agribusiness interest groups, and rural youth to enhance field-level adoption of modern agricultural practices. Implemented in association with specialized ICAR Research Centres and State Agricultural Universities (SAU's) via project-based proposals, the training covers advanced production technologies, high-density planting, organic cultivation, Integrated Pest Management (IPM), and value-added processing techniques. Each training batch is upto a maximum 50 participants for programs conducted within the state or locality of the implementing agency. This financial grant is provided to the organizing research institution/SAU's as a lump-sum contingency fund, calculated at a strict norm of ₹1000 per head, to comprehensively cover institutional organizing costs, participant food and refreshments, resource personnel honorariums, and trainee mobility charges.

- **Exposure Visit of Farmers to Centres of Excellence-outside the state**

The primary objective of the Inter-State Exposure Visit program is to expose tribal and smallholder farmers from non-traditional cashew-growing districts to advanced production and orchard management practices in traditional high-yielding states. Implemented by government and private agencies under the Mission for Integrated Development of Horticulture (MIDH) through project-based proposals, this seven-day residential program is conducted at designated Centres of Excellence for standardized batches of 50 beneficiaries. For general and traditional states, a total financial assistance of ₹3,50,000 per batch is provided, which comprises ₹1000 per day per farmer for boarding, lodging, and including transport for 7 days of Visit.

- **Exposure Visit of Farmers to Centres of Excellence-within the state**

The primary objective of the Intra-State Exposure Visit program is to expose Cashew growing districts of the states to the traditional growing districts within the states for familiarizing production and management practices. Implemented by government and private agencies under the Mission for Integrated Development of Horticulture (MIDH) through project-based proposals, this Five-day residential program is conducted at designated Centres of Excellence for standardized batches of 50 beneficiaries. For general and traditional states, a total financial assistance of ₹2,50,000 per batch is provided, which comprises ₹1000 per day per farmer for boarding, lodging, and including transport for 5 days of Visit.

- **Training on Cashew Apple Utilization for Unemployed Women**

The primary objective of this specialized training programme is to popularize the commercial utility of the underutilized cashew apple, mitigating post-harvest losses and generating supplementary income for farming households by training unemployed women in processing the fruit into value-added byproducts like cashew apple syrup, juice, jam, and candy. Implemented through designated research institutes of State Agricultural Universities (SAUs) and qualified Non-Governmental Organizations (NGOs) equipped with prior DCCD-funded small-scale processing infrastructure, the capacity-building program is standardized for batches of 20 participants.

The Directorate of Cashewnut and Cocoa Development (DCCD), Kochi provides a fixed financial assistance of ₹1,000 per day to farmers including transport. 100% assistance limited to ₹20,000 for 1 day per batch of 20 participants directly to the host institution as a lump-sum grant. This funding is comprehensively utilized to meet all operational requirements, including institutional organizing costs, participant food and refreshments, trainee mobility charges, and professional honorariums for the resource personnel.



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