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ANNUAL REPORT 1999 - 2000

अखिल भारतीय समन्वित काजू अनुसंधान परियोजना

AICRP ON CASHEW

भाकृअनुप
ICAR

राष्ट्रीय काजू अनुसंधान केन्द्र
(भारतीय कृषि अनुसंधान परिषद्)
पुत्तूर दक्षिण कन्नड, कर्नाटक 574 202

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(INDIAN COUNCIL OF AGRICULTURAL RESEARCH)
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ALL INDIA COORDINATED RESEARCH PROJECT ON CASHEW

वार्षिक प्रतिवेदन
ANNUAL REPORT 1999 - 2000

परियोजना समन्वयकर्ता
PROJECT COORDINATOR
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भाकृअनुप
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राष्ट्रीय काजू अनुसंधान केंद्र
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प्राक्कथन

अखिल भारतीय समन्वित काजू अनुसंधान परियोजना की सोलहवीं वार्षिक प्रतिवेदन प्रस्तुत है । इस प्रतिवेदन में वर्ष 1999 जनवरी से दिसंबर तक की अनुसंधान उपलब्धियाँ तथा वित्तीय वर्ष 1999-2000 की अन्य जानकारी सम्मिलित की गई है ।

इस परियोजना में कुल आठ केंद्र और एक उपकेंद्र है जैसे पूर्व तट पर वापट्ला (आन्ध्र प्रदेश), भुवनेश्वर (उड़ीसा), झारग्राम (प. बंगाल) और वृद्धाचलम् (तमिल नाडु); पश्चिम तट पर माडक्कतरा केंद्र और पिलिकौड उपकेंद्र (केरल) तथा वैंगुर्ले (महाराष्ट्र); मैदानी भाग में दो केंद्र, एक चिंतामणि (कर्नाटक) और दूसरी जगदलपुर (मध्य प्रदेश) स्थित है ।

प्रतिवेदन में चालू सोलह अनुसंधान विषयों की उपलब्धियों को क्षेत्रीय स्तर पर और विषयानुसार जैसे सस्य प्रजनन (3), सस्य विज्ञान (5), बागवानी (2), और कीट विज्ञान (6), संकलित कर प्रस्तुत की गई है ।

इस प्रतिवेदन का दो अध्याय है :-

1. तकनीकी परियोजना और क्षेत्रीय तौर पर प्राप्त तकनीकी प्रायोगिक उपलब्धियाँ, और
2. इतिहास, कर्मचारी, वित्तीय प्रावधान, मौसम आँकड़े और शोध प्रकाशन आयोजन पर प्रकाशित है ।

ई वी वी भास्कर राव

ई.वी.वी. भास्कर राव

निर्देशक एवं परियोजना समन्वयकर्ता

पुत्तूर - 574 202

दिनांक : 17-7-2000

ABOUT THIS REPORT

This is the sixteenth Annual Report of the All India Coordinated Research Project on cashew. This report covers the research results for the calendar year January to December 1999 with all other information pertaining to the financial year 1999-2000.

There are eight project centres and one sub centre, four on the East Coast of India, Bapatla (Andhra Pradesh); Bhubaneswar (Orissa); Jhargram (West Bengal) and Vridhachalam (Tamil Nadu), two centres and one sub centre on the West Coast, Madakkathara and Pilicode (Sub centre) (Kerala); Vengurle (Maharashtra) and one each in Maidan parts, Chintamani (Karnataka) and Jagdalpur (Madhya Pradesh) which are implementing the research programmes.

There are fourteen research projects pertaining to disciplines such as, Breeding (3), Agronomy (5), Horticulture (2) and Entomology (6). The results reported by each centre are compiled region-wise and discipline wise and presented in this report.

This report consists of two chapters, they are:

1. Technical : consisting of project wise and region wise experimental results from different centres, and

2. Organisation : consisting of history, staff, budgetary provisions, functioning, meteorological data and research publications.

EVV Bhaskara Rao

(E.V.V. BHASKARA RAO)
DIRECTOR

Puttur

Dated : 17-7-2000

CHAPTER 1 : TECHNICAL

समन्वयकर्ता की रिपोर्ट

अखिल भारतीय समन्वित मसाला व काजू अनुसंधान परियोजना 1971 में चौथी पंच वार्षिक योजना में शुरू की गई, जिसका मुख्यालय केंद्रीय रोपण फ़सल अनुसंधान संस्थान कासरगोड में था । सातवीं पंच वार्षिक योजना में इस परियोजना को दो स्वतंत्र परियोजनाओं - एक काजू पर और दूसरी मसाले पर विभाजित किया गया । अखिल भारतीय समन्वित काजू अनुसंधान परियोजना का मुख्यालय स्वतंत्र रूप से नव संस्थापित राष्ट्रीय काजू अनुसंधान केंद्र पुत्तूर में सन 1986 को स्थानांतरित किया गया ।

अखिल भारतीय समन्वित काजू अनुसंधान परियोजना में आठ केंद्र और एक उपकेन्द्र है, जिसमें चार केंद्र 1971 में अखिल भारतीय समन्वित मसाले व काजू अनुसंधान परियोजना के शुरूवात में बापट्ला (ए.एन.जी.आर.ए.यु. भूतपूर्व ए.पी.ए.यु.) माडक्कतरा (केरल कृषि विश्व विद्यालय, आनक्कयम से स्थानांतरित), वेंगुर्ले (के.के.वी.) और वृद्धाचलम (तमिल नाडू कृषि विश्व विद्यालय) में प्रारंभ किया गया । पाँचवीं पंच वार्षिक योजना में एक केंद्र भुवनेश्वर (ओ.यु.ए.टी.) और छठी पंच वार्षिक यौजना में दो केंद्र - झारग्राम (वी.सी.के.वी.) और चिंतामणि (यू.ए.एस.) को सम्मिलित किया गया । आठवीं योजना में एक केंद्र - जगदलपुर (ऐ.जी.ए.यू.) और एक उपकेंद्र (पिलिकोड–के. कृ. वि.) भी प्रवर्तित हुए। अखिल भारतीय समन्वित काजू अनुसंधान परियोजना के यह केंद्र 8 काजू कृषित राज्यो में स्थित है तथा यह विभिन्न राज्य कृषि विश्व विद्यालयों के प्रशासनिक नियंत्रण में है ।

परियोजना का 1999-2000 में वजट आवंटन रु. 66.67 लाख (रु. 50.00 लाख भा. कृ अ प का अंश) था और व्यय 63.34 लाख (47.51 लाख रुपये भा कृ अ प का अंश) रूपये था ।

काजू की उत्पादन एवं उत्पादन क्षमता बढ़ने हेतु इस परियोजना का लक्ष्य इस प्रकार है :

1. निर्यात स्तर की अष्टी, रोग एवं कीट क्षमता / रोध के उच्छ उपज प्रदत्त प्रजातियों का विकास ।
2. विभिन्न सस्य जलवायु परिस्थितियों में काजू फसल के लिए कृषी प्रौधांगिकी का मानकीकरण।
3. लागत प्रभावी, दक्ष कीट एवं रोग प्रवंधन विधियों का विकास ।

फ़सल सुधार :

परियोजना के केंद्रों में काजू जनन द्रव्य के संग्रहण, परिरक्षण एवं परीक्षण किया जा रहा है । अब तक इन केंद्रों में कुल 1099 प्रजातियों संग्रहित है । इस वर्ष कुल 40 जनन द्रव्य प्रजातियों का संग्रहण किया गया। मौजूदा प्रजातियों का निष्पादन का मूल्यांकन जारी है । बापट्ला में ट्री. नं. 277 शुरु वाद के वनस्पति वृद्धि के चरणों में अच्छी पाई गई। भुवनेश्वर में ओ. सी-14 के उपज से अच्छी पाई गई (4.1 कि. ग्राम पर पेड)। चिंतामणि में सब से अधिक उपज 21.91 कि. ग्राम प्रति वृक्ष के हिसाफ से 2/6 ARSC में पाया गया और उसी किसम में लंबी मिश्रित पुष्पण की अवधी देखी गई। जगदलपुर में एन. आर. सी. 40 अच्छी निष्पादन प्रकट किया । झारग्राम स्थित जे. जी. एम. 74/6, 14.33 कि. ग्राम प्रति वृक्ष के उपज से आगे पाया गया । वृद्धाचलम में एम 15/4 पुरानी प्रजनन द्रव्य संग्रहणों में और एम 89/2 नई संग्रहणों में अच्छी प्रमाणित हुए ।

परियोजना के विभिन्न केंद्रों में क़िस्मों का मूल्यांकन के तर्गत तीन प्रयोग जारी है । चिंतामणि में वापटला और वेंगुर्ले की प्रजातियों का उपज तुलनात्मक परीक्षण जारी है । इस में वि 5 से अच्छी उपज (6.03 की. ग्राम प्रति ताड़) प्राप्त हुई ।

परियोजना के चार केंद्र में वहु स्थानीय परीक्षण 1986 से चालू हैं । भुवनेश्वर और झारग्राम केंद्रं में एच 2/16 क़िस्म से ज़्यादा उपज प्राप्त हुई । यह क़िस्म भुवनेश्वर में लगातार आठ वर्षों से ज़्यादा उपज दे रही हैं । चिंतामणि में इस साल एच 1600 क़िस्म एम 44/3 से अच्छा पाया गयै जो पिछले साल में संचयी उपज में वेहतर था । माडक्कतरा में वी 5 से अत्यधिक उपज प्राप्त हूई ।

आठ परियोजना केंद्रों में जारी अलग वहु स्थानीय परीक्षण में 1992 से रोपित क़िस्मों और संकरणों का परीक्षण की जा रहीं हैं । इस परीक्षण में बापटला केंद्र में ट्री नं. 10/19 और भुवनेश्वर में वी पी पी 30/1 से अत्यधिक उपज प्राप्त हुई । चिंतामणी में एन आर सी सी 2 लगातार पाँच वर्षों से अत्यधिक उपज दे रहीं है । जगदलपुर में एच 303 वेहतर पाया गया । झारग्राम में एच 255 में बेहतर सस्य प्रवर्धन दिखाई दिया । एम 15/4 किस्म माडक्कतरा में अन्य किस्मों से वेहतर पाई गई । वेंगुर्ले में एच 367 और एच 303 सस्य प्रवर्धन में अच्छी पाई गई, तथा वृद्धाचलम में एम 44/3 अन्य किस्मों से अधिक उपज दिया । संकरण कार्यक्रम में बापटला में 130 पहली पीढ़ी की पौधे क्षेत्रीय रूप से स्थापित हो रहे हैं। भुवनेश्वर में चार वर्ष आयु के संकर प्रजाति भुवनेश्वर 1 x कंकाडी अच्छी निष्पादन दिखाई दिया हैं । वृद्धाचलम में दस वर्षों से चल रही परीक्षण में एम 10/4 x एम 26/1 से एम 4/3 x एम 45/1 वेहतर उपज प्राप्त किया । चिंतामणि में 54 पहली पीड़ी के पौधों को जमीन में रोपण किया गया । माडक्कतरा में 1993 में रोपण की गई संकरण प्रजातियों में एच-2 वेहतर उपज प्रकट किया । बाद के वर्षों मे तैयार की गई संकर प्रजातियों के पौधे जमीन में स्थापित हो रहें हैं । वेंगुर्ले में वि 5 x कंकाडी अन्य संकरणों से वेहतर था । वृद्धाचलम में एम 4/3 x एम 45/1 में एम 10/4 x एम 26/1 से वेहतर निषपादन दिखाया; जो दस साल का अत्यधिक संचयी उपच दिया था।

फ़सल प्रबंध :

(अ) सस्य विज्ञान : नैट्रोजन की उर्वरक मात्रा बढाने से काजू पेडों में अधिक उपज और सस्य निष्पादन प्राप्त हुआ। चिंतामणि में पाँसफोरस और पोटाश दोनों उपज पर प्रभाव डाले । नैट्रोजन 1500 पाँसफोरस 250 पोटाश 250 तथा नैट्रोजन 1000 फोसफोरस 250 पोटाश 200 इन दोनों उर्वरकों की प्रयोग से उपज में वृद्धी पाई गई । झारग्राम में 250 ग्राम पोटाश उपज बढ़ाने वाली सिद्ध हुई । सबसे अधिक उपज 10 x 10 मीटर की रोपण में प्रति ताड़ केलिए प्राप्त किया गया, मगर 6 x 6 x 6 त्रिकोणीय रोपण पद्धती में कुल क्षेत्र की उपज अन्य रोपणों से ज्यादा पाई गई । वेंगुर्ला में 5 x 5 रोपण में क्षेत्रीय स्तर पर अत्यधिक उपज तथा 8 x 8 रोपण में प्रति ताड़ के लिए अधिक गुठलियां प्राप्त हुई । अत्यधिक घन सांद्र रोपण 4 x 4 मीटर के दूरी पर प्रति ताड लगाई गई रोपण पद्धति का प्रयोग एवं प्रदर्शनी क्षेत्र आरंभिक चरतणों में विभिन्न परियोजना केन्द्रो में शुरु हो रही हैं ।

हल्दी और एलिफेन्ट फूट याम को काजू के रोपण में अंतराल फ़सल के रूप से भुवनेश्वर में लाभदायक समझी गई। झारग्राम और वृद्धाचलम में मूँगफली के अंतराल फसल अत्यंत लाभदायक सिद्ध हुआ तथा करेला वेंगुर्ले में अधिक लाभदायक पाया गया ।

बूँद सिंचाई के प्रयोग में चिंतामणि, वेंगुर्ले और वृद्धाचलम के केंद्रों में रोपण का काम चल रहा है ।

(ब) बागवानी : एक वौनी किसम्म के प्रजाति भुवनेश्वर में पाया गया उसके कलम बनाने में इस्तेमाल किया जा रहा है । माडक्कतरा में दो कम ओजस्वी किस्मों को परीक्षण किया जा रहा है । रुट स्टॉक कलम के बीच पारस्परिक क्रिया परीक्षण के कलमों को इस्तेमाल किया जा रहै है । कम सफलता तथा कम शक्यता के कारण बागवानी के परीक्षण ज्यादा फलकारी न होने से इन दोनों परीक्षणों को तकनीकी की कार्यक्रमों से निकालने का निर्धारित चौदहवीं द्विवार्षिक कार्य शाला में भुवनेश्वर में किया गया ।

फसल संरक्षण :

पेड़ों को जिन केंद्रों में पुष्पण व फलन के समय संस्तुत कीटनाशक से छिड़काव किया गया वहाँ चाय मच्छर की संख्या कम पाई गई । मानक छिड़काव में मोनोक्रोटोफोस 0.05% उद्धावन के समय, एन्डोसल्फान 0.05% पुष्पण की समय और 0.1% कार्बरिल फलन की समय छिड़काने से अत्यधिक नियंत्रण परियोजना केंद्र में पाई गई । नैसर्गिक शत्रु कीटों की आवादी हमेशा अभिक्रिया किए बिना छोडे पेडों में ज्यादा देखी गई । माडक्कतरा में किसी भी कीटनाशक से चाय मच्छर की नियंत्रण नहीं पाया गया । चाय मच्छर के साथ *कोल्लीटिट्रैकं ग्लियोस्पोरीडिस* शिलींध्र की बाधा भी जटिलता पूर्ण बन जाने से मानक छिडकाव में भी ज्यादा नुकसान हुआ ।

बापट्ला मे इस वर्ष कीटों की बाधा कम दिखाई दिया । भुवनेश्वर में सिफारिश की गई मानक कीटनाशक के छिड़काव से अग्रक / मुकुल छेदक इल्ली, पुष्पगुच्छ रसाद कीड़े, पत्ते मोड़ने वाली कीटों की नियंत्रण पाई गई। चिंतामणि में पत्ते व पुष्पगुच्छ को हानि करने वाली रसाद को सिफारिश की गई मानक कीटनाशी रसायन के छिडकाव से अच्छी तरह नियंत्रण पाया गया । झारग्राम में उद्धावन और पुष्पण के समय छिडकाव करने से पत्ते वेधक कीटों, कांड एवं पुश्प को जाल में सिमटने वाली कीटों से छुटकारा पाया गया । पत्ते मोडने वाली गुलाव व हरे कीट और पुष्प गुच्छों को बाधा करने वाली रसाद से मानक कीटनाशी छिडकाव से मुक्ति पाई गई । वेंगुर्ले में गुठली छेदक तथा अन्य कीटों से भी सक्षम नियंत्रण पाया गया ।

चाय मच्छर व अन्य निचले कीट नियंत्रण के लिए अन्य कीटनाशकों का प्रयोग जारी है । उस में बापट्ला में प्रोफेननोफास 0.05% की छिडकाव बेहतर पाया गया । भुवनेश्वर और झारग्रामों में प्रोफेनोफास पूर्व सिफारिश की गई कीटनाशक से तुलनात्मक देखी गई । चिंतामणि और वेंगुर्ले में सिफारिश की गयी कीटनाशक के साथ क्लोरपैरिफास तुलनात्मक देखी गई । माडक्कतरा और वृद्धाचलम में सिफारिश की गई कीटनाशक ही बेहतर पाया गया ।

कीट निरोधकता की परख में काजू के कांड व जड़े छेदन करने वाला सूँडियों से छुटकारा पाने के लिए मृदा कर्दम के साथ कार्बारिल कूर्चन करने के साथ ताड के निचले जमीन पर लिंडेन की प्रयोग करने से फलकारी होना सिद्ध हुआ । झारग्राम, माडक्कतरा और वेंगुर्ले में 5% नीम का तेल कूर्चन करने के साथ 75g सेविडॉल जमीन पर प्रयोग करने से अच्छी नियंत्रण पाई गई । वृद्धाचलम में अलकतार (डामर) तीन बार कूर्चन करने के साथ ताड के निचले जमीन पर लिंडेन की प्रयोग करने से प्रभावशाली नियंत्रण पाया गया। सुँडियों को निवारण की प्रयोग में सुँडियों को हाथ से निकाल कर ऊपर बताई गई अभिक्रिया की उपयोग फलदायक सिद्ध हुई । विरोधी जीव *मेटारैजियं अनैसोप्लिये* की उपचार प्रयोगों भुवनेश्वर, माडक्कतरा, वेंगुर्ले और वृद्धाचलम में जारी है ।

बीस से ज्यादा बाधक कीटों की जीवन परिस्थिति पर जाँच विभिन्न केंद्रों में की गई। विविध परियोजना केंद्रों में इन के ऊँची आबादी तथा मौसम की परिस्थिति के साथ तुलना की गई ।

महत्वपूर्ण कीटों के प्रतिरोधकता की जाँच में जनन द्रव्यों की परीक्षण जारी है । भुवनेश्वर में H1610, चिंतामणि में ट्री नं. 40 और उस के बाद H 1610, माडकृकतरा में H-8-8 और H 1598, वेंगुर्ले में वी-1 और वृद्धाचलम में M 23/2 x M26/1 चाय मच्छर की बाधा के पिंजरा प्रयोग में संयमनात्मक नियंत्रण का अभिलेख हुआ है ।

प्रौद्योगिकी का हस्तांतरण :

विभिन्न परियोजना केंद्रो में कुल 2,91,000 कलमों की उत्पादन किया गया । उस के साथ विभिन्न राज्यों में कुल 85 प्रदर्शनी क्षेत्र भी लगाए जा चुके है । परियोजना में वयस्थ वैज्ञानिकों द्वारा काजू उत्पादन तकनीकी कलमों के उत्पादन फसल प्रबंध और कीट नियंत्रण के बारे में उत्पादकों को जानकारी व प्रशिक्षण की आयोजन किए गए । विभिन्न सरकारी अधिकारियों को सुधारित रोपण एवं बागवानी तकनीकी की अलग प्रशिक्षण दिया गया । इस के अलावा आकाशवाणी/दूरदर्शन पर प्रस्तुत किए गए कार्यक्रमों में केंद्रों के वैज्ञानिक भाग लिए ।

COORDINATOR'S REPORT

The All India Coordinated Spices and Cashew nut Improvement Project (AICS & CIP) was started during the IV Five Year Plan in 1971 with its headquarters located at the Central Plantation Crops Research Institute, Kasaragod. During the VII Plan, the ongoing project (AICS & CIP) was bifurcated into two separate projects, one on Cashew and another on Spices. The headquarters of the independent All India Coordinated Research Project (AICRP) on Cashew was shifted to the newly established National Research Centre for Cashew, Puttur in 1986.

The AICRP on Cashew has presently eight centres and one sub-centre of which four were started at the inception of AICS & CIP in the year 1971 [Bapatla (ANGRAU the then APAU); Madakkathara (KAU, shifted from Anakkayam); Vengurle (KKV) and Vridhachalam (TNAU)]. During V Plan period, one centre at Bhubaneswar (OUAT) and in VI Plan, two centres, one at Jhargram (BCKVV) and another at Chintamani (UAS) were added. During VIII Plan, one centre at Jagdalpur (IGAU) and sub centre at Pilicode (KAU) were also started. These centres of AICRP on Cashew are located in eight cashew-growing states of the country and are under the administrative control of different State Agricultural Universities.

The budget allocation of the project for the year 1999-2000 was Rs. 66.67 lakhs (Rs. 50.00 lakhs ICAR Share) and the expenditure was Rs. 64.34 lakhs (Rs.47.51 lakhs ICAR Share).

The mandate of the project is to increase production and productivity through:

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

CROP IMPROVEMENT

The collection, conservation and evaluation of germplasm accession are under progress at various AICRP Centres of Cashew. The germplasm material conserved so far under different AICRP Centres amounts to 1099. Current years share accounts to 40. The existing germplasm accessions were evaluated for their performance. At Bapatla, T No. 277 performed well in early stages of vegetative growth. OC-14 with a yield of 4.1 kg/tree performed better at Bhubaneswar. The highest yield (21.91 kg/tree) was recorded for 2/6 ARSC, which had extended continuous mixed phase of flowering at Chintamani. At Jagdalpur, NRC-140 performed better than other accessions. At Jhargram, highest yield was obtained for JGM 74/6 (14.33 kg/tree). At Vridhachalam, among the old germplasm accessions, M 15/4 performed well and among the new accessions, M 89/2 performed better.

Under the varietal evaluation, three experiments are under progress at various centres of AICRP. Varieties from Bapatla and Vengurle are being evaluated in the

The bio-ecology of more than twenty important pests was recorded. Their occurrence and peak population periods were recorded along with the weather parameters at various AICRP Centres.

Screening of germplasm to locate tolerant/resistant types for major pests of the region was carried out. It was found that H 1610 at Bhubaneswar, T No.40 followed by H 1610 at Chintamani, H 8-8 and H 1598 at Madakkathara, V-1 at Vengurle and hybrid M 23/2 x M 26/1 at Vridhachalam were moderately resistant to TMB attack in caging trials.

TRANSFER OF TECHNOLOGY

More than 2,91,000 grafts were produced during the year at different AICRP centres. 85 demonstration plots are also being maintained at different States by the Centres. The Scientists from various centres were involved in training of farmers in Cashew Production Technology including production of grafts, cultivation practices and pest control methods. Various officials from the State Government Department of Agriculture/Horticulture as well as non-governmental organizations were also trained by the Scientists of the Centres regarding the improved cashew cultivation practices. The Scientists were also participated in AIR/TV programmes on cashew cultivation practices.

CENTRES OF ALL INDIA COORDINATED RESEARCH PROJECT ON CASHEW

◇ NATIONAL RESEARCH CENTRE FOR CASHEW, PUTTUR 574 202 - HEADQUARTERS OF AICRP ON CASHEW.

1. CASHEW RESEARCH STATION, (ANGRAU), BAPATLA 522 101, ANDHRA PRADESH.
2. CASHEW RESEARCH STATION, (OUAT), BHUBANESWAR 751 003, ORISSA.
3. AGRICULTURAL RESEARCH STATION, (UAS), CHINTAMANI 563 125, KARNATAKA.
4. ZONAL AGRICULTURAL RESEARCH STATION, (IGAU), JAGDALPUR 494 005, MADHYA PRADESH.
5. REGIONAL RESEARCH STATION, (BCKV), JHARGRAM 721 507, WEST BENGAL.
6. (a) CASHEW RESEARCH STATION, (KAU), MADAKKATHARA 680 656, KERALA.
   (b) REGIONAL AGRICULTURAL RESEARCH STATION, (KAU), PILICODE 671 353, KERALA.
7. REGIONAL FRUIT RESEARCH STATION, (KKV), VENGURLE 416 516, MAHARASHTRA.
8. REGIONAL RESEARCH STATION, (TNAU), VRIDHACHALAM 606 001, TAMILNADU.

GENERAL CHARACTERISTICS OF CENTRES OF AICRP ON CASHEW

The eight coordinating centres and one sub centre are spread in the East Coast, West Coast and Maidan tracts (plateau region) of the country. The centres in the East Coast are located at Bapatla, Bhubaneswar, Jhargram and Vridhachalam. This zone receives low to medium rainfall ranging from 800mm to 2000 mm annually and is distributed over a period of 7-8 months from June to January. The soil is mainly sandy, red sandy loam, red loam and laterite. The centres in the West Coast are located at Madakkathara, Pilicode and Vengurle. This zone receives rainfall ranging from 2800 mm to 3800 mm annually and is distributed over a period of 7-9 months from April/ June to December. The soil is typically sandy, sandy loam, sandy clay loam and laterite (Oxisol). Maidan tract is characterised by even land. The coordinating centres Chintamani and Jagdalpur fall in this region.

EXPERIMENTAL RESULTS

I. CROP IMPROVEMENT

Gen. 1: Germplasm collection, maintenance and description of types.

Centres:

East Coast: Bapatla, Bhubaneswar, Jhargram, and Vridhachalam
West Coast: Madakkathara, Pilicode, and Vengurle
Maidan tracts/ others: Chintamani and Jagdalpur

The objectives of the project are:

(a) To evaluate the existing germplasm of cashew in different centres.

(b) To collect local germplasm materials with desirable characters such as high yiel cluster bearing habit, bold sized nuts, short duration of flowering, off season flowerir types etc. from different cashew growing regions, and

(c) To establish clonal germplasm conservation blocks in different centres.

1.Germplasm collection and conservation:

A total of 1059 accessions have been conserved and is being maintained in different centers. During the year 1999, 40 collections were made by different centers, of which 34 have already been planted (Table 1.1). The details of source collection, number of collections and salie features of collections are presented Table 1.2.

Table 1.1: Cashew germplasm holding in different centres.

Centre	No. of accessions		
	Existing	Collected during1999	Total
East Coast			
Bapatla	127	1	128
Bhubaneswar	88	5	93
Jhargram	118	--	118
Vridhachalam	261	8	269
West Coast			
Madakkathara	127	--	127
Pilicode	64	6*	70
Vengurle	161	3	164
Maidan tract/others			
Chintamani	103	17	120
Jagdalpur	10	--	10
Total	1059	40	1099

* Clones to be planted.

Table 1.2: Cashew germplasm collected during 1999 by different centres.

Centre	Source of collection	No. of collections	Salient features
Bapatla (East Godavari)	Tetagunta	One	High yielding accession
Bhubaneswar	Konark	One	Cluster bearing and high yielding
	Jariput	Four	-do-
Chintamani	Chikkadasarahalli	Eight	High yielding clones
	Narayanadasarahalli	Four	-do-
	Hebbari	Four	-do-
	Niltur	One	-do-
Pilicode	Padimaruth, Kasaragod	Four	Two bold nut types, mid-season flowering and one medium nut size, early bearing and one small nut, mid-season flowering type.
	Karalam	One	Bold nut, non-cluster bearing, and late season.
	Cheemeni	One	Medium nut, cluster bearing and late season flowering type
Vengurle	Vetore, Vengurle	One	Bold nut type
	NRCC Puttur	Two	Germplasm accessions
Vridhachalam	Southern Tamil Nadu	Six	High yielding types
	Northern Tamil Nadu	Two	High yielding types
Total		Forty	

2. Germplasm evaluation:

Evaluation of cashew germplasm at different centres has been carried out during the year 1999. The promising accessions in different centres are presented in Table 1.3 - 1.8.

BAPATLA

During the year the plant height, girth and the canopy spread were recorded. The germplasm accession T.No.71 has recorded highest plant girth of 22.5 cm followed by 5/1 with girth of 21.8 cm. Highest canopy spread was observed in accession 277 with 217 cm (E-W) and 190 cm (N-S). The performance of promising accessions is presented in Table 1.3.

Table 1.3: Performance of promising germplasm accessions at Bapatla.

No	Accession	Height (cm)	Girth (cm)	Canopy Spread (cm)	
				E-W	N-S
1.	T No.40	115	18.3	145	166
2.	3/4	117	19.0	180	150.5
3.	4/3	156	18.0	181	203
4.	4/5	126	18.6	191	185
5.	228	138	20.0	180	200
6.	233	133	18.0	166	186
7.	268	140	18.6	181	76
8.	BLA 139/1	133	19.6	193	200
9.	BLA 39/4	144	18.6	198	174
10.	ABT-1	153	18.3	166	166
11.	5/1	180	21.8	186	190
12.	2/3	151	21.6	181	176
13.	10/2	180	21.5	181	188
14.	T.No.71	160	22.5	168	177
15.	277	177	20.7	217	190
16.	6/20	148	18.0	2.4	2.2

BHUBANESWAR

At Bhubaneswar, the maximum yield was recorded in OC - 14 with a yield of 4.10 kg/tree followed by OC-6 with 3.66 kg/tree. The yield recorded for promising germplasm accessions is presented in Table 1.4.

CHINTAMANI

At Chintamani, the yield and yield characteristics were recorded during evaluation of germplasm accessions during the year. The highest yield (21.91 kg/tree) was reported for 2/6 ARSC (3/108 Gubbi) followed by 44/5 ARSC (V-5) with a yield of 10.5 kg/tree. The highest nut weight was observed in 41/3 ARSC and maximum shelling percentage was also seen in the same germplasm accession. The data on promising germplasm accessions are presented in Table 1.5.

The flowering behaviour of promising germplasm accessions was studied. The accessions ARSC 2/6 exhibited a continuous mixed phase of one month during March followed by predominant male phase. In Chantamani-1 mixed phase was also about one month duration but interspersed with male phase in between. In other accessions also similar trend of mixed phase was observed.

JAGDALPUR

At Jagdalpur, highest yield was recorded for NRC-140 (400 g/tree). However, the plant girth (37.3 cm), canopy spread (2.7x2.4 M) and plant height (2.0 M) were more in NRC-138. The performance of germplasm at Jagdalpur Centre is presented in Table 1.6.

Table 1.4: Performance of promising germplasm accessions at Bhubaneswar.

Accession Number	Nut Weight (g)	Yield kg/tree	Cumulative Yield	Shelling (%)
OC-1	6.7	1.78	7.120	32
OC-2	6.2	2.75	6.240	33
OC-3	6.5	2.87	8.620	30
OC-4	4.5	1.91	6.390	22
OC-6	6.9	3.66	8.630	27
OC-7	5.5	1.73	5.750	33
OC-10	4.5	1.10	2.280	30
OC-12	5.7	1.80	5.340	33
OC-14	5.3	4.10	5.060	34
OC-18	5.3	1.74	3.800	33
OC-21	7.2	1.93	3.670	32
OC-22	6.6	2.93	8.370	33
OC-24	5.5	1.11	5.520	34
OC-31	4.7	2.44	9.030	33
OC-38	7.3	2.94	4.710	31
OC-43	5.9	1.00	4.040	31
OC-45	6.0	1.10	2.770	33
OC-53	7.8	1.33	2.270	30
OC-55	6.8	1.15	1.170	25
OC-63	4.0	1.73	1.740	25
OC-66	7.5	1.14	1.360	26
OC-83	7.8	3.30	3.700	25

Table 1.5: Performance of promising germplasm accessions at Chintamani.

Accession Number	Year of Planting	Cumulative Yield (kg/tree)	Yield (kg/tree)	Mean Yield (kg/tree)	Nut Wt. (g)	Shelling %
2/6 ARSC (3/108 Gubbi)	1982	141.60 (15 Yrs)	21.91	9.44	4.10	28.0
39/6 ARSC (1/40 Ullal)	1985	87.39 (10 Yrs)	6.30	8.74	5.90	28.1
41/3 ARSC (5/37 Manjeri)	1985	116.59 (11 Yrs)	7.00	10.60	7.18	29.5
44/1 ARSC (Vengurla-5)	1985	118.43 (11 Yrs)	10.20	10.76	4.08	27.4
44/5 ARSC (Vengurla-5)	1985	102.90 (11 Yrs)	10.50	9.35	4.08	27.4

Table 1.6: Performance of germplasm accessions at Jagdalpur.

Accession No.	Height (m)	Girth (cm)	Canopy Spread (m)		No. of primary branches	No. of flowering panicles	Flowering period	Yield (g/tree)	Nut Wt. (g)
			N-S	E-W					
NRC-130	1.4	29.6	2.1	2.1	3.0	37.0	Mid	267.5	5.25
NRC-131	1.4	26.5	1.5	1.6	3.1	17.6	Mid	210.4	4.10
NRC-136	1.4	23.1	1.4	1.2	2.7	23.6	Late	262.5	4.70
NRC-137	1.7	29.8	1.9	2.0	3.1	17.9	Late	395.5	4.80
NRC-138	2.0	37.3	2.7	2.4	3.5	17.8	Early	342.0	4.70
NRC-140	1.3	26.1	1.7	1.7	3.6	17.2	Early	400.0	4.30
NRC-190	1.2	23.5	1.3	1.5	2.8	22.4	Mid	70.0	4.00
NRC-191	1.5	29.7	2.6	2.2	3.7	28.6	Mid	107.5	3.20
NRC-192	1.8	28.7	2.3	2.3	3.7	21.9	Mid	75.0	3.00
NRC-193	1.2	23.4	1.6	1.5	3.3	20.6	Early	340.0	4.80

JHARGRAM

At Jhargram, the evaluation of germplasm accessions indicated highest yield for JGM 74/6 (14.33 kg/tree) followed by JGM 66/7 (13.73/kg). The cumulative yield was highest for JGM 74/6 (105.23 kg/tree) for a period of 12 years. The shelling percentage was however high (33.3%) for JGM 16/1. The performance of promising germplasm accessions is presented in Table 1.7.

Table 1.7: Performance of promising germplasm accessions at Jhargram.

Accession No.	Year of Planting	Cumulative yield (kg/tree) for 12 years	Yield (kg/tree)	Nut Wt. (g)	Shelling %
JGM 1/4	1983	77.27	11.93	5.7	31.3
JGM 10/3	1983	62.43	9.69	4.9	33.2
JGM 11	1983	55.14	9.46	5.8	32.0
JGM 16/1	1983	89.30	12.46	5.5	33.3
JGM 17/1	1983	81.68	12.83	5.6	31.2
JGM 19/1	1984	84.08	10.66	5.1	30.5
JGM 20/6	1983	82.00	10.46	5.3	32.6
JGM 29/8	1984	71.01	10.23	6.1	39.2
JGM 31/1	1984	73.89	11.76	6.5	30.6
JGM 48/4	1985	82.46	10.13	5.2	32.3
JGM 58/12	1985	72.71	13.22	6.2	30.6
JGM 66/7	1983	98.37	13.73	5.0	29.6
JGM 74/6	1983	105.23	14.33	5.9	29.3
JGM 79/5	1984	85.35	8.96	5.3	32.2
JGM 80/2	1984	102.51	13.33	4.8	33.0

VRIDHACHALAM

At Vridhachalam, among the old germplasm collections the highest yield was obtained for M 15/4 (2.08 kg/tree). Among the new germplasm highest yield was seen in M 89/2 (1.69 kg/tree) followed by M 84/2 (1.525 kg/tree). The performance of germplasm accessions is presented in Table 1.8.

Table 1.8: Performance of promising germplasm accessions at Vridhachalam.

Accession No.	Year of Planting	Canopy Spread		Flowering habit	Apple Wt. (g)	Nut Wt. (g)	Yield kg/tree	Shelling %
		N-S	E-W					
OLD GERMPLASM								
M 4/3	1989					4.6	0.60	25.6
M 26/4	1989					5.7	0.95	27.0
M 15/4	1989					5.8	2.08	29.5
NEW GERMPLASM								
M 69/4	1994	2.5	2.6	Mid	40	5.9	1.25	27.1
M 70/1	1994	2.8	3.9	Mid	45	6.6	1.00	27.3
M 79/4	1994	4.3	2.6	Mid	30	5.9	1.57	23.7
M 24/4	1994	4.7	4.9	Mid	20	3.7	1.10	27.0
M 84/2	1994	3.8	4.6	Mid	40	4.6	1.53	26.1
M 89/2	1994	3.9	4.6	Late	15	3.4	1.69	26.4

Gen.3: Varietal evaluation

Expt.1: Comparative yield trial (CYT)

Centre:

Chintamani

The Objective is to evaluate the performance of varieties of Bapatla and Vengurle centres.

Experimental details:

Design	:	RBD
Replication	:	Three
Varieties:		
Bapatla	:	BPP-1, BPP-3, BPP-4, BPP-5, BPP-6
Vengurle	:	V-1, V-2, V-3, V-4, and V-5

The trial was started during 1986 and the data on plant growth, yield and nut parameters are furnished in the Table 1.9. Vengurla-3 recorded highest plant height (6.51 m) and stem girth (100.6 cm). The nut yield was highest in Vengurla-5 (6.03 kg/tree) and the cumulative yield was also high in the same variety (49.4 kg/tree) following by Bapatla-3 (39.1 kg/tree). The highest nut weight (6.11g) was recorded for Vengurla-4. The shelling percentage was high in Vengurla-4 and Vengurla-1 (29.5% and 28.5% respectively).

Table 1.9: Growth and yield performance of varieties under Comparative Yield Trial at Chintamani.

Variety	Height (m)	Girth (cm)	Canopy shape	Yield kg/tree 1999	Cum. yield for 10 years	Flowering period	Nut wt. (g)	Shelling (%)
Vengurla-1	5.98	92.2	Compact	1.28	26.30	Medium	5.77	28.5
Vergurla-2	5.73	83.8	Medium	0.64	30.80	Long	4.62	27.9
Vengurla-3	6.51	100.6	Sparse	2.37	35.00	Medium	5.91	25.1
Vengurla-4	4.91	79.1	Sparse	1.20	23.60	Medium	6.11	29.5
Vengurla-5	5.82	86.9	Compact	6.03	49.40	Medium	4.42	24.9
Bapatla-1	5.83	79.5	Compact	1.41	23.20	Medium	4.90	28.1
Bapatla-3	5.73	88.5	Medium	3.16	39.10	Medium	4.95	27.7
Bapatla-4	6.33	94.4	Medium	1.42	23.20	Long	4.91	27.7
Bapatla-5	5.54	84.1	Compact	0.91	24.80	Medium	5.27	27.6
Bapatla-6	5.87	98.6	Compact	3.04	30.40	Medium	5.73	27.8
SEM±	0.27	3.96		0.98	2.69			
CD at 5%	0.78	11.73		2.89	7.96			

Expt. 2: Multilocation trial-86 with varieties from Vittal, Vridhachalam, Vengurle, Bapatla and Madakkathara (MLT 86).

Centres

East Coast: Bhubaneswar and Jhargram
West Coast: Madakkathara
Maidan tract: Chintamani

The objectives are to evaluate performance of high yielding varieties in different locations.

Experimental details:

Design	:	RBD
Replication	:	Three
Varieties	:	No. of entries: 19
Bapatla entries	:	T.No.40, T.No.129, H 2/15, H 2/16
Vengurle entries	:	V-2, V-3, V-4, V-5 (H-24), M 44/3 (VRI-2)
Vridhachalam entries	:	M 26/2, M 33/3, M 44/3 (VRI-2)
Vittal entries	:	VTH 30/4, VTH 59/2, M 44/3 (VRI-2)
Madakkathara entries	:	H 1598 (Kanaka), H 1600, H 1608 (Dhana), H 1610
Year of planting	:	1986

BHUBANESWAR

At Bhubaneswar, maximum of flowering panicles was found in BPT-40 (31) whereas the number of nuts per panicle was high in M 26/2. Highest yield was obtained for H 2/16 (14.23 kg/tree) and the cumulative yield was highest in the same variety after 8 harvests (67.83 kg/tree). Highest apple weight was found in VTH 30/4 (100.1 g). Shelling percentage was above 30% in varieties H 1598, T 129, BPT 40, M 44/3, M 26/2, VTH 44/3, VTH 59/2, Vengurla-2 and Vengurla-4 (Table 1.10). However, the experimental plot was damaged during the super cyclone on 29th October 1999.

CHINTAMANI

The trial was started in 1986 with 19 varieties. During the year the yield was significantly high in H 1600 (5.91 kg/tree) compared to the next highest M 44/3 (4.93 kg/tree). The cumulative yield was highest in M 44/3 for ten harvests (44.23 kg/tree). Shelling percentage was also high in the same variety (30.5%) whereas the nut weight was highest in H 1608 (7.99 g) followed by Vengurla-3 (7.94 g). The data is presented in Table 1.11.

Table 1.10 Performance of varieties under MLT 86 at Bhubaneswar.

Variety	Flowering Period	Yield (kg/tree) 9th harvest	Cum. yield (kg/tree) 9 harvests	No. of fruits/ panicle	Nut Wt. (g)	Shelling %
H 1598	Mid-season	10.88	39.28	5.30	6.20	30.6
H 1600	Late	6.47	30.02	4.50	7.20	27.1
H 1608	Mid-season	8.10	50.45	3.30	9.15	24.6
H 1610	Late	2.99	23.09	3.40	9.06	27.9
T 129	Late	2.92	18.92	2.30	6.45	30.2
BPT 40	Early	5.27	30.17	5.40	5.90	34.7
H 2/15	Early	5.68	26.88	2.60	8.30	30.3
H 2/16	Early	14.23	67.83	6.50	8.60	29.0
M 44/3	Early	4.95	19.65	5.70	5.10	32.0
M 26/2	Early	7.86	30.15	6.70	5.25	30.5
VTH 44/3	Early	5.45	19.0	4.70	5.25	32.7
VTH 30/4	Late	5.80	27.20	1.70	8.15	29.0
VTH 59/2	Late	7.12	23.72	4.70	7.15	32.9
V-2	Mid-season	8.06	34.51	5.50	5.50	33.6
V-3	Mid-season	10.00	34.10	4.20	8.85	27.7
V-4	Mid-season	8.12	37.77	3.90	8.76	28.2
CD 5%		2.69				

JHARGRAM

Plant growth was maximum in VTH 30/4, which recorded 6.26 m height and 94.65 cm girth. Highest nut yield per tree was recorded in H 2/16 (8.63 kg). The growth parameters and yield performances are presented in Table 1.12.

MADAKATHARA

Maximum height and girth were observed in H 1610 (9.35 m, 138.1 cm respectively). Highest canopy spread was observed in V-3 (12.48 m followed by H 1610 (12.37 m). However, highest yield was obtained for V-5 (12.56 kg/tree) followed by V-3 (12.13 kg/tree). The growth and yield performance of different varities is presented in Table 1.13.

Table 1.11: Performance of varieties under MLT 86 at Chintamani

Variety	Height (m)	Girth (cm)	Canopy Shape	Yield (kg/tree) 9th Harvest	Cum. yield (kg/tree) for 9 harvests	Nut Wt. (g)	Shelling %
H 1598	4.57	76.62	Medium	2.51	27.12	5.27	24.7
H 1600	4.71	85.10	Compact	5.91	32.72	6.33	28.1
H 1608	4.61	80.02	Medium	4.01	35.11	7.99	28.4
H 1610	4.87	91.15	Medium	2.37	32.72	7.38	28.0
TN 129	4.80	83.68	Medium	3.57	27.17	5.22	28.3
TN 40	4.56	82.75	Compact	3.14	24.27	4.65	29.6
H 2/15	4.33	70.90	Compact	3.46	27.66	6.97	27.7
H 2/16	4.70	78.67	Sparse	2.84	24.88	7.32	24.6
V-2	4.12	64.38	Sparse	3.17	24.94	4.33	29.5
V-3	4.51	85.38	Sparse	1.60	27.24	7.94	28.0
V-4	4.73	82.63	Sparse	3.17	26.98	6.15	27.1
H 24	4.58	76.67	Compact	4.28	32.82	4.30	28.0
M 44/3 (Vengurla)	4.23	67.05	Compact	1.36	18.71	4.91	28.7
M 44/3 (VRI)	4.30	72.20	Compact	4.93	44.23	4.34	28.8
M 44/3 (VTH 12)	4.54	68.03	Compact	3.09	26.69	5.07	30.5
M 30/4 (VTH 30)	4.50	71.33	Medium	3.09	26.69	5.07	30.5
M 59/2 (VTH 59)	4.80	80.14	Sparse	2.44	27.59	4.63	30.1
SE m±	0.18	4.05		0.73	2.99		
CD 5%	NS	11.64		2.10	8.58		

Table 1.12: Performance of varieties under MLT 86 at Jhargram

Variety	Height (m)	Girth (cm)	Canopy Shape	Yield (kg/tree) 9th harvest
VTH 30/4	6.26	94.6	Compact	5.96
VTH 59/2	4.63	74.8	Medium	6.59
H 2/15	5.36	72.1	Compact	5.76
H 2/16	5.15	81.7	Medium	8.63
TN 40	5.33	74.4	Compact	5.33
TN 129	85.56	66.3	Medium	5.01
H 1608	4.76	74.4	Compact	3.76
H 1598	4.33	69.8	Medium	4.83
H 1600	3.56	56.3	Medium	4.86
H 1610	5.63	94.3	Medium	4.53
M 26/2	3.13	62.5	Sparse	4.33
M 33/3	4.96	63.4	Medium	6.13
M 44/3	3.83	54.2	Semi-dwarf	4.26
CD at 5%	0.75	0.46		0.28

Table 1.13: Performance of varieties under MLT 86 at Madakkathara.

Variety	Height (m)	Girth (cm)	Canopy Spread (m)	Yield (kg/tree) 9th harvest	Cum. yield (kg/tree) for 9 harvests
H 1598	8.51	105.9	10.84	8.04	85.12
H 1600	7.68	103.7	11.18	3.32	64.44
H 1608	6.94	95.3	9.99	5.83	70.45
H 1610	9.35	138.1	12.37	2.29	36.42
T 30/4	7.73	99.5	10.44	11.51	70.65
T 59/2	7.63	99.66	10.43	3.46	42.93
T 129	7.84	102.5	11.26	8.28	38.25
T 40	7.70	92.35	9.87	4.39	38.64
H 2/15	7.37	88.96	10.04	5.83	50.59
H 2/16	7.52	95.83	11.59	6.27	42.99
V-2	7.59	73.2	8.53	0.90	30.42
V-3	9.13	112.8	12.48	12.13	68.84
V-4	8.32	91.33	10.37	7.71	60.84
V-5	7.49	95.91	10.83	12.56	85.42
M 33/3	7.36	87.60	9.81	4.05	56.56
M 44/3	6.69	73.41	8.93	8.37	80.99
M 26/2	7.45	97.63	9.64	5.71	85.77
AKM-1	6.64	82.0	9.01	5.04	68.22
SEm±	0.4	4.81	0.47	1.14	
CD	0.81	9.83	0.95	2.32	

Expt. 3: Multilocation trial-92 with varieties from Bapatla, Vengurle, Vridhachalam, and NRC Cashew, Puttur (MLT-92).

Centres:

East Coast: Bapatla, Bhubaneswar, Jhargram and Vridhachalam
West Coast: Madakkathara and Vengurle
Maidan tracts: Chintamani and Jagdalpur

The objectives of the experiment are to evaluate the performance of new high yielding varieties in different locations.

Experimental details:

Design	:	RBD
Replication	:	Three
Varieties	:	No. of entries - 13
Bapatla entries	:	3/28, 3/33, 10/19, 30/1
Vengurle entries	:	H 68, H 255, H 303, H 320, H 367
Vridhachalam entries	:	M 15/4, M 44/3
Puttur entries	:	VTH 107/3, VTH 40/1
Year of planting	:	1992

BAPATLA

During the year maximum plant height, girth, canopy spread and yield were recorded in T.NO. 10/19 (3.77 m, 52.93 cm, 5.59 m-EW, 5.48 m-NS, 6.33 kg/tree respectively). The flowering intensity was more in M 44/3, 3/28, 107/3 and 367. However nut weight was maximum for Hy 320 (7.4g). The data on growth, flowering characteristics and yield are presented in Table 1.14.

BHUBANESWAR

Maximum number of flowering panicles was recorded in M 44/3 (27). However, maximum yield and cumulative yield were obtained for BPP 30/1 (5.69 kg/tree, 15.63kg respectively) followed by H 303 (5.4 kg/tree, 15.80 kg). Maximum shelling percentage was found in M 44/3 (32.65%). The data is presented in the Table 1.15.

CHINTAMANI

NRCC-1 has recorded maximum plant height and stem girth (4.4m, 69.47 cm respectively). However, NRCC-2 has recorded highest yield as well as cumulative yield for five years (4.28 kg/tree, 13/88 kg/tree respectively). Highest nut weight was observed in Hy 255 (8.27 gm) and highest shelling percentage was recorded in NRCC-1 (30.7%). The data on growth and yield characteristics of varieties under MLT-92 is presented under Table 1.16.

JAGDALPUR

Maximum plant height (2.6 m), stem girth (46.7 cm) and yield (1.24 kg/tree) were observed in H 303. Canopy spread was maximum in H 367. Maximum number of flowering panicles was observed in 30/1 (26.4). The data on flowering and yield characteristics is presented in Table 1.17.

Table 1.14: Performance of varieties under MLT 92 at Bapatla

Variety	Height (m)	Girth (cm)	Canopy Spread (m)		Yield (kg/tree)	Cum. yield (kg/tree) No. of harvest	Flowering period	No. of fruits/ panicle	Nut Wt (g)	Shelling (%)
			EW	NS						
3/28	3.32	42.83	4.40	4.44	4.393	7.046	Mid	3.6	6.4	25
3/33	3.18	42.90	4.44	4.53	3.187	5.465	Mid	4.4	5.0	25
10/19	3.77	52.93	5.59	5.48	6.33	9.665	Mid	8.0	7.0	24
30/1	3.37	45.23	4.28	4.33	4.407	7.329	Early	4.6	5.5	27
Hy 68	3.07	42.1	3.83	4.22	2.700	4.030	Mid	3.2	5.8	24
Hy 367	3.02	38.4	4.45	4.37	2.79	4.668	Mid	4.6	6.4	24
H 303	3.22	41.5	3.89	3.92	2.507	4.417	Early	3.6	6.8	25
Hy 255	2.68	37.7	3.66	3.93	1.770	2.268	Mid	2.6	6.2	25
Hy 320	2.89	40.5	4.00	4.31	2.517	4.010	Mid	3.4	7.4	26
M 44/3	3.03	47.2	4.85	4.46	5.513	9.713	Early	6.4	4.4	27
M 15/4	3.41	49.2	4.92	4.63	5.580	9.960	Early	12.5	6.4	26
107/3	3.07	39.9	4.66	3.85	3.330	5.337	Mid	4.0	5.5	25
40/1	3.33	41.3	4.30	4.45	3.740	5.821	Early	4.4	5.0	25
CD 5%	0.284	7.81	0.84	0.863	0.76			0.89	1.2	
SEm±	0.137	3.78	0.41	0.42	0.368			0.43	0.58	

JHARGRAM

Maximum plant height (3.86 m) and girth (44.4 cm) were noticed in H 255. Least height was observed in M 44/3 (2.05 m). The data on growth characteristics of different varieties is presented in Table 1.18.

Table 1.15: Flowering and yield characteristics of different varieties under MLT - 92 at Bhubaneswar.

Variety	Flowering period	Yield (kg/tree)	Cum. yield (kg/tree) 4th harvest	No. of fruits/ panicle	Nut Wt (g)	Shelling %
NRCC-1	Late	2.85	5.43	2.0	6.97	35.8
NRCC-2	Mid-season	3.95	9.57	3.7	8.63	32.5
M 44/3	Early	2.05	7.67	5.3	5.80	33.3
M 15/4	Mid-season	2.73	8.74	4.0	6.27	32.3
BPP 3/33	Mid-season	4.04	10.11	2.8	5.80	32.8
BPP 10/19	Mid-season	3.57	8.66	3.3	5.97	33.3
BPP 30/1	Early	5.69	16.15	6.0	5.93	30.0
BPP 3/28	Early	4.71	10.61	4.5	7.28	30.6
H 303	Early	5.40	15.80	4.5	8.63	33.8
H 320	Early	4.46	15.63	3.1	7.74	30.0
H 255	Late	1.83	10.33	2.5	9.21	34.0
H 367	Mid-season	1.42	7.94	2.4	10.23	30.0
H 68	Mid-season	3.22	9.60	5.3	8.16	30.0
SEm±		0.36				
CD 5%		1.04				

Table 1.16: Flowering and yield characteristics of different varieties under MLT - 92 at Chintamani.

Variety	Height (m)	Girth (cm)	Canopy Shape	Yield (kg/tree)	Cum. yield (kg/tree) 5th harvest	Nut Wt (g)	Shelling %
Hy 68	4.05	67.58	Compact	22.59	6.29	7.51	25.2
Hy 367	3.66	60.77	Medium	1.46	4.96	7.96	29.6
Hy 302	3.70	71.83	Medium	2.04	9.52	7.34	27.7
Hy 255	4.12	65.38	Medium	1.45	3.69	8.27	29.8
Hy 320	4.30	62.28	Medium	3.22	7.45	7.98	27.8
M 44/3	2.99	47.91	Compact	3.05	8.94	5.01	28.6
M 15/4	3.68	63.44	Compact	1.72	5.26	5.87	28.5
NRCC-1	4.40	69.47	Compact	3.11	7.10	6.64	30.7
NRCC-2	3.39	52.64	Sparse	4.28	13.88	5.33	27.0
T 30/1	3.33	54.23	Compact	2.58	6.25	4.69	29.0
T 3/33	4.01	64.47	Compact	2.92	5.46	6.25	27.4
T 10/19	3.78	62.20	Compact	0.76	1.98	4.81	30.0
T 3/28	4.21	63.58	Compact	3.17	8.08	6.56	28.2
Ullal-1	4.05	67.34	Medium	2.87	5.41	6.06	29.3
SEm±	0.17	3.93		0.72	1.36		
CD 5%	0.48	11.39		NS	3.94		

Table 1.17: Flowering and yield characteristics of different varieties under MLT - 92 at Jagdalpur

Variety	Height (m)	Girth (cm)	Canopy Shape		Yield (kg/tree)	Flowering period	Nut Wt (g)
			NS	EW			
3/28	1.8	32.9	2.9	3.1	0.126	Late	3.7
3/33	1.1	15.3	1.5	1.6			
10/19	1.0	13.7	1.5	1.8			
30/1	2.1	33.0	3.3	2.9	0.247	Mid	4.4
M 15/4	2.4	37.1	3.3	3.3	0.403	Early	4.8
M 44/3	2.2	40.7	3.4	3.4	0.575	Late	5.2
NRCC-1	2.4	38.6	3.8	3.8	0.245	Early	4.2
NRCC-2	2.4	38.0	3.6	3.8	0.540	Early	5.5
H 68	2.4	45.0	3.7	2.4	0.806	Late	6.0
H 303	2.6	46.7	3.5	3.5	1.240	Late	5.0
H 367	2.3	44.5	4.9	4.4	0.900	Late	5.8

Table 1.18: Growth performance of different varieties under MLT-92 at Jhargram.

Varieties	Height (m)	Girth (cm)
T 30/1	2.56	25.6
T 3/33	2.83	29.4
H 303	2.73	36.4
H 255	3.86	44.4
H 320	3.53	35.3
M 44/3	2.05	21.2
NRCC-2	2.33	26.2

MADAKKATHARA

Maximum tree height was observed in 107/3 (5.04 m), maximum girth was also recorded in the same variety (59.22 cm). Highest canopy spread was observed in M 15/4 (5.87 m). Minimum plant height was observed in M 44/3 (3.73 m). Highest yield was obtained from M 15/4 (1.3 kg/tree). The data on growth and yield characteristics is presented in Table 1.19.

VENGURLE

Maximum tree height was observed in H 303 (116.66 cm). M 15/4 has recorded minimum tree height (78.33 cm). Maximum girth was recorded in H 367 (13.33 cm). The vegetative growth data presented in Table 1.20.

Table 1.19: Growth and yield characteristics of different varieties under MLT - 92 at Madakkathara.

Variety	Height (m)	Girth (cm)	Canopy spread (m)	Yield (kg/tree)
T 30/1	4.61	54.17	4.87	0.32
T 3/33	4.94	50.64	5.20	-
T 10/19	4.60	45.77	4.39	0.32
T 3/28	4.41	49.99	5.25	--
H 68	4.41	46.27	4.28	--
H 367	4.04	43.75	4.56	0.32
H 303	4.79	41.15	3.21	0.17
H 255	4.92	52.25	5.42	--
H 320	3.88	46.00	4.53	0.52
M 44/3	3.73	42.25	5.41	0.61
M 15/4	4.50	47.42	5.87	1.30
NRCC-1	5.04	59.22	4.67	--
NRCC-2	4.13	47.00	4.76	0.13
Dhana	4.49	54.50	5.20	--
SEm±	0.15	1.22	0.11	0.09
CD	0.30	2.50	0.23	0.18

Table 1.20: The growth parameters of different varieties under MLT-92 at Vengurle.

Variety	Height (cm)	Girth (cm)
H 255	71.66	10.16
H 303	116.66	12.0
H 320	81.66	10.33
H 367	96.66	13.33
T 30/1	83.33	10.33
T 3/33	96.66	9.10
T 10/19	76.66	10.16
T 3/28	83.33	9.66
M 44/3	85.00	11.00
M 15/4	78.33	9.33
NRCC-1	115.00	10.66
NRCC-2	83.33	9.33

VRIDHACHALAM

Maximum plant height was observed in T 10/19 (3.59m) and minimum height was observed in H 255 (2.03 m). Highest plant girth was observed in NRCC-1. However, highest yield was observed obtained in M 44/3 (1.156 kg/tree and cumulative yield (4.656 kg/tree). No varieties have recorded a shelling outturn of more than 30%. However, maximum shelling percentage (29.5%) was observed in NRCC-1. The growth and yield data are presented in Table 1.21.

Table 1.21: Performance of different varieties under MLT 92 at Vridhachalam

Variety	Height (m)	Girth (cm)	Canopy Spread (m)		Yield (kg/tree)	Cum. yield (kg/tree) No. of harvest	Flowering period	No. of fruits/ panicle	Nut Wt (g)	Shelling %
			EW	NS						
T 30/1	2.54	27.6	4.6	4.2	0.485	1.655	Early	5	7.6	22.6
T 3/33	3.00	32.8	4.7	4.4	0.585	2.085	Late	3	7.7	21.9
T 10/19	3.59	39.4	5.5	5.7	0.411	1.161	Mid	6	3.9	25.6
T 3/28	2.62	32.2	5.2	5.7	0.912	1.912	Late	4	5.4	27.7
H 68	2.69	29.2	6.0	5.7	1.017	2.517	Late	3	5.9	22.0
H 367	2.89	40.3	4.6	5.3	0.626	2.455	Mid	3	8.0	24.7
H 303	3.09	39.6	5.0	4.9	0.882	2.582	Late	3	6.6	24.2
H 255	2.03	23.2	5.4	5.6	0.312	1.812	Mid	2	6.3	25.4
H 320	3.37	39.8	5.8	5.3	0.945	2.175	Mid	3	6.3	22.2
M 44/3	2.64	29.3	4.4	5.0	1.156	4.656	Early	7	6.5	24.0
M 15/4	3.35	45.4	5.3	6.7	1.128	4.098	Early	6	6.4	25.1
NRCC-1	3.41	54.4	5.5	5.1	1.049	1.049	Late	3	6.1	29.5
NRCC-2	3.12	34.3	4.3	4.3	1.000	3.630	Mid	3	7.1	25.0

Gen. 4: Hybridisation and selection.

Centres:

East Coast: Bapatla, Bhubaneswar, Jhargram and Vridhachalam
West Coast: Madakkathara and Vengurle
Maidan tract: Chintamani

The objectives of this experiment is to utilise the high yielding genotypes selected from germplasm for crossing with other genotypes having desirable traits like bold nuts, cluster bearing habit, compact canopy, short flowering period, late synchronised flowering types and high shelling percentage.

BAPATLA

At Balatpa, crossing programme was carried out in Feb - Mar. 1999. A total of 177 hybrids nuts were obtained, out of which 140 have been germinated in the nursery and field planted. Only 130 have established in the field.

The F1 seedlings of previous years have been multiplied clonally and planted in the field for further evaluation.

BHUBANESWAR

At Bhubaneswar, six different cross combinations were made and 107 hybrid nuts were obtained. The maximum success under crossing was observed for Bhubanheswar-1 x VTH 711/4 (5.37%) followed by H 2/16 x M 44/3 (4.1%). The hybrid seedling obtained has been planted in the field for further evaluation.

The F1 progeny planted during1995 started yielding and the data on yield is presented in Table 1.22. The highest yield was obtained for Bhubaneswar - 1 x Kankadi (2.2 kg/tree). The same hybrid has recorded maximum shelling percentage also (31.0).

CHINTAMANI

During the year five different crosses were made and 54 nuts were obtained. These seed nuts were planted in the field at close spacing to collect scions for further evaluation. The details of crossing are furnished in Table 1.23.

Table 1.22: Performance of hybrids at Bhubaneswar.

Cross combinations	Hybrid No.	Yield kg/tree	Cumulative yield (kg/tree) 2 harvests	Apple Wt. (g)	Nut Wt. (g)	Shelling %
Bhubaneswar-1 x Kankadi	1	0.950	1.550	58	8.6	31.0
Bhubaneswar-1 x Kankadi	6	2.100	3.600	71	8.0	30.6
Bhubaneswar-1 x Kankadi	9	1.300	1.950	67	6.7	31.0
Bhubaneswar-1 x Kankadi	14	2.200	2.200	78	9.5	30.3
Bhubaneswar-1 x VTH 711/4	4	1.250	1.750	70	10.6	30.5
Bhubaneswar-1 x VTH 711/4	5	1.300	1.300	55	11.5	28.6
Bhubaneswar-1 x VTH 711/4	7	1.750	1.750	65	11.5	30.5
Bhubaneswar ClusterxVTH 711/4	11	0.750	0.750	62	9.5	29.5

Table 1.23 : Details of hybridization experiment carried out at Chintamani.

Cross combination	Flowers pollinated	Seeds obtained	F1 Planted
Gubbi 3/108 x Vetore 56	300	18	18
Chintamani 1 x Vetore-56	250	14	12
Vengurla 5 x Vetore-56	150	10	7
ME 4/4 (35/1 ARSC) x Vetore - 56	250	12	10
M 44/3 (VRI) x Vetore-56	50	--	--

JHARGRAM

During the year hybridization was taken up using different cross combinations of Jhargram-1, M 44/3, BLA 39-4, 2/9 Dicherla, D.C. 5 and D.C. 8. The success rate of cross-pollination was 0.3%. The F1 were planted in the nursery at closer spacing. The parent for cross combination viz., VTH 711/4 and Kankadi were collected from Cashew Research Station, Bhubaneswar.

MADAKKATHARA

Out of the 56 hybrids planted in 1993 the highest yield was obtained from H-2 (BLA 139-1 x P 3-2) (990g/tree) followed by H-10 (BLA-139-1x P 3-2) (780g/tree). The data recorded from 27 hybrids planted in 1994 indicated that H-70 has the maximum girth and H-83.

Maximum canopy spread. Out of the 92 hybrids planted in 1995 H-165 was having maximum girth and spreading canopy. 13 hybrids were planted during 1996 and are under evaluation. The data on promising hybrids is presented below in Table 1.24.

VENGURLE

The F1 hybrid seedlings obtained during 1991 were planted in the field for further evaluation. During the year a total of 244 hybrid seeds were sown in the nursery and 197 F1 seedlings were raised. The performance of promising hybrids planted in 1991 is presented in Table 1.25. V-5 x Kankadi performed better than other hybrids in terms of yield (5.99 kg/tree).

Table 1.24: Performance of promising hybrids at Madakkathara.

Cross combination	Hybrid No.	Year of Planting	Height (m)	Girth (cm)	Canopy spread (m)	Yield (kg/tree)
BLA 139-1 x P 3-2	H-2	1993	5.5	50	6.75	0.99
BLA 139-1 x P 3-2	H-10	1993	4.1	56	5.3	0.78
BLA 139-1 x P 3-2	H-60	1994	4.6	48	4.35	--
BLA 39-4 x P 3-2	H-70	1994	3.5	55	3.5	--
V-5 x H- 1591	H-83	1994	4.0	48	5.8	--
Madakkathara-1 x P 3-2	H-101	1995	4.5	40	3.7	--
Madakkathara-1 x P 3-2	H-165	1995	3.7	55	4.4	--
BLA 139-1 x Vetore-56	H-185	1996	3.2	16	1.8	--
BLA 139-1 x Vetore-56	H-186	1996	2.4	20	2.9	--

Table 1.25: Performance of promising hybrids at Vengurle.

Cross combination	Hybrid No.	Nut Wt. (g)	Apple Wt. (g)	Yield (kg/tree)	Shelling (%)
V-5 x Kankadi	H-636	8.78	45	4.26	28.5
V-5 x Kankadi	H-640	8.00	60	4.29	29.5
V-5 x Kankadi	H-641	8.70	50	5.99	28.5
V-5 x Kankadi	H-662	8.00	40	5.10	29.0
V-5 x Kankadi (hybrid)	H-675	8.47	50	5.80	29.0
V-5 x Kankadi (hybrid)	H-677	8.32	62	4.09	28.5
V-5 x Kankadi (hybrid)	H-681	9.44	62	4.48	28.0
V-5 x Kankadi (hybrid)	H-689	8.20	78	3.56	28.0
V-2 x Kankadi	H-764	8.30	76	5.56	28.5
V-2 x Kankadi	H-784	8.00	86	4.30	29.0

VRIDHACHALAM

The performance of F1 hybrids was evaluated during the year including eight different combinations. Highest cumulative yield was obtained for M 10/4 x M 26/1 (34.5 kg) for 10 years. However, highest yield was obtained for M 4/3 x M 45/1 (5.2 kg/tree). The cross combinations M 10/4 x M 45/4, M 26/2 x M 45/4 and M 44/3 x M 45/1 showed moderate TMB resistance. The detail of the performance of hybrids is presented below in Table 1.26.

Table 1.26: Performance of hybrids planted during 1987 at Vridhachalam.

Cross combinations	Hybrid No.	Mean yield for last 10 yrs.	Highest yield obtained	Cumulative yield (kg/tree) 10 harvests	Apple Wt. (g)	Nut Wt. (g)	No. of fruits per panicle	Shelling %
M 10/4 x M 26/1	H 10	3.45	3.6	34.5	60	6.10	4	25.5
M 10/4 x M 45/4	H 11	2.02	2.9	20.2	61	5.90	5	27.1
M 10/4 x M 75/3	H 12	1.75	2.5	17.5	6.60	63	3	27.1
M 26/2 x M 26/1	H 13	2.94	4.5	29.4	6.80	58	4	26.2
M 26/2 x M 45/4	H 14	2.25	3.2	22.5	6.60	62	4	28.7
M 26/2 x M 75/3	H 15	1.64	2.8	16.4	5.60	58	3	26.7
M 44/3 x M 26/1	H 16	2.68	5.0	26.8	6.40	62	6	28.6
M 44/3 x M 45/1	H 17	2.28	5.2	22.8	6.80	56	5	27.6

II. CROP MANAGEMENT

A. AGRONOMY

Agr. 1: NPK fertilizer experiment.

Centres:

East Coast: Bapatla, Bhubaneswar, Jhargram, and Vridhachalam
West Coast: Madakkathara, Vengurle
Maidan tract: Chintamani and Jagdalpur

The main objective of this experiment is to study the response of Cashew grafts to different doses of NPK fertilizers.

Experimental details:

Design	: Three factorial confounded design with 27 treatment combinations
Replication	: Two
Treatments	: N - 0,500, and 1000 g/plant P - 0,125, and 250 g/plant K - 0,125, and 250 g/plant.
No. of plants per plot	: Six

BAPATLA

The results indicated that plant height, spread, girth increased with the nitrogen application from 0 to 500g N/tree. There was no significant different between the 500g N and 1000g N treatments. Highest yield was obtained for N1P0K1 (6.0 kg/tree), the same tree had also showed maximum height (2.85 m). Highest girth (70 cm) was observed for N0P1K2. The interaction between fertilizer treatments and yield was statistically analysed and presented in Table 2.1.

On-farm trial:

On farm trial was carried out in APFDC Plantations. During the year there was significant difference between the different treatments. The data on effect of different fertilizer treatments is presented in Table 2.2.

Table 2.1: Effect of N P K fertilizers and their interaction on nut yield at Bapatla.

	P0	P1	P2	Mean	K0	K1	K2
N0	2.93	1.9	2.33	2.39	2.8	1.83	2.53
N1	4.0	3.07	3.8	3.62	2.9	4.23	3.73
N2	3.13	4.7	3.66	3.83	3.76	4.33	4.4
Mean	3.35	3.22	3.26		2.82	3.46	3.55
K0	2.43	2.96	3.07				
K1	4.1	3.3	3.0				
K2	3.53	3.4	3.73				
F test	N NS	P NS	K NS	NP NS	NK NS	PK NS	NPK NS

SEm± For N, P, K = 0.42; SEm± For NP, NK, PK = 0.73
SEm± For NPK = 1.26

Table 2.2: Effect of higher doses of fertilizer in on farm trial at Bapatla.

Treatments	Girth (cm)	Canopy (m)	No. of panicles	Yield (kg/tree)
T1 - 500-125-125 (NPK)	130.0	11.9	19.2	9.0
T2 - 1000-250-250	138.2	12.6	18.6	13.5
T3 - 1500-375-375	134.0	12.5	20.4	14.4

BHUBANESWAR

Application of NPK significantly increased the number of flowering panicles/sq.m over control. Maximum number of flowering panicles (22.11) was recorded with 1000g N. Similar trend was observed in case of number nuts/panicle also. Maximum yield/plant obtained (6.93 kg/tree) was for N2P2 followed (6.17 kg/tree) for N2P1. The interaction effect of yield was found significantly superior in P2K2 over all treatment combinations. The effect of NPK and their interaction on yield is presented in Table 2.3.

CHINTAMANI

The various dosages of N, P, K fertilizers influenced the vegetative growth of cashew. Plant height was significantly influenced by various treatments whereas stem girth was influenced more by P2O5 and canopy spread was found to be influenced by K2O levels only. Nut yield was influenced by K2O and P, K interaction. Highest yield was obtained in K2P2 (4.55 kg/tree). The effect of N, P, and K fertilizers is presented in Table 2.4.

The pooled analysis of data on individual years has shown significant different in nut yield among various NPK interactions. The mean yield was significantly highest in N2P2K2 (5.41 kg/tree) and N1P2K2 (4.39 kg/tree) which were on par at P=5%. The detailed data on interactions is presented in Table 2.5.

Table 2.3: Effect of NPK and their interaction on yield at Bhubaneswar.

	P0	P1	P2	Mean	K0	K1	K2
N0	1.67	1.91	2.13	1.91	1.57	1.88	2.27
N1	3.43	3.62	4.38	3.81	3.10	3.47	4.87
N2	5.77	6.17	6.93	6.29	5.73	6.07	7.07
Mean	3.62	3.90	4.48		3.47	3.81	4.73
K0	3.25	3.42	4.20				
K1	3.22	3.72	4.77				
K2	3.93	4.28	5.23				

CD 5% for N, P, K= 0.23; CD 5% for NP, NK, PK = 0.41
SEm± For N, P, K = 0.08; SEm± For NP, NK, PK = 0.14
SEm± = For NPK = 0.24

Table 2.4: Effect of NPK and their interaction on yield at Chintamani

	P0	P1	P2	Mean	K0	K1	K2
N0	2.98	2.78	3.62	3.13	3.84	1.82	3.72
N1	2.80	2.66	1.95	2.47	3.04	1.53	2.85
N2	2.12	1.48	3.23	2.28	2.34	1.30	3.20
Mean	2.63	2.31	2.93		3.07	1.55	3.26
K0	3.98	2.50	2.74				
K1	1.86	1.27	1.52				
K2	2.6	3.5	4.55				

CD 5% for N, P= NS; CD 5% for K = 0.84; CD 5% for NP, NK = NS
CD 5% for PK = 1.45
SEm± For N, P = 0.285; SEm± For K = 0.285; SEm± For NP, NK = 0.493
SEm± For PK = 0.493

Table 2.5: Effect of different combination of NPK on yield of cashew nut at Chintamani

Treatment	Yield kg/tree								
	1991	1992	1993	1994	1995	1996	1997	1999	Mean
000	1.39	0.86	1.16	2.24	2.99	0.79	1.17	3.34	1.69
001	1.65	0.56	2.18	2.72	4.85	1.41	2.25	2.38	2.07
002	2.20	0.68	4.87	3.64	4.18	1.42	2.00	3.23	2.58
010	1.65	0.46	2.55	4.05	5.48	1.25	3.61	3.74	2.56
011	2.33	0.92	2.16	4.73	5.94	1.69	2.30	1.18	2.40
012	3.28	0.67	4.34	3.03	4.64	2.19	1.70	3.43	2.99
020	2.39	0.60	2.32	2.76	3.98	1.74	1.20	4.44	2.67
021	2.99	0.83	1.53	1.83	3.15	1.99	1.95	1.90	2.03
022	2.19	0.75	2.67	2.78	9.23	2.36	5.00	4.51	3.44
100	1.95	1.00	1.78	5.74	4.78	1.28	2.71	5.33	2.68
101	1.72	0.45	3.60	6.06	3.31	1.36	2.10	2.13	2.50
102	2.42	0.86	2.14	3.22	2.16	1.43	2.90	0.94	1.78
110	1.90	1.57	1.89	2.47	4.96	1.28	2.67	1.94	2.23
111	2.95	0.93	2.60	3.65	3.02	2.06	3.20	2.00	2.62
112	3.48	0.98	6.31	6.94	7.31	2.51	3.64	4.05	4.10
120	2.21	0.77	2.35	3.43	4.45	1.55	2.91	1.86	2.33
121	3.07	1.17	2.45	3.45	2.84	1.78	4.22	0.45	2.54
122	3.82	1.05	6.84	5.83	9.21	3.32	6.28	3.56	4.39
200	2.35	0.86	1.78	5.55	5.88	1.88	3.10	3.78	2.87
201	2.13	0.47	1.82	4.87	7.12	1.93	3.63	1.07	2.83
202	2.27	0.84	3.88	6.17	3.90	2.50	4.00	2.03	2.96
210	2.09	0.50	2.37	4.44	6.21	1.51	3.15	1.83	2.55
211	3.60	0.62	3.38	4.33	3.91	2.09	3.92	0.64	2.64
212	4.21	0.93	4.44	8.28	8.73	3.34	3.97	1.99	4.14
220	2.24	0.61	2.82	5.10	6.14	1.70	3.30	1.92	2.91
221	3.26	0.93	2.58	7.37	4,27	2.43	3.66	2.20	2.57
222	3.61	1.05.	5.59	11.34	7.27	4.36	5.23	5.59	5.41

SEm± for years =0.571; CD 5% = 1.91; SEm± for treatments = 0.235 CD 5% = 0.68
SEm± for interaction = 0.665 CD 5% = 1.84

On farm trial:

Two on farm trials initiated during 1998 in cashew plants which were planted in 1996 are in progress at different farmers fields in Kolar district. The plants are yet to yield and yield is expected in the current harvesting season.

JAGDALPUR

On farm trial:

At Jagdalpur, in addition to the normal treatments, one additional treatment of 1500g N, 250g P and 375g K was also imposed. Due to non-availability of sufficient number of grafts in the trial, which was conducted in farmers field, the experiment was laid out in simple RBD as observational trial. The data on the effect of NPK fertilizers on growth parameters of cashew seedlings is presented in Table 2.6.

JHARGRAM

At Jhargram, highest yield was obtained for N0K2 (3.28 kg/tree) under NPK fertilizer trial imposed in Jhargram-1 cashew grafts. The details of the NPK interaction on cashew yield are presented in Table 2.7.

MADAKKATHARA

At Madakkathara the growth parameters were recorded in this experiment. Maximum height (4.90m) was observed for N2P0K0, maximum girth (61 cm) was observed for N2P0K0 as well as N2P1K1. However, maximum canopy spread (5.51 m) was observed for N0P0K1.

On farm trial:

On farm trial was carried out in farmer's field with Madakkathara-1 grafts. During the year maximum yield was obtained for T-2 (1125g N, 488g P. 1125g K). Plant growth and yield did not increase substantially beyond the T-2 dose. The data recorded on growth and yield parameters is presented below in Table 2.8.

VENGURLE

At Vengurle, the stem girth (40 cm), east-west canopy spread (3.77 m) and yield (3.36 kg/tree) was observed to be highest under the treatment N1P2K2. However, maximum height was seen for N2P1K1 (3.31 m). The details of growth and yield in response to NPK fertilizers is presented in Table 2.9.

Table 2.6: Effect of NPK on growth characteristics at Jagdalpur

Treatment	Height (cm)	Girth (cm)	Spread (cm)	
			N-S	E-W
T-1 Control	161.25	18.81	121.68	120.93
T-2 500g N, 125g P, 125g K	199.3	24.31	190.31	149.06
T-3 1000g N, 250g P, 250g K	207.37	26.81	200.93	214.37
T-4 1500g N, 250g P, 375g K	200.9	26.87	137.93	147.18

SEm± 3.03 0.73 6.58 2.77; CD 5% 9.70 2.35 21.05 9.52

VRIDHACHALAM

The trial has been laid out with VRI-2 grafts and data on tree height, canopy spread and flowering period indicated the maximum height of 1.82 m for treatment T 21 (N 1000g, P 125g and K 125g). The flowering period was from February to March. The incidence of pest and disease was very minimum.

Table 2.7: Effect of NPK fertilizer and their interaction on yield at Jhargram

	P0	P1	P2	Mean	K0	K1	K2
N0	2.44	2.64	2.26	2.45	2.10	1.97	3.28
N1	2.18	2.56	2.86	2.53	1.87	2.61	3.18
N2	2.37	2.92	2.64	2.64	2.19	2.47	3.28
Mean	2.33	2.71	2.58		2.05	2.35	3.25
K0	1.57	2.11	2.42	2.03			
K1	2.89	2.64	2.12	2.35			
K2	3.13	2.37	3.22	3.24			

Table 2.8: Effect of NPK fertilizer on growth and yield under on-farm trial at Madakkathara.

Treatment	Height (m)	Girth (cm)	Canopy spread (m)	Yield (kg/tree)
T-1 (750g N, 325g P, 750g K)	4.59	64.29	5.45	1.14
T-2 (1125g N, 488g P, 1125g K)	5.26	60.29	6.68	2.52
T-3 (1500g N, 650g P, 1500g K)	4.59	63.85	6.5	2.36

Table 2.9: Growth and yield performance in response to NPK fertilizers at Vengurle

Treatment	Height (m)	Girth (cm)	Canopy spread		Nut Wt. (g)	Yield (kg/tree)
			N-S	E-W		
N0P0K0	3.50	34	3.65	3.45	0.495	6.10
N0P0K1	3.45	33	3.82	3.65	0.960	6.74
N0P0K2	3.26	30	3.61	3.55	0.730	7.08
N0P1K0	3.45	31	3.45	3.60	0.772	6.55
N0P1K1	3.10	32	3.59	3.50	1.300	6.40
N0P1K2	3.45	38	3.81	3.75	1.905	6.46
N0P2K0	3.42	34	3.69	3.65	1.700	7.00
N0P2K1	3.62	36	4.35	4.40	1.800	7.19
N0P2K2	2.28	31	3.65	3.43	1.590	6.90
N1P0K0	3.65	42	3.90	3.97	2.450	6.77
N1P0K1	3.50	34	3.77	3.67	2.825	6.52
N1P0K2	3.65	34	3.80	3.60	2.150	6.80
N1P1K0	3.91	39	4.64	4.31	4.350	7.15
N1P1K1	3.91	37	4.20	4.30	2.675	7.05
N1P1K2	3.62	43	4.24	5.02	5.850	6.77
N1P2K0	4.47	39	4.41	4.07	3.775	6.60
N1P2K1	4.30	41	4.21	4.19	2.225	7.30
N1P2K2	3.95	43	4.82	4.70	4.050	7.30
N2P0K0	3.80	38	4.35	4.77	4.125	6.50
N2P0K1	3.80	37	3.90	3.68	2.850	7.00
N2P0K2	3.80	36	3.75	3.95	3.050	7.26
N2P1K0	4.02	40	4.25	4.27	3.630	7.32
N2P1K1	4.35	45	5.00	4.75	3.450	7.31
N2P1K2	3.80	40	4.19	4.45	3.175	7.70
N2P2K0	3.96	42	4.32	5.05	3.965	7.85
N2P2K1	4.11	47	4.44	4.71	3.805	7.30
N2P2K2	4.15	37	4.55	4.45	3.400	7.15

Agr. 4: Spacing trial.

Centres:

East Coast: Jhargram
West Coast: Vengurle

The main objective of this experiment is to find out the optimum plant population per unit area at different ages of plantation for maximisation of yield.

Experimental details:

Design	:	RBD
Replication	:	3
Plot size	:	25m x 25m
Area covered	:	2.25 ha
Variety	:	Red Hazari (Jhargram), V-4 (Vengurle)
Year of planting	:	July 1982 (Jhargram), July 1990 (Vengurle)

Different spacing trials :

T1	5m x 5m	:	Square with no thinning
T2	5m x 5m	:	Square with thinning of 50% plants (after 6 years in 1990)
T3	5m x 5m	:	Square with thinning of 75% plants (after 11 years)
T4	10m x 5m	:	Rectangular
T5	10m x 5m	:	Rectangular with thinning of 50% plants (after 6 years, done in 1990)
T6	10m x 10m	:	Square
T7	10m x 10m x 10m	:	Triangular
T8	8m x 8m	:	Square
T9	8m x 8m x 8m	:	Triangular
T10	6m x 6m	:	Square
T11	6m x 6m x 6m	:	Triangular
T12	5m x 5m	:	Square with selective thinning of 50-75% plants. During 1990, 50% plants were removed selectively.

JHARGRAM

Maximum number of nut per plant was observed in 10x10 m rectangular system followed by 6x6 m square system of planting (579, 561 respectively). However, maximum yield per block (45.32 kg/block) was noted in 6x6x6 m triangular system of planting followed by 6x6 m square system of planting (43.04 kg/block). Maximum cumulative yield (545.55 kg/block) was recorded in 6x6x6 m triangular planting without thinning followed by 5x5 m square without thinning (528.29 kg/block). The data on yield performance of trees under different spacing is given in Table 2.10.

Table 2.10: Yield performance of cashew trees under different spacing at Jhargram.

Treatment	No. of plants/block	Canopy spread	No. of nuts/ tree	Yield		Cumulative yield (12 harvests) Kg/ Block
				(kg/ tree)	(kg/ block)	
T-1	25	Medium	283	1.33	33.25	528.29
T-2	13	-do-	345	1.56	20.28	283.23
T-3	25	-do-	256	1.19	29.75	442.79
T-4	8	-do-	416	2.11	16.88	291.19
T-5	4	-do-	459	2.39	9.56	129.51
T-6	4	-do-	579	2.46	9.84	94.59
T-7	7	-do-	545	2.21	15.47	161.83
T-8	9	-do-	523	2.53	22.77	124.52
T-9	12	-do-	431	2.01	24.72	340.15
T-10	16	-do-	561	2.69	43.04	521.99
T-11	22	-do-	469	2.06	45.32	545.55
T-12	13	-do-	316	1.43	18.59	294.62
CD 5%			5.61	0.04		

VENGURLE

At Vengurle, the yield in 1997 was poor due to heavy incidence of tea mosquito bug and in 1998 due to removal of bud sticks for grafting. Therefore it was suggested not to collect bud sticks from the experimental plants. There was no significant difference between plant height, girth and tree canopy in each row.

Vengurla-4 varieties planted under spacing trial experiment. Maximum yield was observed in T-3 (895 kg/ha) as compared to other treatments. The data on growth and yield performance of cashew trees is presented in Table 2.11.

Table 2.11: Growth and yield performance of cashew trees under spacing trial at Vengurle.

Treatment	No. of trees/ha	Height (m)	Girth (cm)	Canopy spread		Yield	
				NS	EW	(kg/ tree)	(kg/ ha)
T-1	400	3.16	39	3.64	3.57	2.39	958
T-2	400	3.31	39	3.63	3.69	2.21	884
T-3	400	3.14	39	3.67	3.40	2.24	895
T-4	200	3.04	37	3.54	3.54	1.86	373
T-5	200	2.93	36	3.63	3.49	2.14	428
T-6	100	3.10	35	2.84	3.39	1.81	186
T-7	115	2.84	32	3.16	3.16	1.89	217
T-8	156	3.12	40	3.50	3.49	2.34	360
T-9	180	3.04	33	2.97	2.97	2.25	412
SEm±		0.216	2.071	0.214	0.224	0.147	
CD 5%		NS	NS	NS	NS	NS	

Expt. 2: High density planting trial

Centres:

East coast: Bhubaneswar.
West coast: Vengurle
Maidan tract: Chintamani

BHUBANESWAR

During July 1996, high density planting with a spacing of 4 m x 4m using the variety H 2/16 covering an area of 0.4 ha was done. During the current year the yield of 750 kg/ha was recorded from the above plot.

CHINTAMANI

During 1997 high density planting was established using Chintamani-1 grafts at a spacing of 4 x 4 m. The observation was recorded at a random from 25 plots. The growth parameters are presented in Table 2.12.

Table 2.12. Growth characteristics of Chintamani-1 grafts under high density planting at Chintamani.

Parameters	Plant height (m)	Girth (cm)	Canopy spread (m)	
			EW	NS
Maximum	2.4	17.0	1.70	1.65
Minimum	1.45	10.0	0.90	0.80
Mean	1.87	13.33	1.16	1.12

VENGURLE

High density planting was done using variety Vengurla-7 at spacing of 4 x 4 m during August 1998 in an area of 0.2 ha. The data recorded on growth parameters is presented in Table 2.13.

Table 2.13: Growth characteristics of high density planting at Vengurle.

Row No.	Height (cm)	Girth (cm)	No. of branches
1	93.4	12.5	17.2
2	96.9	14.7	19.0
3	82.5	13.5	15.4
4	73.5	13.0	16.7
5	98.5	13.4	19.4
6	101.0	15.3	21.5
7	110.2	14.8	20.6
8	106.5	15.2	18.9
9	101.5	13.1	19.9
10	94.5	13.1	15.3
11	84.0	12.1	11.1
12	100.0	13.8	15.1

The above data are averages of 10 grafts in each row.

Agr. 6: Cashew based cropping system.

Centres:

East Coast: Bapatla, Bhubaneswar, Jhargram and Vridhachalam
West Coast: Madakkathara and Vengurle

The objectives are to:

(a) Identify compatible inter-crops with cashew in the initial stages of orchard development.
(b) Study the economic benefits of inter-cropping system.
(c) Work out a soil fertility management strategy for the inter-cropping system.

Experimental details:

Main plot : 4
Sub-plot -3 : 3
No. of replications : 3
Design : Split plot
Sub-plot:
FO - No additional fertilizer to inter-crop
F1 - Additional fertilizer application to the inter-crops as per the state recommendation.
F2 - 50% of the additional fertilizer application to the inter-crop.

BAPATLA

During the year the experiment was not conducted due to lack of fencing and gracing problems and also due to severe drought.

BHUBANESWAR

Intercrops grown: Cowpea, pumpkin, bottleguard, amorphophanalous and turmeric.

The cashew plants were spaced at 10x10 m as a main crop and the other intercrops were grown at different spacing. The details of spacing and yield obtained for the main crop as well as for intercrop is presented below in Table 2.14.

Table 2.14: Performance of cashew and its intercrop at Bhubaneswar.

Treatments	Spacing		Yield (Qtl./ha)	
	Row	Plant	Cashew	Intercrop
Cashew alone	10 m	10 m	8.32	
Cashew + Cowpea			9.60	24
Cashew+Pumpkin	1.50 m	1.20 m	8.40	70
Cashew+Bottlegourd	1.20 m	1.20 m	8.30	90
Cashew+Amorphophalous	0.6 m	0.6 m	8.80	60
Cashew+Turmeric	30 cm	25 cm	8.60	60

While taking the economy of cashew growing, turmeric was found most economic crop under cashew plantation. Growing amorphophalous as well as cowpea were also found economical.

JHARGRAM

Intercrops grown: Blackgram, groundnut, cowpea

The yields obtained from intercrops were 280, 520, 400 kg/ha respectively. It was found that groundnut was most economical crop under cashew plantation during the early stages of plantation development.

MADAKKATHARA

Intercrops grown: Adathoda and Colieus.

The performance of medicinal plants under cashew plantation was not promising. Thus during the XIV Biennial Workshop it was suggested to remove the medicinal plants and replant it with pineapple and tuber crops. The planting will be taken up during the current rainy season.

VENGURLE

Intercrops grown: Ridge gourd, bitter gourd, cucumber, okra, snake gourd, cowpea and bottle gourd.

At Vengurle, growing bitter gourd was found highly profitable, cucumber ranked second as an economical intercrop. It was found feasible to grow intercrops in the spaces in cashew orchard during the initial stages of plantation development, particularly in the kharif season.

VRIDHACHALAM

Intercrop grown: Black gram, cowpea, sesamum and groundnut.

The experiment was conducted in high-density cashew plantation at 4 x 4 m spacing. The maximum tree girth (32.9 cm) and more canopy spread were obtained in the plot grown with groundnut as intercrop. The root distribution, soil moisture were also high when the intercrop was groundnut. Moreover, groundnut was found highly profitable as an intercrop in cashew plantation. The details of the performance of intercrops under cashew plantations are given in Table 2.15.

Table 2.15: Performance of cashew and its intercrop at Vridhachalam.

Treatment	Height (cm)	Girth (cm)	Canopy (cm)		Soil moisture (%)	Root distribution (cm)	Yield (kg/ha)	
			EW	NS			Main crop	Intercrop
Cashew alone	312	30.2	3.32	3.19	16	--	220	--
Cashew + Black gram	354	33.2	3.28	3.14	18	11.9	225	325
Cashew + Cowpea	350	33.4	3.36	3.27	18	10.3	230	420
Cashew + Sesamum	356	32.6	3.05	3.11	15	10.6	240	120
Cashew + Groundnut	316	32.9	3.34	3.38	20	13.3	260	600

Agr. 7: Drip irrigation trial

Centres:

East Coast: Vridhachalam
West Coast: Vengurle
Maidan tract: Chintamani

The objective is to study the response of cashew to supplementary irrigation during flushing and flowering phases and to work out the critical stages of irrigation.

Experimental details:

Treatments	:	Five
T1	:	No irrigation
T2	:	Irrigating 20% of cumulative pan evaporation
T3	:	Irrigating 40% of cumulative pan evaporation
T4	:	Irrigating 60% of cumulative pan evaporation
T5	:	Irrigating 80% of cumulative pan evaporation
Spacing	:	7m x 7m
Planting material	:	Softwood grafts
Variety	:	Chintamani: Chintamani-1
		Vengurle: Vengurla-7
		Vridhachalam: VRI-3

Planting of 240 grafts of Chintamani-1 has been done during September 1997. The establishment of plants is quite satisfactory at Chintamani Centre. At Vengurle, this trial has been laid out at Agricultural Research Station, Mulde, Kudal, and Sindhudurg District. Soft wood grafts of Vengurla-7 were planted at a spacing of 7 m x 7 m for the purpose of implementing the trial. Planting for this experiment will be carried out soon after establishment of drip irrigation facilities at Vridhachalam.

B. HORTICULTURE

Hort. 4: Screening of rootstock for dwarfing characters.

Centres:

East Coast: Bapatla and Bhubaneswar
West Coast: Madakkathara and Vengurle

The objective of the trial is to identify dwarfing characters in cashew by screening of root stocks at nursery stage based on morphological, anatomical and physiological characters like height, girth, number of stomata, bark percentage and phenolic contents. Later to take up inbreeding work by resorting to selfing of the identical dwarf trees.

Experimental details:

Studies on dwarfing rootstocks should be taken up by the identified centres and these root stocks may be individually compared with vigorous types rather than as a group.

BAPATLA

Survey for dwarf plants is being done for preparing grafts.

BHUBANESWAR

One semi dwarf type was identified and grafted materials are prepared during 1998, which were field planted during 1999 for further evaluation.

MADAKKATHARA

The growth characteristics of two less vigorous and apparently dwarf cashew types have been studied and the observations are being presented in Table 2.16. Fruit setting was poor in T 2286 and no seeds have been obtained. Inbreeding programmes were tried as an alternative method but still there was no success.

Table 2.16. Growth characteristics of less vigorous cashew types at Madakkathara

Variety/Type	Height (m)	Girth (cm)	Spread (M)		Branches
			EW	NS	
T 2286	4.2	80	6.8	7.3	2
	4.3	65	3.9	5.9	3

Twenty Brazilian types were collected and are being evaluated to identify the dwarfing character since August 1993. After five years of planting, the Brazilian type B 7, B 19 and B 20 appeared to be dwarf and compact (2.5 m height, 1.5 m E-W, 1 m N-S spread.

Hort.5: Rootstock - scion interaction studies in cashew

Centres:

East Coast: Bapatla, Bhubaneswar, Jhargram and Vridhachalam.
West Coast: Madakkathara, Pilicode and Vengurle
Maidan tract: Chintamani

The objective of the experiment is to study the influence of root stock or interstock on the growth of the scion variety and to select rootstock or interstock which induces dwarfing or semi-tall growth habit to the grafted plant (scion variety).

Experimental details:

(a) Number of rootstocks: 3
(b) Number of interstocks: 1
(c) Number of scion varieties: 2

Details of rootstocks / interstocks / scion varieties to be tried in different centres.

Centre	Root stock	Interstock	Scion variety
Bapatla	a) M 44/3 (VRI-2)	1. M 44/3 (VRI-2)	1. BPP-6
	b) M 26/2 (VRI-3)		2. BPP-8
	c) Local rootstock		
Bhubaneswar	a) M 44/3 (VRI-2)	1. M 44/3 (VRI-2)	1. Bhubaneswar-1
	b) M 26/2 (VRI-3)		2. BPP-8
	c) Local rootstock		
Chintamani	a) M 44/3 (VRI-2)	1. M 44/3	1. Chintamani-1
	b) M 26/2 (VRI-3)		2. Ullal-4
	c) Local rootstock		
Jhargram	a) M 44/3 (VRI-2)	1. M 44/3	1. Jhargram-1
	b) M 26/2 (VRI-3)		2. M 44/3
	c) Local rootstock		
Madakkathara	a) M 44/3 (VRI-2)	1. M 44/3	1. Dhana
	b) M 26/2 (VRI-3)		2. Priyanka
	c) Local root stock		
Pilicode	a) M 44/3 (VRI-2)	1. M 44/3	1. Dhana
	b) M 26/2 (VRI-3)		2. Priyanka
	c) Local root stock		
Vengurla	a) M 44/3 (VRI-2)	1. M 44/3	1. V-4
	b) M 26/2 (VRI-3)		2. V-7
	c) Local root stock		
Vridhachalam	a) M 44/3 (VRI-2)	1. M 44/3	1. M 26/2 (VRI-3)
	b) M 26/2 (VRI-3)		2. M 44/3 (VRI-2)
	c) Local root stock		

BAPATLA

Single grafts and double grafts with rootstocks of VRI-2, 3 and BPP-5 using M 44/3 as interstock and BPP-6 and BPP-8 as scion material were prepared. The single and double grafts are ready for planting in the field.

BHUBANESWAR

During 1998 planting season, seeds of M 44/3, M 26/2 and Bhubaneswar-1 were collected and seedlings were raised in poly bags. M 44/3 scion sticks were grafted on rootstocks of M 44/3, M 26/2 and Bhubaneswar-1 during August 1998. H 2/16 (BPP 8) scion sticks were double grafted in M 44/3, M 26/2 and Bhubaneswar-1. The grafts prepared along with the rootstock have been planted during July 1999 in the field for further evaluation.

CHINTAMANI

Single grafts of Chintamani 1 and Ullal 4 were prepared using M 44/3, Chintamani 1 and M 26/2 (VRI 3) as rootstocks during 1999. However, the success in obtaining double grafts was not there.

JHARGRAM

The grafts of all the different combinations were prepared and are all ready for field planting.

MADAKKATHARA

The grafts of different rootstocks and scion combinations were prepared for double grafting as well as for further evaluation. The detail of grafts being prepared is presented in Table 2.17.

Table 2.17. Detail of grafts prepared at Madakkathara

Double grafts	Combination	No. of grafts
	M 44/3 + M 44/3 + Dhana	35
	M 44/3 + M 44/3 + Priyanka	35
	M 26/2 + M 44/3 + Dhana	24
	M 26/2 + M 44/3 + Priyanka	24
	A 1 + M 44/3 + Dhana	56
	A 1 + M 44/3 + Priyanka	56
Single grafts		
	M 44/3 + Dhana	20
	M 44/3 + Priyanka	15
	M 26/2 + Priyanka	23
	M 26/2 + Dhana	26
	A 1 + Dhana	23
	A 1 + Priyanka	23
Double grafts established		
	M 44/3 + M 44/3 + Dhana	3
	M 44/3 + M 44/3 + Priyanka	3
	M 26/2 + M 44/3 + Dhana	9
	M 26/2 + M 44/3 + Priyanka	0
	A 1 + M 44/3 + Dhana	6
	A 1 + M 44/3 + Priyanka	2

VRIDHACHALAM

M 44/3, M 26/2 and local type has been raised as rootstock and first grafting was done with M 44/3. The second grafting was done with M 26/2 and M 44/3 after sixty days of first grafting. M 44/6 has been used as the interstock for VRI-2 and VRI-3. The double grafted plants are ready for field planting and evaluation.

III. CROP PROTECTION

Ent. 1: Chemical control of pest complex in cashew.

The project is aimed to find out an effective spray schedule for the management of tea mosquito bug and other minor pests of cashew. This project also aims at testing the alternate chemicals in comparison with standard insecticidal spray schedule against pests of cashew.

Expt. 1: Control of major pest : Tea mosquito bug, *Helopeltis antonii.*

Centres:

East Coast: Jhargram, and Vridhachalam
West Coast: Madakkathara, Vengurle
Maidan tract: Jagdalpur, Chintamani

Treatments:

T1	:	Monocrotophos (0.05%) one spray at flushing
T2	:	Endosulfan (0.05%) one spray at flowering
T3	:	Carbaryl (0.1%) one spray at fruiting
T4	:	T1 and T2
T5	:	T1, T2, and T3
T6	:	T1 and T3
T7	:	T2 and T3
T8	:	Endosulfan (0.05%) at flowering stage followed by neem oil (2%)
T9	:	Carbaryl (0.1%) at flowering stage followed by neem oil (2%) at fruiting stage
T10	:	Control

CHINTAMANI

During the year due to lack of incidence of tea mosquito bug (TMB) at the time of flushing, first spray was avoided. The percent incidence of TMB and the number of natural enemies at flowering, fruiting and harvesting stages in different treatments is presented in Table 3.1. In trees which received spray at flowering and fruiting stages least incidence of TMB was recorded. However, the population of natural enemies was highest in untreated control (T-10) during all the stages. The yield was highest in T-5 (3.45 kg/tree), which was significantly higher than all other treatments.

JAGDALPUR

At Jagdalpur, leaf and inflorescence damage due to TMB was maximum in T-3 (5.74 and 61.10 % respectively), which was higher than that of control. However, highest yield (4.77 kg/tree) was obtained for T-5, which was significantly higher than other treatments. The incidence of TMB and other pests of cashew is presented in Table 3.2.

Table 3.1: Incidence of tea mosquito bug and natural enemies at Chintamani.

Treatment	TMB (%)		Natural enemies		Yield (kg/tree)
	30 days after II spray	30 days after III spray	30 days after II spray	30 days after III spray	
T-1	15.33	12.27	2.74	1.96	0.53
T-2	1.42	9.62	1.67	2.16	1.31
T-3	36.13	1.95	5.43	1.92	0.72
T-4	1.30	9.50	0.89	2.43	1.76
T-5	1.35	1.89	0.63	1.19	3.45
T-6	15.38	1.91	2.46	1.37	0.81
T-7	1.48	1.78	0.91	1.29	1.93
T-8	1.61	1.85	1.52	1.69	1.92
T-9	1.62	1.83	1.19	1.59	1.91
T-10	36.58	13.42	6.02	2.91	0.29
SEm±	0.83	0.50			0.12
CD 5%	2.47	1.49			0.36

Table 3.2: Incidence of TMB and other pests of cashew at Jagdalpur.

Treatment	Flower damage (%)		Leaf damage (%)			Yield (kg/tree)
	TMB	TMB	Leaf miner	Caterpillar	Leaf roller	
T-1	50.53	3.61	0.79	4.31	2.69	1.27
T-2	7.34	7.45	3.35	2.42	3.43	1.83
T-3	61.10	5.74	2.86	5.17	3.22	1.25
T-4	7.53	1.39	1.95	3.85	2.79	2.00
T-5	5.65	1.03	0.28	1.62	1.24	4.77
T-6	47.39	1.54	1.94	3.07	2.21	1.52
T-7	16.82	2.10	1.29	4.46	4.30	2.00
T-8	11.87	1.29	1.28	6.06	3.17	2.50
T-9	45.79	2.43	1.53	3.55	4.51	1.77
T-10	54.83	5.59	6.83	12.37	6.87	0.97

JHARGRAM

Due to the low population of TMB at Jhargram, the experiment of control on major pest - TMB was not carried out during the year.

MADAKKATHARA

During the year the percentage of damage caused by TMB was very high. The TMB infestation was combined with the *Colletotrichum gleosporioides* resulting in high losses even in the treatment T-5 (2.6 kg/tree). The details of pest incidence are presented in Table 3.3.

Table 3.3: Incidence of tea mosquito bug (TMB) at Madakkathara

Treatment	Pre-treatment count		After II spray		After III spray		Yield (kg/ tree)
	Shoot (%)	Panicle (%)	Panicle (%)	Nut (%)	Panicle (%)	Nut (%)	
T-1	Skipped the spray						
T-2	11.30	23.12	25.67	19.89	26.77	37.00	1.8
T-3	22.64	28.55	32.07	38.90	38.65	11.33	1.2
T-4	20.00	29.63	29.55	24.50	36.60	39.72	1.4
T-5	16.85	21.30	27.90	23.60	30.05	31.33	2.6
T-6	19.60	25.55	21.53	30.50	35.50	39.54	1.3
T-7	20.60	24.04	24.50	34.60	32.76	33.87	1.8
T-8	18.60	21.54	28.66	33.33	35.66	36.39	1.3
T-9	22.14	30.44	33.00	38.66	37.90	41.65	1.0
T-10	24.60	31.50	36.32	40.50	39.66	46.55	0.85

VENGURLE

The pesticide treatments in first and second sprays were not significantly effective, whereas, 30 days after the III spray the incidence of pest was significantly low as compared to the control. The treatment T-5 was found to be highly effective. The data on various pesticide treatments is presented in Table 3.4.

VRIDHACHALAM

At Vridhachalam, the most effective treatment was the standard spray (T-5) followed by T-7. The details of incidence of various pests of cashew are presented in Table 3.11.

Table 3.4: Incidence of tea mosquito bug (TMB) at Vengurle

Treatment	Pre-treatment count	Percent damage after 30 days		
		I Spray	II Spray	III Spray
T-1	4.91	8.64	19.84	31.40
T-2	6.53	10.95	15.61	30.30
T-3	7.87	12.52	20.19	27.38
T-4	3.43	6.50	13.21	26.61
T-5	6.49	9.06	12.46	19.10
T-6	5.58	9.61	16.34	24.23
T-7	5.15	10.13	15.39	22.23
T-8	4.77	10.54	15.73	23.68
T-9	4.50	8.79	14.64	29.32
T-10	5.45	13.76	22.69	37.27
SEm±	1.70	1.85	1.98	2.17
CD 5%	NS	NS	NS	6.45

Expt. 2 : Control of minor pests.

Centres:

East Coast: Bapatla, Bhubaneswar, Jhargram, Vridhachalam
West Coast: Madakkathara, Vengurle
Maidan tract: Chintamani and Jagdalpur

BAPATLA

In general the pest incidence was low during the year compared to previous years. The treatments T-4, T-5, T-6 and T-7 were the effective ones. The details of incidence of various minor pests are presented in Table 3.5.

BHUBANESWAR

The treatment T-1 in first round of spray was found most effective in controlling shoot tip caterpillar. The inflorescence thrips and leaf folders were susceptible for T-5 treatment. The natural enemies observed in the experiment were spiders, predator spiders (*Angeope* sp.), mirid bugs, lady bird beetles and black ants. Maximum population of spiders was observed in T-10, whereas, the effect of different treatments was non significant at 30 days after the I, II and III sprays on spider population. The data on incidence of various pests of cashew is given in Table 3.6.

Table 3.5: Incidence of minor pests of cashew at Bapatla

Treatments	Pre-treatment count			Post-treatment count March '99			Post-treatment count April '99	Yield (kg/ tree)
	L.f. (%)	H.h.	L.m. (%)	L.f. (%)	H.h.	L.w. (%)		
T-1	20.10	1.5	4.5	13.2	1.0	3.25	13.50	12.0
T-2	23.20	1.6	3.8	15.1	1.4	2.50	13.00	11.4
T-3	24.5	1.8	3.9	19.4	1.60	2.25	9.0	11.8
T-4	21.8	2.0	4.0	6.0	1.20	1.90	10.20	13.8
T-5	22.0	1.6	5.0	4.8	0.6	1.75	7.25	14.9
T-6	21.5	1.7	3.8	8.8	1.0	2.00	9.25	14.3
T-7	21.9	1.8	4.4	10.0	1.2	1.85	9.00	14.0
T-8	22.4	1.6	4.2	13.6	1.2	2.00	9.75	12.8
T-9	22.8	2.0	4.1	18.2	1.0	2.20	8.25	13.0
T-10	33.5	1.6	3.5	20.4	2.0	3.25	13.5	11.2

L.f = Leaf folder; L.m. = Leaf miner; H.h. = *Hipotima haligramma*; L.w. = Leaf webber

Table 3.6: Occurrence of minor pests of cashew at Bhubaneswar.

Treatment	Shoot tip borer		Leaf folder (%)	Inflorescence thrips				30 days after III spray	Nut yield (kg/tree)
	Pre-treatment count	30 days after I spray		30 days after I spray		30 days after II spray			
				YT	BT	YT	BT	BT	
T-1	5.83 (2.52)	0.39 (0.94)	1.01 (1.26)	1.76 (1.50)	2.96 (1.86)	0.93 (1.19)	1.92 (1.55)	0.78 (1.13)	3.560
T-2	5.33 (2.41)	1.54 (1.43)	1.42 (1.38)	1.90 (1.55)	4.20 (2.17)	0.50 (1.0)	1.30 (1.34)	0.87 (1.17)	1.950
T-3	5.31 (2.41)	1.19 (1.30)	2.09 (1.61)	1.90 (1.55)	2.60 (1.76)	1.03 (1.24)	2.03 (1.59)	0.38 (0.94)	1.760
T-4	5.65 (2.48)	1.36 (1.36)	1.37 (1.37)	1.80 (1.55)	5.03 (2.35)	0.40 (0.95)	1.25 (1.32)	0.90 (1.18)	4.650
T-5	6.59 (2.66)	0.52 (1.0)	0.42 (0.96)	1.30 (1.34)	3.20 (1.92)	0.22 (0.84)	1.01 (1.23)	0.71 (1.10)	7.320
T-6	5.94 (2.54)	1.16 (1.29)	1.16 (1.29)	2.03 (1.59)	5.30 (2.41)	0.46 (0.98)	1.29 (1.34)	0.84 (1.16)	2.350
T-7	6.33 (2.61)	1.76 (1.36)	1.37 (1.37)	1.70 (1.48)	3.80 (2.07)	0.79 (1.14)	1.50 (1.41)	1.03 (1.24)	1.630
T-8	4.90 (2.32)	1.45 (1.95)	1.59 (1.45)	1.67 (1.47)	2.93 (1.85)	0.74 (1.11)	1.63 (1.46)	0.25 (0.87)	3.360
T-9	4.75 (2.29)	1.89 (1.55)	1.42 (1.39)	2.00 (1.58)	2.76 (1.81)	0.84 (1.16)	1.42 (1.38)	0.88 (1.17)	2.320
T-10	5.15 (2.38)	3.19 (1.92)	3.29 (1.95)	2.50 (1.74)	4.13 (2.15)	1.89 (1.55)	3.24 (2.15)	1.70 (1.48)	1.300
SEm±	0.16	0.27	0.24	0.14	0.34	0.03	0.18	0.13	
CD 5%	NS	0.57	0.51	NS	NS	0.16	NS	0.28	

Figures in parentheses are $\sqrt{x + 0.5}$ transformed means
YT : Yellow thrips; BT : Black thrips

CHINTAMANI

The incidence of leaf and blossom webber and inflorescence thrips was least in trees received spray at flowering stage. Similarly, the incidence was low in plants sprayed at fruiting stages also. The data on incidence of different minor pests is presented in Table 3.7.

JAGDALPUR

The incidence of minor pests was low in standard spray i.e. T-5. Maximum yield

4.77 kg/tree was obtained, which was significantly superior over the other combinations. The data on minor pests of cashew is presented above in Table 3.2.

JHARGRAM

The incidence of leaf miner, shoot and blossom webber and shoot tip caterpillar was very low in T4, T5 and T6 treatments. The average incidence of leaf miner, shoot and blossom webber and shoot tip caterpillar was 1.60, 1.70, 1.71 and 1.68 respectively in T1, T4, T5 and T6 as compared to 3.26 in control. It was observed that insect control is effective when the plants were sprayed two to three rounds of treatments T4, T5 and T6. Maximum nut yield was 3.025 in T4 as compared to 1.265 kg/tree in control. The details of incidence of different pests of cashew are presented in Table 3.8.

MADAKKATHARA

The incidence of minor pests like leaf miner, leaf roller, blossom webber and thrips was also low in T5 treatment followed by T7. Population of natural enemies like ants, spiders and chrysopa were also high in T7 treatment as compared to T5 (Table 3.10). The Details of observation done on minor pests of cashew is presented in Table 3.9.

Table 3.7: Incidence of minor pests of cashew at Chintamani.

Treatment	Leaf and blossom webber (%)	Inflorescence thrips/panicle	
	30 days after II spray	30 days after II spray	30 days after III spray
T-1	5.37	13.36	17.42
T-2	0.79	6.86	17.55
T-3	12.54	13.50	3.76
T-4	0.90	5.63	17.46
T-5	0.59	5.51	3.67
T-6	12.85	13.54	3.61
T-7	0.62	5.19	3.48
T-8	0.71	6.20	3.60
T-9	0.72	6.01	3.73
T-10	12.78	13.34	17.80
SEm±	0.55	0.59	0.44
CD5%	1.63	1.75	1.31

Table 3.8. Incidence of minor pests of cashew at Jhargram

Treatments	Pre-treatment count			After First Spray			After Second Spray			Yield (kg/tree)
	Leaf miner	Shoot and blossom	Shoot tip caterpillar	Leaf miner	Shoot and blossom	Shoot tip caterpillar	Leaf miner	Shoot and blossom	Shoot tip caterpillar	
T-1	1.58(1.44)	0.5(1.0)	1.0(1.22)	1.69(1.32)	1.30(1.34)	1.8(1.52)	4.68(2.28)	4.7(2.28)	3.9(2.10)	2.650
T-2	2.60(1.76)	0.8(1.14)	0.9(1.18)	2.8(1.82)	3.5(2.6)	2.0(1.76)	4.0(2.26)	5.0(2.47)	4.6(2.26)	4.380
T-3	2.89(1.84)	0.7(1.10)	1.0(1.22)	2.92(1.85)	3.8(2.07)	2.3(1.67)	8.5(3.0)	5.9(2.53)	5.3(2.41)	4.300
T-4	1.81(1.52)	1.0(1.22)	0.8(1.10)	1.70(1.48)	1.35(1.36)	0.8(1.14)	2.33(1.61)	2.39(1.7)	1.72(1.49)	3.025
T-5	1.92(1.56)	0.6(1.05)	1.1(1.26)	1.71(1.49)	1.34(1.36)	0.9(1.18)	2.40(1.70)	2.31(1.73)	1.76(1.50)	3.000
T-6	1.59(1.45)	0.8(1.14)	0.8(1.14)	1.68(1.48)	1.30(1.34)	1.6(1.45)	2.42(2.29)	2.35(2.41)	2.02(1.92)	2.965
T-7	2.50(1.73)	0.7(1.10)	0.8(1.14)	2.98(1.87)	4.0(2.12)	2.0(1.58)	4.75(2.36)	5.3(2.57)	3.2(2.07)	2.895
T-8	2.44(1.71)	0.5(1.0)	0.9(1.18)	3.0(1.87)	4.2(2.17)	1.9(1.55)	5.38(2.36)	6.10(2.57)	3.8(2.07)	2.675
T-9	2.57(1.44)	0.6(1.05)	1.0(1.22)	3.12(1.90)	3.9(2.10)	2.3(1.64)	6.25(2.60)	5.13(2.37)	4.6(2.26)	2.435
T-10	2.57(1.75)	0.6(1.05)	0.9(1.18)	3.26(1.04)	4.38(2.21)	3.6(2.02)	10.98(3.39)	12.02(3.54)	9.8(3.21)	1.265
CD 5%	0.10	0.10	0.9	0.10	0.09	0.09	0.08	0.98	0.10	0.12

Table 3.9. Incidence of minor pests of Cashew at Madakkathara

Treatments	Pre-treatment count			After II spray			After III Spray	
	Leaf miner		Leaf roller	Blossom webber (%)	Thrips	Mean score	Thrips	Mean score
	Shoot (%)	Leaves (%)						
T1				Skipped Ist Spray				
T2	1.67	15.67	1.4	3.34	0.15	0.11	1.2	0.31
T3	2.99	14.55	2.3	2.3	1.00	0.30	1.0	0.13
T4	3.85	19.50	2.8	2.06	0.60	0.14	2.14	0.40
T5	1.00	10.50	0.45	1.87	1.90	0.30	1.09	0.07
T6	2.65	14.60	1.55	2.45	1.50	0.25	2.22	0.40
T7	2.89	11.30	2.36	2.60	0.50	0.26	1.45	0.20
T8	3.50	16.50	1.69	2.30	0.70	0.29	1.33	0.15
T9	3.60	13.40	2.30	3.40	0.80	0.60	2.30	0.20
T10	4.11	17.00	2.60	3.43	1.40	0.77	2.60	0.41

Table 3.10: Occurrence of natural enemies of cashew pests at Madakkathara.

Treat-ment	Pre-treatment count		After II spray				After III spray			
	Ants	Spiders	Ants	Spiders	Mirid bugs	Chrysopa	Ants	Spiders	Mirid bugs	Chrysopa
T1	Skipped the Ist Spray									
T2	4.5	2.1	3.4	2.8	0.0	1.4	2.8	2.4	0.2	0.5
T3	3.2	2.6	3.0	2.0	1.4	0.2	2.4	2.4	0.0	0.9
T4	2.8	1.6	2.5	1.0	0.5	1.3	2.8	2.0	1.3	1.5
T5	3.4	2.2	2.7	1.8	0.2	1.6	2.4	2.5	1.4	1.2
T6	1.8	2.0	2.0	1.4	0.1	1.3	1.5	1.1	0.3	0.8
T7	2.6	1.6	2.4	1.0	1.2	1.0	2.0	1.2	1.0	1.0
T8	1.9	2.6	2.0	2.2	0.0	1.0	1.9	1.3	0.7	0.7
T9	2.9	1.3	1.9	1.0	0.2	0.6	2.0	1.0	0.8	1.2
T10	3.4	1.5	2.7	1.4	1.3	1.5	3.1	2.7	1.3	1.0

VENGURLE

During all stages, T5 (standard treatment) was found to be most effective but T2 and T10 were equally effective at peanut stage. The details of incidence of minor pest of cashew are presented in Table 3.11.

VRIDHACHALAM

The incidence of pink leaf folder (*Anigraea albomaculata* Hamp), green leaf folder (*Sylepta auaratiacalis* Fish), nut borer (*Thylocopula panerosema*) and other minor pests population was very low in treatment T5.

Table 3.11. Incidence of flower thrips at different stages at Vengurle

Treatment	Average damage		
	Peanut	Pebble nut	Mature nut
T1	26.69	38.43	48.37
T2	26.11	38.15	47.38
T3	24.81	37.70	47.34
T4	23.55	36.11	42.89
T5	18.11	23.90	27.11
T6	22.04	34.59	45.28
T7	22.04	37.72	45.28
T8	22.19	36.68	46.39
T9	25.18	33.28	45.19
T10	38.98	53.66	65.78
SEm±	0.99	1.12	1.03
CD 5%	2.93	3.33	3.05

Expt. 3: Evaluation of new chemicals for control of TMB and other pests.

Centres:

East Coast: Bapatla and Bhubaneswar
West Coast: Madakkathara and Vridhachalam
Maidan Tract: Jagdalpur

Treatments:

T 1	:	Recommended sprays for the region
T 2	:	Chlorpyriphos 0.05%
T 3	:	Triazophos 0.1%
T 4	:	Ethofenprox 0.015%
T 5	:	Profenophos 0.05%
T 6	:	Control

BAPATLA

Among the new chemicals which were tested against the pest complex, profenophos 0.05% was found to be better. Chlorpyriphos 0.05% was also equally good. The details of incidence of pests recorded after treatment with new chemicals is presented in Table 3.12.

BHUBANESWAR

Apart from tea mosquito bug the other major pests recorded during the period were inflorescence thrips and shoot tip caterpillars. The standard spray was the most effective treatment compared to other treatments. However, profenophos (T5) was also found equally good against these pests. Chlorpyriphos was an effective control against inflorescence thrips. The details of incidence of various pests in response to the treatment with new chemicals are presented in Table 3.13.

CHINTAMANI

The results indicated that new chemicals tried were comparable to the standard chemicals in control of TMB, leaf and blossom webber and inflorescence thrips. Highest yield of 3.11 kg/tree was recorded in T1 and T2. The details of the incidence of pests of cashew are presented in Table 3.14.

JAGDALPUR

Among the new chemicals tested, ethofenprox 0.015% was found to be better than all other treatments. Average nut yield was 5.75 kg/tree in this treatment. The details of incidence of pests of cashew in response to the new chemicals tried are presented in Table 3.15.

Table. 3.12: Incidence of pests recorded after spraying with new chemicals at Bapatla.

Treatment	Pre-treatment count			Post treatment count after III spray				Yield (kg/tree)
	L.F. (%)	S.T.C H.h	Wee	L.F. (%)	S.T.C H.h	L.W. (%) on nuts	Wee	
T1	20.8	2.0	2.50	4.6	1.0	2.5	--	13.5
T2	18.9	2.4	2.25	5.6	1.2	3.6	--	12.6
T3	21.4	2.6	2.75	6.5	1.6	4.6	--	12.0
T4	19.4	2.5	2.00	6.6	1.8	5.0	--	12.1
T5	20.0	2.8	2.20	4.6	1.1	2.0	--	12.8
T6	20.4	2.2	2.50	9.0	2.4	12.75	1.0	10.4

Table 3.13: Incidence of pests recorded after spraying with new chemicals at Bhubaneswar.

Treatment	Shoot tip caterpillar (%)		Yellow Inflorescence thrips		Black Inflorescence thrips			Yield (kg/tree)
	One DBS	30 DAS	30 DAS after Ist spray	30 DAS after II spray	30 DAS after Ist spray	30 DAS after II spray	30 DAS after III spray	
T1	5.21	0.97	2.08	0.35	2.67	4.60	1.18	6.70
T2	5.66	2.14	2.24	0.53	3.95	6.65	1.50	3.20
T3	6.22	2.19	2.36	0.75	3.36	7.05	2.63	2.60
T4	6.22	1.81	1.94	0.80	3.26	5.83	2.38	5.76
T5	5.37	1.53	2.13	0.73	3.82	5.35	2.48	3.76
T6	6.08	5.33	2.81	1.60	5.19	10.80	4.93	2.10
Sem±	0.18	0.23	0.12	0.07	0.17	0.15	0.07	
CD 5%	NS	0.50	NS	0.14	NS	0.31	0.14	

DBS = Days before spray; DAS = Days after spray

JHARGRAM

Standard treatment T1 was the most effective one in controlling pests of cashew at Jhargram. Among the new insecticides tested Profenophos (0.05%) was effective against inflorescence thrips. A good control over shoot tip caterpillar could be obtained in T1 (4.85) and T5 (7.50) respectively. The details of incidence of TMB and other pests of cashew at Jhargram are presented in Table 3.16.

MADAKKATHARA

When compared to the standard spray, T2, T3 and T4 were found equally good. Highest yield was recorded in T3 (1kg/tree) followed by T2 (0.8 kg/tree). Minor pests like leaf miner, leaf roller and blossom webber were also found to be low in T2, T3 and T4 treatment. The details of incidence of pest of cashew in response to the new chemicals are presented in Table 3.17.

Table 3.14. Incidence of pests recorded after spraying with new chemicals at Chintamani.

Treatment	TMB (%)		Leaf and blossom webber (%)	Inflorescence thrips		Yield (kg/tree)
	30 DAS II spray	30 DAS III spray	30 DAS II spray	30 DAS II spray	30 DAS III spray	
T1	1.59	2.10	1.28	3.92	1.74	3.11
T2	1.86	2.13	0.73	1.94	2.70	3.11
T3	1.87	2.18	2.02	1.52	1.68	2.96
T4	2.03	2.11	1.02	1.85	2.05	2.98
T5	1.92	2.04	1.44	1.49	1.70	2.87
T6	36.54	15.55	13.19	12.97	16.85	0.38
SEm±	0.49	0.37	0.36	0.10	0.32	0.16
CD 5%	1.48	1.12	1.08	0.30	0.96	0.48

Table 3.15. Incidence of pests recorded after spraying with new chemicals at Jagdalpur

Treatments	TMB (%)		Leaf miner (%)	Caterpillar (%)	Leaf roller (%)	Yield (kg/tree)
	Inflorescence	Leaves				
T1	8.11	1.22	2.27	4.85	2.46	2.13
T2	7.31	0.87	0.64	3.28	4.79	2.37
T3	5.25	0.46	1.83	6.79	2.42	4.92
T4	1.67	0.36	0.37	2.40	2.06	5.75
T5	7.36	0.43	2.69	6.76	3.34	3.25
T6	52.21	5.94	7.57	13.54	7.93	1.14

VENGURLE

Spraying with Chlorpyriphos was comparable with the standard spray (T1). However, effective control of TMB was observed by standard spray during the later stages of nut development. T4 was also found equally good chemical in controlling TMB compared to T2. The details of incidence of TMB in response to new chemicals are presented in Table 3.18.

VRIDHACHALAM

The standard spray (T1) was the most effective treatment.

Table 3.18: Incidence of pests recorded after spraying with new chemicals at Vengurle

Treatments	Pre-treatment count	Percent damage 30 days after spray		
		Ist Spray	II Spray	III Spray
T1	3.77	7.14	12.46	23.67
T2	2.87	6.24	12.72	25.28
T3	5.35	8.57	15.04	23.75
T4	Not sprayed due to non availability			
T5	3.10	9.13	16.79	25.61
T6	6.17	14.95	26.81	39.63
SEm±	--	2.229	1.587	1.327
CD 5%	NS	NS	4.891	4.089

Table 3.16. Incidence of pests recorded after spraying with new chemicals at Jhargram.

Treatments	Pre-treatment count		After Ist Spray		After II Spray		After III Spray		Yield (kg/tree)
	Shoot tip caterpillar	Inflorescence thrips	Shoot tip caterpillar	Inflorescence thrips	Shoot tip caterpillar	Inflorescence thrips	Shoot tip caterpillar	Inflorescence thrips	
T1	3.90(2.10)	2.82(1.82)	3.58(2.02)	3.03(1.88)	3.62(2.03)	3.82(2.08)	4.85(2.31)	3.25(1.94)	3.225
T2	3.82(2.08)	2.85(1.83)	5.62(2.47)	4.62(2.26)	7.22(2.78)	4.53(2.24)	8.60(3.02)	5.96(2.54)	2.805
T3	4.06(2.16)	2.62(1.77)	6.21(2.59)	4.96(2.34)	7.95(2.91)	5.71(2.49)	8.92(3.07)	6.42(2.63)	2.650
T4	4.10(2.14)	2.45(1.72)	6.81(2.70)	4.97(2.34)	7.23(2.78)	5.89(2.53)	8.45(2.99)	6.24(2.60)	2.700
T5	3.89(2.10)	2.53(1.74)	4.63(2.20)	4.28(2.19)	6.33(2.61)	5.97(2.54)	7.50(2.83)	5.71(2.49)	3.000
T6	4.08(2.14)	2.03(1.82)	8.50(3.0)	7.82(2.88)	10.34(3.29)	9.08(3.10)	14.83(3.92)	12.80(3.65)	1.895
CD 5%	0.09	0.09	0.08	0.10	0.0-9	0.12	0.13	0.10	0.12

Table 3.17: Incidence of pests recorded after spraying with new chemicals at Madakkathara

Treatment	TMB		Pre-treatment count (Leaf miner)		Post-treatment count (Leaf miner)		Leaf roller	Blossom webber	Apple & nut borer	Thrips	Yield (kg/tree)
	(%)	Score	Shoot %	Leaf %	Shoot %	Leaf %					
T1	28.52	0.83	--	12.55	--	6.22	0.55	1.65	0.45	--	0.90
T2	27.35	0.79	1.32	11.90	0.55	4.53	--	--	0.13	--	0.80
T3	27.32	0.77	--	7.60	--	3.11	2.65	0.85	--	0.63	1.00
T4	26.02	0.69	2.90	18.70	1.32	5.65	--	--	--	--	0.75
T5	29.56	0.94	--	13.40	--	7.20	--	--	--	--	0.70
T6	40.56	1.31	1.39	16.45	--	16.83	--	2.55	1.11	0.75	0.45

Ent.2: Control of stem and root borer.

Expt.1: Prophylactic control trial.

Centres:

East Coast: Bhubaneswar, Jhargram, and Vridhachalam
West Coast: Madakkathara, Vengurle

The objective is to evaluate different pesticides and neem products for prophylaxis against attack by stem and root borer.

Treatments:
Swabbing with Neem oil 5% in 25 trees
T1 Twice + Sevidol 75g
T2 Thrice + Sevidol 75g
T3 Four times + Sevidol 75g

Swabbing with coal tar + Kerosene (1:2) in 25 trees OR mud slurry + carbaryl
T4 Twice + Lindane 0.2%
T5 Thrice + Lindane 0.2%
T6 Four time + Lindane 0.2%
T8 Control

BHUBANESWAR

Among the treatments tried, mud slurry + carbaryl swabbing along with Lindane soil application was found to be better than swabbing with neem oil. Maximum infestation (24%) was observed in untreated control. The details of occurrence of CSRB in prophylactic trial are given in Table 3.19.

JHARGRAM

Swabbing of neem oil (5%) and soil application of Sevidol 8G 75g/tree was most effective prophylactic control in two application schedules per year. The infestation of CSRB was negligible in T4 and T5. The occurrence of CSRB in prophylactic control experiment is Table 3.20.

MADAKKATHARA

Neem oil 5% swabbing at four intervals along with Sevidol 75g/tree (T3) and Mud slurry + Carbaryl 0.2% in an interval of four times an year were found to be more effective than other treatments. The occurrence of CSRB in prophylactic control treatment is presented in Table 3.21.

VENGURLE

Swabbing with neem oil 5% along with Sevidol 4G oil application four times in a year was found to be an effective treatment (T3). Swabbing with Mud slurry along with 2% Carbaryl and soil application of 2% Lindane was also found to be equally effective. The details of treatment against CSRB are presented in Table 3.22.

Table 3.19: Occurrence of CSRB in prophylactic trial at Bhubaneswar.

Treatment	Infested trees (%)							Stages of infestation			
	Apl.	May	June	July	Aug.	Sept.	Oct.	Early	Middle	Adv.	Dead
T1	--	8	16	16	16	16	16	4	8	4	--
T2	--	4	8	--	4	4	4	--	4	--	--
T3	--	8	--	4	4	--	4	4	--	--	--
T4	--	--	--	4	4	4	4	4	--	--	--
T5	--	--	4	--	--	--	--	--	--	--	--
T6	--	4	--	--	4	--	4	4	--	--	--
T7	--	20	20	20	24	24	24	4	12	9	--

Table 3.20: Occurrence of CSRB in prophylactic trial at Jhargram

Treatment	No. of trees	Trees with CSRB egg before treatment	No. of trees infested after treatment	% of infestation	Stages of infestation							
					Early		Middle		Advanced		Dead	
					No.	%	No.	%	No.	%	No.	%
T1	25	4	--	--	--	--	--	--	--	--	--	--
T2	25	5	--	--	--	--	--	--	--	--	--	--
T3	25	5	--	--	--	--	--	--	--	--	--	--
T4	25	4	2	8	1	4	1	4	--	--	--	--
T5	25	5	1	4	--	--	--	--	--	--	--	--
T6	25	3	--	--	--	--	--	--	--	--	--	--
T7	25	4	4	16	1	4	3	12	--	--	--	--

Table 3.21: Occurrence of CSRB in prophylactic trial at Madakkathara

Treatment	No. of trees infested											
	Jan.	Feb.*	Mar.	Apl.	May*	June	July	Aug.	Sept.*	Oct.	Nov.*	Dec.
T1	5	1	--	--	1	2	2	2	2	--	--	--
T2	2	3	--	--	--	--	--	--	1	--	--	1
T3	2	1	--	--	--	--	--	--	--	--	--	1
T4	4	2	--	--	1	--	2	2	1	--	--	--
T5	3	3	--	--	1	--	--	--	--	--	--	1
T6	2	2	--	--	--	--	--	--	--	--	--	2
T7	5	4	5	5	5	4	4	4	5	5	5	5

*Clearance and treatment application.

Table 3.22: Occurrence of CSRB in prophylactic trial at Vengurle

Treatment	No. of trees treated	No. of trees infested after treatment	% infestation	% control
T1	25	3	12	88
T2	25	1	4	96
T3	25	0	0	100
T4	25	2	8	92
T5	25	2	8	92
T6	25	0	0	100
T7	25	6	24	76

VRIDHACHALAM

The most effective treatment was swabbing coal tar thrice with the application of Lindane 0.2% (T5). The treatment T3 i.e. swabbing neem oil 5% four times with soil application of Sevidol 75g/tree was also found to be equally good treatment.

Table 3.23: Occurrence of CSRB under curative trial treatments at Bhubaneswar.

Treat ments	Recovery (%)	Stages of attack (%)		
		Early	Middle	Advanced
T1	73	87	13	--
T2	45	82	18	--
T3	18	82	18	--

Table 3.24: Occurrence of CSRB under curative trial treatments at Jhargram.

Treat ments	No. of trees	Stage of attack						Recovery stage					
		Early		Middle		Advanced		Early		Middle		Advanced	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
T1	25	5	20	5	20	2	8	3	12	2	8	--	--
T2	25	6	24	5	20	2	8	4	16	3	12	--	--
T3	25	5	20	6	24	1	4	4	16	3	12	--	--
T4	25	6	24	5	20	2	8	6	24	4	16	--	--
T5	25	6	24	6	24	2	8	4	16	3	12	--	--
T6	25	6	24	6	24	2	8	2	8	--	--	--	--

Table 3.25: Occurrence of CSRB under curative trial treatments at Madakkathara.

Treat ment s	No. of trees	Stage of attack						Recovery stage					
		Early		Middle		Advanced		Early		Middle		Advanced	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
T1	6	2	8	3	12	1	4	2	80	2	60	1	<10
T2	6	3	12	3	12	--	--	3	90	2	50	--	--
T3	4	1	4	2	8	1	4	1	30	2	<10	1	<10

VRIDHACHALAM

Among all the treatments recovery percentage was higher when treatment was imposed in early stages of infestation except treatment No.4 i.e. swabbing with Coal tar + Kerosene and Sevidol 75G application. Extraction of grub, swabbing coal tar, soil application of Sevidol and swabbing with *Meterrhizium anisopliae* may be effective in combination during early stages of insect attack. The occurrence of CSRB at Vridhachalam under curative trial is presented in Table 3.27.

Table 3.26: Occurrence of CSRB under curative trial treatments at Vengurle.

Treat ments	No. of trees	Stage of attack						Recovery stages						Avg. recovery
		Early		Middle		Advanced		Early		Middle		Advanced		
		No	%	No	%	No	%	No	%	No	%	No	%	
T1	16	8	50	5	31.25	3	18.75	6	75	4	80	3	100	85.00
T2	16	7	43.75	5	31.25	4	25	6	85.71	4	80	3	75	80.24
T3	12	7	58.33	1	8.33	4	33.33	5	71.43	1	100	2	50	73.81

Table 3.27: Occurrence of CSRB under curative trial treatments at Vridhachalam

Treatments	No. of trees	Stage of attack			Recovery Stages		
		Early	Middle	Advanced	Early	Middle	Advanced
T1	16	4	3	3	4	1	--
T2	12	4	3	3	4	1	--
T3	10	4	3	3	4	2	--
T4	18	3	4	3	3	1	--
T5	16	4	3	3	6	2	--

Ent.3: Bio-ecology of pests of regional importance and survey of pest complex and natural enemies.

Centres:

East Coast: Bhubaneswar, Jhargram, and Vridhachalam
West Coast: Madakkathara, Vengurle
Maidan tract: Chintamani and Jagdalpur

The project is aimed to study population dynamics of pests of regional importance and to correlate the same with weather parameters.

Many pests have been identified infesting cashew plants during various cropping seasons. The common name and scientific name of pests infesting cashew are given below.

Common Name	Scientific Name
Tea mosquito bug	*Helopeltis antonii*
Root and stem borer	*Plocaederus ferrugineus*
Leaf miner	*Acrocercops syngramma*
Leaf and blossom webber	*Lamida moncusalis*
Leaf thrips	*Rhipiphorothrips cruentatus*
-do-	*Selenothrips rubrocinctus*
Inflorescence thrips	*Sciriothrips dorsalis*
-do-	*Rhynchothrips raoensis*
Shoot tip caterpillar	*Cheleria haligramma*
Hairy caterpillar	*Metanastria hyartica*
Leaf folder	*Dudua approbola*
Fruit and nut borer	*Thylecoptila panerosema*
Bark eating caterpillar	*Indarbela tetraonis*
Leaf beetle	*Monolepta longitarsus*
Leaf weevils	*Mylocerus discolor*
Termites	*Odentotermus obesus*
Aphids	*Toxoptera odinae*
Blister beetle	*Zonabris pustulata*
Mealy bug	*Ferrisia virgata*
Tree hopper	*Oxyrachis terrandus*
Spittle bug	*Eurybrachis tomentosus*
Nut crinckler	*Paradesymus rostratus*
Paddle legged bug	*Anoplochnemis phaseana*
Cetonid beetles	*Oxcycetonia versicolor*
-do-	*Heterothinus elegans*
Red banded wasp	*Vespa cincta*
Green plant bug	*Neazara viridula*

BHUBANESWAR

Observations on major pests and natural enemies was done in comparison with the ecological factors in selected trees from January 1999 to December 1999 and the data is presented in Table 3.28.

The shoot caterpillar (*Hypatima haligramma* M.) was active during January and from July to December, the peak incidence of the pest (12.32%) during first fortnight of October. Leaf beetle (*Menolepta longitarsus* Jac.) was found during June and July coinciding with new flushes after the onset of southwest monsoon. Peak period was the first fortnight of July. Leaf miner (*Acrocercops syngramma* M.) was present during July to December with a peak (11.76%) in second fortnight of October. Apple and nut borer (*Nephopteryx* Sp.) was observed during April with a peak (3.13%) in the first fortnight. Yellow and Black inflorescence thrips (*Frankliniella schultzei* T and *Haplothrips ceylonicus* Sch. respectively) were recorded. The later was observed from second fortnight of January to second fortnight of April with a maximum during the second fortnight of March. The yellow thrips were observed from January to first fortnight of April with maximum (4.2) during second fortnight of February.

Besides the above pests, minor pests like leaf folder, brown aphid (*Toxaptera ordinae*), mealy bugs (*Ferrisia virjata* Cell), Gundhi bug (*Leptoconisa acuta* Thumb), hairy caterpillar, leaf and blossom webber (*Lamida moncusalis* L.), bark borer (*Indrabela tetraonis* M.) and termites (*Odomtoterms* Sp.) were observed in small numbers.

A study of field parasitisation of major insect pests on cashew indicated that shoot caterpillar, leaf and blossom webber and leaf miner were parasitized on an average to an extent of 8.0, 7.0 and 16.8% respectively. *Brecon brevicornis* parasitized (12%) on leaf and blossom webber during April. *Elasmus* species parasitized on shoot tip caterpillar (12%) during October and *Sympiesis* species on leaf miner during October. The other predators present in cashew ecosystem were spiders, lady bird beetle, *Verania cinta* Gorh., *Memochilus sexmaculata* F.), black ant, mirid bug etc. The population of these predators is presented in Table 3.28.

CHINTAMANI

The tea mosquito bug was observed from the first fortnight of September to March. Maximum tea mosquito bug population (38.68%) was seen in the second fortnight of February. It was found to be feeding on guava from July to September and on neem from August to November. Leaf miners were found from first fortnight of July to end of February with a maximum of (45.11%) during second fortnight of October. Leaf and blossom webber was found from second fortnight of July to second fortnight of April with a peak during October second fortnight (16.03%). Leaf thrips were maximum during second fortnight of September (16.08 Nos./leaf) with an occurrence from first fortnight of July to first fortnight of April. Inflorescence thrips were found from the first fortnight of April to first fortnight of July with a peak incidence (24.8 No./panicle). Fruit and nut borer was noticed during the second fortnight of March and reached maximum (14.12%) during second fortnight of May and there after sudden reduction was noticed. The seasonal occurrence of major pests of cashew at Chintamani is presented in Table 3.29.

Table 3.28: Seasonal occurrence of pests and predators of cashew at Bhubaneswar

		Pests										Predators		
		Shoot caterpillar (%)	Leaf beetle (%)		Leaf Miner (%)		Apple & Nut borer	Infl. thrips		Leaf folder (%)	Brown aphid (%)	*Bracon brevicornis* on leaf and blossom webber	*Elasmus* on shoot tip caterpillar	*Sympiesis* on leaf miner
			Shoots	Leaves	Shoots	Leaves		YT	BT					
Jan	I	0.28	--	--	--	--	--	0.43	--	1.41	--	--	--	--
	II	0.84	--	--	--	--	--	1.15	0.25	0.57	--	--	--	--
Feb	I	--	--	--	--	--	--	3.48	0.29	--	--	--	--	--
	II	--	--	--	--	--	--	4.20	2.08	--	--	--	--	--
Mar	I	--	--	--	--	--	--	2.92	3.33	--	--	4.0	--	--
	II	--	--	--	--	--	--	1.17	3.75	--	--	8.0	--	--
Apr	I	--	--	--	--	--	3.13	0.19	0.83	--	--	8.0	--	--
	II	--	--	--	--	--	--	--	0.52	--	--	12.0	--	--
May	I	--	--	--	--	--	--	--	--	--	--	12.0	--	--
	II	--	--	--	--	--	--	--	--	--	--	4.0	--	--
June	I	--	--	--	--	--	--	--	--	--	--	4.0	--	--
	II	--	0.65	0.52	--	--	--	--	--	--	--	4.0	--	--
July	I	1.52	1.70	1.19	--	--	--	--	--	--	--	--	--	--
	II	1.20	0.96	0.84	0.23	--	--	--	--	--	--	--	--	--
Aug	I	4.48	--	--	4.20	2.50	--	--	--	--	--	--	--	8.9
	II	6.72	--	--	4.20	2.60	--	--	--	--	--	--	--	12.0
Sept.	I	7.84	--	--	4.48	2.74	--	--	--	--	--	--	4.0	16.0
	II	10.36	--	--	5.04	2.91	--	--	--	--	--	--	8.0	20.0
Oct.	I	12.32	--	--	10.1	4.37	--	--	--	--	--	--	8.0	25.0
	II	9.24	--	--	11.8	3.97	--	--	--	--	--	--	12.0	20.0
Nov.	I	--	--	--	--	--	--	--	--	--	--	--	--	--
	II	5.47	--	--	2.60	1.13	--	--	--	--	--	--	--	--
Dec.	I	4.52	--	--	2.53	1.44	--	--	--	--	0.52	--	--	--
	II	3.30	--	--	2.34	1.42	--	--	--	--	0.82	--	--	--

JAGDALPUR

At Jagdalpur highest infestation was found by CSRB on cashew trees followed by termite and TMB. The predators and parasites present in cashew eco-system were spiders, preying mantid, reduvid bug, black ant, wasp, lady bird beetle and apantales. Seasonal occurrence of pest and their natural enemies is presented in Table 3.30.

JHARGRAM

Stem and root borer was the severe pest in neglected plantations in West Bengal. The pest was recorded throughout the year. The TMB was recorded from late October up to March and its population was low in Jhargram (2%). Shoot and blossom webber was recorded from second fortnight of August. Peak period of infestation coincided with new flushes during second fortnight of October to first fortnight of November. Shoot caterpillar was also a serious pest in West Midnapore and its presence was recorded from October to February. The population was very high during February and September-October months. The thrips were observed during three months coinciding with the flower initiation to nut formation stages. Both leaf thrips and inflorescence thrips were noticed in cashew trees. The percentage of infestation of leaf miner was high during October and January months, which was coincided with the new flush formation. Apple and nut borer was recorded in March and April, but its population was very low. Termites were found damaging the plant from younger stage up to bigger trees throughout the year particularly in red and laterite zones. The incidence of leaf folder was noticed in flushing stage. Only few localized infestation were noticed in certain localities. The data on occurrence of pests is correlated with weather parameters at Jhargram in Table 3.31.

MADAKKATHARA

The tea mosquito infestation was noticed throughout the year except June, July and August. During 1998-99 TMB along with anthracnose disease caused by *Colletotrichum gleosporioides* was very high causing 85 to 95% crop loss. The minor pests recorded were leaf miner (July to October), ranging from 2.8 to 16.45, leaf roller during July - September, blossom webber from December - February (3.5 to 12.3). Infestation by apple and nut borer was very high during January to April ranging from 25 to 28%.

The natural enemies and other agents noticed in the unsprayed area were ants, spiders, mirid bugs, chrysopa, honeybees, flies and wasps. The details of pests recorded are presented in Table 3.32 and 3.33.

VENGURLE

Tea mosquito bug and flower thrips found to attack cashew trees severely during January to March. The leaf miner and CSRB were found to infest cashew throughout the year but in low intensities. The details of occurrence of various pests and natural enemies of cashew pests are presented below in Table 3.34.

Table 3.29: Seasonal occurrence of pests of cashew at Chintamani.

Months	Fortnight	TMB (%)	Leaf miner (%)	Leaf & Blossom webber (%)	Leaf thrips (No/trees)	Inflorescence thrips No./infl.	Fruit & Nut borer (%)
Jan.	I	29.12	14.16	13.08	12.03	5.06	--
	II	31.63	6.32	15.81	12.84	8.12	--
Feb.	I	34.41	3.96	6.42	7.31	12.10	--
	II	38.68	0.26	4.34	5.63	18.98	--
March	I	18.14	--	2.11	2.03	19.88	--
	II	6.06	--	1.21	0.32	20.46	0.26
April	I	1.03	--	0.42	--	24.83	1.82
	II	--	--	--	--	16.28	4.36
May	I	--	--	--	--	8.36	8.06
	II	--	--	--	--	6.92	14.12
June	I	--	--	--	--	2.83	6.32
	II	--	--	--	--	0.42	2.11
July	I	--	0.81	--	0.43	--	0.22
	II	--	3.23	0.33	1.86	--	--
Aug.	I	--	16.03	3.42	3.42	--	--
	II	--	21.04	6.21	8.43	--	--
Sept.	I	0.36	27.08	8.92	14.26	--	--
	II	2.32	31.43	11.14	16.08	--	--
Oct.	I	6.42	40.62	14.62	11.03	--	--
	II	10.08	45.11	16.03	12.93	--	--
Nov.	I	12.46	12.08	6.11	6.42	--	--
	II	14.32	--	--	2.02	--	--
Dec.	I	--	--	--	--	--	--
	II	--	--	--	--	--	--

Table 3.30: Seasonal occurrence of pests and natural enemies at Jagdalpur.

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
CSRB	5.0	6.0	1.0	12.0	12.0	12.0	--	--	--	6.0	--	--
Termite	2.0	4.0	4.0	5.0	5.0	5.0	--	--	--	4.0	6.0	20.0
TMB	6.0	20.0	38.5	52.7	40.0	--	--	--	--	--	--	7.0
P.mantid	3.0	10.0	20.9	25.0	11.0	--	--	--	--	--	--	--
R. bug	2.0	5.0	6.7	2.0	--	--	--	--	--	--	--	--
Spider	8.7	12.7	18.7	28.7	30.6	28.4	25.1	--	--	8.0	10.0	--
L.miner	--	--	2.3	6.7	7.9	7.9	--	--	--	4.5	15.0	--
B. ant	6.50	8.30	10.43	18.0	20.0	10.7	5.2	--	--	30.0	4.0	--
L.folder	--	2.3	5.7	6.7	8.5	9.0	--	--	--	9.0	3.7	--
Apantales	--	2.1	3.6	1.2	--	--	--	--	--	--	--	--
L&B webber	--	--	2.6	3.4	3.4	--	--	--	--	--	--	--
Aphid	--	--	--	--	--	--	--	--	--	--	--	--
L.B.B.	--	--	--	--	--	--	--	--	--	--	8.0	--
A&N borer	--	--	--	6.45	10.4	15.7	--	--	--	15.0	--	--
Wasp	--	2.1	3.2	5.0	--	--	--	--	--	2.0	8.0	--

Table 3.31: Correlation of weather parameters with the occurrence of pests of cashew at Jhargram.

Month	Temp (°C)		RH		Rain fall	No. of Rainy days	Percentage damage					
	Max	Min	AM	PM	(mm)		TMB	BW	LM	Thrips	ANB	STC
Jan.	24.3	11.6	80.2	49.7	21.0	3	2.0	0.8	1.3	0.8	--	6.8
Feb	26.0	16.9	78.5	55.3	5.3	2	1.5	0.4	8.6	12.8	--	8.6
March	31.3	20.9	73.4	49.8	28.0	5	1.0	0.3	3.0	10.3	1.0	4.0
April	36.0	20.8	78.8	41.0	34.6	4	--	--	--	8.4	2.6	0.3
May	37.0	23.5	80.6	44.5	36.2	6	--	--	--	--	1.0	--
June	37.8	24.0	84.4	50.3	98.6	9	--	--	--	--	--	--
July	35.3	23,5	90.5	74.3	384.6	24	--	--	--	--	--	--
Aug.	35.0	24.0	90.0	74.0	309.3	23	--	0.6	1.2	--	--	1.6
Sept.	35.6	25.6	85.9	65.4	238.3	15	--	10	6.4	--	--	12.6
Oct.	30.2	22.8	84.5	50.2	160.4	13	0.3	16.4	13.3	--	--	6.3
Nov.	29.0	14.6	80.5	44.3	36.0	6	0.8	12.3	4.0	--	--	2.8
Dec.	25.5	12.9	76.4	39.9	19.2	4	1.9	5.6	0.6	--	--	0.8

TMB = Tea mosquito bug BW = Shoot and blossom webber LM = Leaf miner

ANB = Apple and nut borer STC = Shoot tip caterpillar

Table 3.32: Seasonal occurrence of pests of cashew at Madakkathara.

Month	Temp (°C)		RH		Rain fall	No. of Rainy days	Leaf miner (%)		LR	BW	Thrips		AP&NB
	Max	Min	AM	PM	mm		Shoot	Leaves	(%)	(%)	%	Score	
Jan.	21.5	32.4	76	40	0	0	--	--	--	4.85	2.56	0.08	26.75
Feb.	23.3	34.5	77	35	22.8	1	--	--	--	12.3	--	--	24.85
March	25.6	35.5	88	48	00	--	--	--	--	--	--	--	28.31
April	24.5	33.4	88	58	39	4	--	--	--	--	--	--	--
May	24.7	30.7	92	72	430.5	18	--	--	--	--	--	--	--
June	23.0	29.4	94	75	500.2	23	--	--	--	--	--	--	--
July	23.0	28.4	96	82	823.3	28	2.82	8.55	1.75	--	--	--	--
Aug.	22.9	29.8	94	73	260.1	12	3.5	14.65	3.5	--	--	--	--
Sept.	23.4	31.6	89	63	28.4	3	--	15.2	3.8	--	--	--	--
Oct.	23.2	30.5	94	75	506.2	15	--	16.45	--	--	--	--	--
Nov.	22.7	31.4	81	57	9.1	1	--	--	--	--	1.4	0.01	--
Dec.	22.7	30.7	72	48	0.0	0.0	--	--	--	3.55	5.23	0.27	--

LR = Leaf roller BW = Blossom webber AP&NB = Apple and nut borer

Table 3.33: Monthly occurrence of TMB and natural enemies of cashew pests at Madakkathara.

Month	Tea Mosquito Bug						Ants	Spider	Mirid bug	Chry-sopa	Bees/ flies/ wasps
	Shoots		Panicles		Nuts						
	(%)	Score	(%)	Score	(%)	Score					
Jan.	--	--	48.55	1.85	65.25	2.55	3.6	2.50	--	0.87	1.65
Feb.	--	--	57.00	2.12	75.00	2.65	2.8	1.70	--	1.50	2.5
March	--	--	--	--	88.00	2.10	2.6	0.87	--	--	--
April	--	--	--	--	82.50	3.60	3.1	1.20	--	--	--
May	--	--	--	--	95.50	3.90	1.5	1.00	--	--	--
June	--	--	--	--	--	--	0.25	0.53	--	--	--
July	--	--	--	--	--	--	0.63	0.61	--	--	--
Aug.	--	--	--	--	--	--	2.4	0.95	2.60	--	0.77
Sept.	0.95	0.02	--	--	--	--	2.8	1.30	0.80	--	1.67
Oct.	1.30	0.1	1.35	0.03	--	--	2.71	1.89	1.30	--	2.65
Nov.	2.50	0.2	3.65	0.30	--	--	4.60	2.70	--	0.65	2.70
Dec.	--	--	3.70	0.40	2.85	0.12	3.96	3.10	--	1.20	3.50

VRIDHACHALAM

The occurrence of pests and natural enemies was recorded in farmers plantations at Pudukoorapettai village. In the fields, observations were taken at every fortnight on the intensity of pest infestation and their seasonal abundant (Table 3.35). The natural enemies of cashew and their hosts in the stage at which attacked, period of occurrence and their intensity were recorded and presented in 3.36.

Table 3.34: Occurrence of pests of cashew and their natural enemies at Vengurle

Name of Pest	Scientific Name	Occurrence	Intensity
Tea mosquito bug	*Helopeltis antonii*	Jan – March	Severe
		April	Moderate
		May - Dec.	Severe
Flower thrips	*Rhipiphorothrips* sp.	Jan – March	Severe
		April	Moderate
		May - Nov.	Low
		Dec.	Severe
CSRB	*Plocaederus ferrugineus*	Throught the year	Low
Leaf Miner	*Acrocercops syngramma*	Through out the year	Low
Aphid	*Toxoptera odinae*	Jan - March	Low
Mealy bug	*Ferisia virgata*	Feb - March	Low
Leaf eating beetles	*Manolepta* sp. *Coenoblus* sp.	June - August	Low
Leaf cutting weevils	*Depous marginatus*	June - August	Low
Web Worm	*Orthaga exvinacae*	Oct - November	Low
Semilooper	--	Oct - November	Low
Apple & Nut borer	*Nephopleryx* sp.	Jan - April	Low
Natural enemies			
Spider	*Three species**	Throughout the year	Low
Leady bird beetle on aphids	*Coccinella saptempunctata*	Jan – March	Moderate
		Dec	Low
Praying mantid	--	Jan – March	Low
		Oct - December	Low
Crysopa	--	Jan - February	Low
Hymenopteran parasite on apple and nut borer	--	Feb - April	Low

Table. 3.35: Occurrence of cashew pests at Vridhachalam.

Name of Pest	Scientific Name	Occurrence	Intensity
Tea mosquito bug	*Helopeltis antonii*	March-April	3.75
Flower thrips	*Scirtothrips dorsalis*	April-May	8.2
CSRB	*Plocaederus ferrugineus*	Through out the year	8.4
Leaf Miner	*Acrocercops syngramma*	August-October	7.3
Aphid	*Toxoptera odinae*	March	1.46
Leaf twisting weevils	*Apoderus transquebaricus*	December-March	1.05
Apple & Nut borer	*Thylocaptila penerosema*	Feb - April	4.67
Green leaf folder	*Sylepta aurantiacalis*	July-Sept. Nov - March	18.6
Pink leaf folder	*Anigraea albomaculata*	Nov - February	9.44
Shoot tip caterpillar	*Hypotima haligramma*	April - June	3.7
Diamond hairy caterpillar	*Metanastria hytaca*	December - March	17.5
Leaf weevil	*Myllocerus* spp.	Throughout the year	2.49
Tailed mealy bug	*Ferisia virgata*	March - May	7.9
Leaf thrips	*Rhisphiphorothrips cruentatus*	July - August	3.45
Termites	*Odontotermes obesus*	December-January	5.4
Snail	*Cryptozona bistrialis* (Beck)	April-August	4.7

Table 3.36: Occurrence of national enemies of pests of cashew at Vridhachalam

Natural enemy	Host	Stage of attack	Occurrence	Intensity
Parasitoids				
Cotesia (Apanteles) sp.	Green leaf folder	Larva	Dec - Feb.	45.00
Brachymeria sp.	Diamond hairy caterpillar	Pupae	Feb - April	10.25
Predators				
Menochilus sexmaculatus	Aphids, Thrips	Adult & Nymphs	Feb - March	1.00
Scymnus sp	Mealy bugs	Adult & Nymphs	April - June	2.25
Chrysoperia comea	Mealy bugs	Nymphs	April - June	3.50
Preying mantids	Leaf folders			
Leaf and blossom webber	Adult & Nymphs	Oct. - March	0.50	
Spiders	Leaf folders			
Leaf and blossom webber	Adult & Nymphs	Sept - April	1.30	
Pathogens				
Metarrhizium anisopliae	Stem and Root borer	Grubs & Pupae	Oct - Feb	13.50
Beauveria bassiana	Stem and root borer	Grubs & Pupae	Oct - Feb	10.0

Ent. 4: Screening of germplasm to locate tolerant/resistant types to major pests of the region.

Centres:

East Coast: Bhubaneswar, Jhargram, and Vridhachalam
West Coast: Madakkathara, Vengurle
Maidan tract: Chintamani

The objective is to identify germplasm accessions tolerant/resistant to the pests, of regional importance.

BHUBANESWAR

Screening of MLT-86 accessions against the resistance/ tolerance to shoot tip caterpillar revealed that out of the 16 accessions tested, H-1610 was the highly resistant genotype (0.00 - 1.10% damage) followed by VTH-30/4 (0.00-1.15%) and the accession VTH-59/2 was the highly susceptible genotype (1.65 - 39.6%) followed by H-2/16 (0.00 - 18.85% damage).

The accessions in the germplasm were also tested against the tolerance/ resistance and out of the 70 accessions tested it was found that the accession OC34 was least infested by shoot tip caterpillar (0.03 - 0.80%) followed by OC 7 and OC 9 (0.00 - 1.00%) infestation. The accession OC67 showed high susceptibility (5.23 - 31.70% followed by OC55 (2.30 - 31.30% damage). The above observations were recorded during August to October 1999 period.

CHINTAMANI

Different accessions/varieties were screened for tea mosquito bug infestation from MLT 86. The results revealed that all the accessions/varieties were affected by TMB at panicle stage. However, the least mean damage score was recorded in TN 40 (0.34), H 1610 (0.42), M 44/3 (VRI 0.61) and V 3 (0.61). In germplasm ME 4/4 (0.46) and 1/64 (0.43) recorded least damage score.

JHARGRAM

Eight germplasm accessions were screened against inflorescence thrips and shoot tip caterpillar. The mean incidence of shoot tip caterpillar ranges from 4.9 to 9.8 and 5.1 to 10.2.

MADAKKATHARA

The MLT 86 accessions were screened against the pests of cashew in the field under natural conditions, the grafts of 16 varieties were subjected to cage multiplication studies and reaction to feeding was noted on 0-4 scales. Least amount of feeding was found in varieties H 8-8 and H 1598 (0-1), whereas high feeding was noticed in the case of H 8-15 (3-4). H 8-7, K 10-1, H 3-17, K 22-1 and H 1591 showed less damage by the TMB (1-2).

VENGURLE

The released varieties and hybrids produced at the Centre were screened against TMB and the damage was recorded as percentage incidence and range score. Highest damage was observed in V-4 (19.82 - 21.91%, 0.79 - 0.83 score) followed by Hy 303 (23.61% and 0.94 score). Least damage was observed in V-1 (14.64 - 19.27%, 0.59 - 0.77 score). The data on screening of germplasm against TMB is presented in Table 3.37.

VRIDHACHALAM

F1 hybrids of high yielding varieties and TMB field tolerant types were screened for natural incidence of TMB. Lowest incidence of TMB was observed in M 26/2 x M 26/1 (H 13) with a mean score of 1.00. Highest damage was observed in M 44/3 x M 26/1 (H 16) and M 44/3 x M 45/1 (H 17) with a mean score of 2.25 in both varieties. The MLT 86 entries and germplasm types were also screened against the pests of cashew. The mean score of damage by TMB in MLT entries ranged from 1.0 - 2.50.

Table 3.37: Screening of germplasm against TMB at Vengurle.

Accession	Score	Per cent
V-1	0.59 - 0.77	14.64 - 19.27
V-2	0.61 - 0.82	15.41 - 20.54
V-3	0.64 - 0.80	15.87 - 20.00
V-4	0.79 - 0.83	19.82 - 23.91
V-5	0.70 - 0.83	17.42 - 20.83
V-6	0.69 - 0.86	17.22 - 21.43
V-7	0.62 - 0.83	15.51 - 20.83
Hy 303	0.94	23.61
Hy 320	0.81	20.21
Hy 367	0.62 - 0.80	15.84 - 19.90

CHAPTER II. ORGANISATION

(a) HISTORY, OBJECTIVES, GROWTH AND SALIENT ACHIEVEMENTS

The All India Coordinated Spices and Cashew nut Improvement Project (AICS & CIP) was started during the fourth five Year Plan in 1971 in which five centres (four University centres and one ICAR-institute based centre) were identified for conducting research on cashew. These centres were located at Bapatla (Andhra Pradesh), Vridhachalam (Tamil Nadu), Anakkayam (Kerala) (later shifted to Madakkathara), Vengurle (Maharashtra) and CPCRI, Regional Station, Vittal (Karnataka).

During the fifth plan period, one centre at Bhubaneswar (Orissa) and in sixth Plan period two centres one at Jhargram (West Bengal) and another at Chintamani (Karnataka) were added. During VIII Plan period one centre at Jagdalpur (Madhya Pradesh) and a sub centre at Pilicode (Kerala) were started.

The headquarters of the project was located at Central Plantation Crops Research Institute, Kasaragod. During the Seventh Plan period, the Project was bifurcated into:

1. All India Coordinated Cashew Improvement Project. The headquarters of the independent cashew project was shifted to National Research Centre for Cashew, Puttur in 1986.
2. All India Coordinated Spices Improvement Project.

Presently, there are eight coordinating centres and one sub-centre, four in the east coast viz. Bapatla, Bhubaneswar, Jhargram, Vridhachalam, three in the west coast viz. Madakkathara, Vengurle, Pilicode and one in the Maidan Parts of Karnataka-Chintamani and one in the Central India at Jagdalpur.

The objective of the Project is to increasing production and productivity through:

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

The first Workshop of All India Coordinated Spices and Cashew nut Improvement Project was held at Kasaragod in October 1971 in which the research programmes were drawn up, identifying the problems and fixing the priorities. Subsequently, the progress of work was reviewed and research programmes modified / added as per the need in the Workshops held in Trivandrum, Kerala (1972); Coimbatore, Tamil Nadu (1975); Panjim, Goa (1978); Trichur, Kerala (1981); Calicut, Kerala (1983); Trivandrum, Kerala (1985); Bhubaneswar, Orissa (1987); Coimbatore, Tamil Nadu (1989); National Group discussion in lieu of X Biennial Workshop at Kasaragod, Kerala (1991); Bangalore, Karnataka (1993), Kasaragod, Kerala (1995) and Dapoli, Maharashtra (1997) and Bhubaneswar, Orissa (1999). Two group discussions were also held one in horticulture at CPCRI, Regional Station, Vittal (1986) and other in entomology at Trichur (1988). Recently, on 21st January 2000 at Cashew Research Station, Madakkathara a group discussion was held to discuss about High density planting with different levels of fertilizer and pruning in cashew plantation and Soil fertility based fertilizer recommendations.

Highlights of the XIV Biennial Workshop of AICRP on Cashew

The XIV Biennial Workshop of All India Coordinated Research Project on Cashew (AICRP on Cashew) was held at Orissa University of Agriculture & Technology, Bhubaneswar from 28th to 30th October 1999.

The important persons present during the workshop were Mr. R.K. Bhujabal, Vice Chancellor, OUAT, Bhubaneswar; Dr. S.P. Ghosh, DDG (Hort), Dr. R.N. Pal, ADG (PC), ICAR; Dr. KV Ahmad Bavappa, FAO Consultant & Retd. Director, CPCRI; Dr. P. Rethinam, Director, NRC Oil Palm; Dr. H.H. Khan, Project Coordinator (Palms), CPCRI; Mr. PP Balasubramanian, Director, DCCD, Kochi; Dr. CP Radhakrishnan Nair, Sr. Scientist, CPCRI (RS), Kayamkulam; Dr. GSLHV Prasada Rao, Professor (Agrimet), KAU Thrissur and Scientists from NRCC and Coordinating Centres. Delegates from State Department of Agriculture/Horticulture were also participated.

There were three technical sessions, namely Crop Improvement, Crop Management, Crop Protection.

The Crop Improvement session was chaired by Dr. KV Ahmad Bavappa. Balli-2 Variety developed by ICAR Research Complex for Goa was recommended for release in Goa State during the Session as Goa-1. During the session, two lead papers were presented namely one on "Influence of weather and soil factors on cashew across east and west coast of India" by Dr. GSLHV Prasada Rao, and the other on "Review of performance of cashew varieties in different agro-ecological regions of India" by Dr. M.G. Bhat and Dr. EVV Bhaskara Rao. The progress of research work done under germplasm collection and evaluation, varietal evaluation and hybridization were reviewed. The Crop Management session was chaired by Dr. P. Rethinam in which the progress in agronomy and horticulture projects were reviewed and recommendations were made on fertilizer application, drip irrigation, high density planting, organic manuring, etc.

Inaugural session of XIV Biennial Workshop of AICRP on Cashew

Major recommendations of the Workshop were:

* While recommending cashew for an area, more than one variety may be recommended so as to avoid reduce yield losses due to pest outbreak.
* Steps have to be taken to double the productivity in all cashew growing areas.
* Dwarf accessions may be used in hybridization programme at the Centres wherever available.
* Laying out of a new experiment on fertilizer application and pruning trials in high density plantations was suggested in order to increase productivity. This experiment was thus included in the technical programmes of Chintamani, Jhargram, Madakkathara, Vengurle and Vridhachalam.
* Correlation of pest incidence with weather parameters has to be strictly followed by all the centres so as to understand and workout strategies for pest control.

Group Meeting held at Cashew Research Station (KAU) Madakkathara on 21st January 2000.

As per the decision taken in the XIV Biennial Workshop of AICRP on Cashew held at OUAT Bhubaneswar, a group meeting was convened at Cashew Research Station (CRS), Madakkathara for discussing the following items.

* High density planting with different levels of fertilizer and pruning in cashew plantation.
* Soil fertility based fertilizer recommendations, and
* Varietal recommendations for different cashew growing districts of the country.

Dr. EVV Bhaskara Rao, Director and Project Coordinator (Cashew); Dr. K.V. Peter, Director of Research, Dr. GHSLV Prasada Rao, Professor (Agrimet), Dr. N. Saifuddin, Professor (Soil Science), KAU, Thrissur; Mr. PP Balasubramanian, Director, DCCD, Kochi; Mr. N. Yadukumar, Sr. Scientist, NRCC Puttur; Dr. KM Nair, Sr. Scientist, NBSS&LUP, Bangalore; Dr. M. Abdul Salam, Assoc. Professor & Head, Dr. (Mrs.) Susannamma Kurien, Assoc. Professor, Dr. V.G. Jayalekshmy, Asst. Professor, CRS, Madakkathara; Dr. Y. Raghuramulu, Horticulturist, ARS, Chintamani and Mr. V. Lakshmanan, Jr. Horticulturist, RRS, Vridhachalam have participated in the discussions.

During the deliberations the design and layout prepared by Dr. M. Abdul Salam, Dr. Y. Raghuramulu and Mr. K. Vijayakumar, Sr. Scientist of CPCRI, Kasaragod were considered. The split plot plan designed by Mr. K. Vijayakumar was finally accepted for high density planting with different levels of fertilizer application. During the discussion, it was however decided not to prune the cashew trees except for shape pruning.

Dr. M. Abdul Salam and Mr. N. Yadukumar have presented their experimental data and recommendations on soil fertility based fertilizer recommendations. The generally accepted national level of classification of soil as low fertile, medium fertile and high fertile was thought to be feasible for soil test based fertilizer application recommendations for soil amendment. Based on this, the soils of

different Coordinating Centres and soils of few farmers were categorized and a chart was prepared for dosage compensation of nutrients.

It was decided to obtain the data available for rubber growing soils of the country for understanding the soil fertility of different regions, preparing agro climatic base by integrating climatic data with soil nutrient status and comparing the data from high fertile soil with low fertile soil to understand the influence of soil fertility on the performance of cashew group for a given agro climatic region.

Mr. Yadukumar presented his classification of different varieties for region specific recommendations. It was observed that the performance of the variety released from a particular center was good for cultivation in some other centers also based on the data available on maximum and minimum temperatures, relative humidity, rainfall, evaporation, water deficit, bisexual flower phase and harvesting periods. These climatological data were compared for 25 cashew-growing districts in different States.

Even though there are 35 cashew-growing districts in India spread over different states, the comparable data on weather parameter could be obtained only for 25 districts. Therefore, it was decided to collect information for remaining districts also. The region specific varietal database will be compiled at NRCC Puttur by gathering the above information.

The significant achievements of the project are summarized below:

1. The collection, conservation and evaluation of germplasm accession is under progress at various AICRP Centres of Cashew. The germplasm material conserved so far under different AICRP Centres amounts to 1099. Current years share accounts to 40. The existing germplasm accessions were evaluated for their performance. At Bapatla, T No. 277 performed well in early stages of vegetative growth. OC-14 with a yield of 4.1 kg/tree performed better at Bhubaneswar. The highest yield (21.91 kg/tree) was recorded for 2/6 ARSC, which had extended continuous mixed phase of flowering at Chintamani. At Jagdalpur, NRC-140 performed better than other accessions. At Jhargram, highest yield was obtained for JGM 74/6 (14.33 kg/tree). At Vridhachalam, among the old germplasm accessions, M 15/4 performed well and among the new accessions, M 89/2 performed better.
2. Under the varietal evaluation, three experiments are under progress at various centres of AICRP. Varieties from Bapatla and Vengurle are being evaluated in the experiment on Comparative Yield Trial at Chintamani. The variety V-5 performed good in terms of yield (6.03 kg/tree).
3. Multilocation trial started from 1986 is in progress at four AICRP Centres. At Bhubaneswar and Jhargram, highest yield was obtained for H 2/16. The variety was consistently yielding high for eight years at Bhubaneswar. At Chintamani, during the current year, H 1600 has performed better than earlier

M 44/3 which was better in terms of cumulative yield. At Madakkathara, highest yield was obtained for V-5.

4. In a separate multilocation trial laid out since 1992, the varieties and hybrids from different centres are under evaluation at eight AICRP Centres. At Bapatla, T No. 10/19 recorded highest yield, at Bhubaneswar, BPP 30/1 performed well in terms of yield. At Chintamani, NRCC Selection-2 has recorded highest yield for the previous five years. At Jagdalpur, H 303 performed better. At Jhargram, H 255 performed better in vegetative growth. M 15/4 yielded better than other varieties at Madakkathara. At Vengurle, H 367 and H 303 performed good in terms of vegetative growth and at Vridhachalam, M 44/3 yielded better than other varieties.
5. In the hybridization programme at Bapatla, 130 F1 hybrid progenies are getting established in the field. At Bhubaneswar, highest yield (2.2 kg/tree) was obtained from Bhubaneswar-1 x Kankadi which was four years old. At Chintamani, 54 F1 progenies were field planted. At Madakkathara, out of the 56 hybrids planted during 1993, H - 2 has performed better in terms of yield. The F1 hybrids of later years are under field establishment stage. At Vengurle, V-5 x Kankadi performed better than hybrids. At Vridhachalam, M 4/3 x M 45/1 performed better than M 10/4 x M 26/1 which had highest cumulative yield for ten years.
6. Increasing dose of Nitrogen fertilizer increase the yield and performance of cashew trees. At Chintamani, both P & K have shown influence on yield. The treatments N 1500, P 250, K 250 as well as N 1000, P 250 and K 250 have shown high yield. At Jhargram, 250g K was found to enhance yield.
7. Yield per tree was maximum in widest planting i.e. 10x10 m rectangular system, whereas, yield per unit area was maximum at 6x6x6 m triangular planting at Jhargram. At Vengurle, highest yield per unit area was obtained for 5x5m square planting and highest nut yield per tree was seen in 8x8 m square planting. 4x4m high density planting trial is at its initial stages in various AICRP Centres.
8. Intercropping turmeric and amorphophalus in cashew plantation was found to be economical at Bhubaneswar. Groundnut was found economical at Jhargram and Vridhachalam. Bittergourd was found highly profitable at Vengurle.
9. Laying out of drip irrigation experiment is under progress at Chintamani, Vengurle and Vridhachalam.
10. One dwarf rootstock was obtained at Bhubaneswar, which was used in grafting programme for screening of rootstock for dwarfing characters. At Madakkathara, two less vigorous types were evaluated. Twenty Brazilian dwarf type obtained from a farmer are also under evaluation. In order to understand rootstock-scion interaction, single and double grafts of various combinations were tried. However, due to low success and lack of feasibility both the horticulture experiments were withdrawn from the technical programme as per the decision taken in the XIV Biennial Workshop of Cashew held at Bhubaneswar.

11. In all the Centres, trees which had received spray at flowering and fruiting stages, least incidence of TMB was recorded. Standard spray of monocrotophos 0.05% at flushing, endosulfan 0.05% at flowering and 0.1% carbaryl at fruiting stages was the most effective control against TMB and other minor pests of cashew. However, the population of natural enemies was maximum in trees left untreated with chemicals. Unfortunately, at Madakkathara, the damage due to TMB was very high and all the control measures did not succeed. The TMB infestation was combined with the *Collectorichum gleosporioides* resulting in high losses even in standard spray.
12. During the year minor pests were low compared to the previous years at Bapatla. At Bhubaneswar, shoot tip caterpillar; inflorescence thrips and leaf folders were found affecting cashew trees, which could be controlled effectively by the above-mentioned standard sprays. At Chintamani, leaf and blossom webber and inflorescence thrips were a problem and were effectively controlled by standard sprays. At Jhagram, the incidence of leaf miner, shoot and blossom webber and shoot tip caterpillar were effectively controlled by spraying with monorotophos (0.05%) one spray at flushing, endosufun (0.05%) one spray at flowering. Standard sprays at Madakkathara could effectively control these same pests; inflorescence thrips and pink and green leaf folders as well as nut borers and other minor pests could be controlled by standard spray at Vengurle.
13. Among the alternative new chemicals being tested for the control of TMB and other minor pests of cashew, at Bapatla, Profenophos 0.05% was found better than other treatments. At Bhubaneswar and Jhargram also the same chemical performed well, but it was not significantly better than the standard chemicals. At Chintamani, standard spray and spray with Chlorpyriphos 0.05% were of similar control effect, even though all the chemicals tried had comparable control over the pests. At Jagdalpur, ethofenprox was found a better treatment than other treatments. At Madakkathara, T2, T3 and T4 were equal with the standard spray. At Vengurle, chlorpyriphos was comparable with the standard spray but, during later stages, the standard spray itself was a good control over the pests. At Vridhachalam, standard spray was the most effective control.
14. In prophylactic control trial of cashew stem and root borer (CSRB), mud slurry + carbaryl swabbing along with lindane soil application was found to be the best treatments. At Jhargram, Madakkathara and Vengurle, swabbing with neem oil 5% and application of sevidol (75g/tree) was the most effective treatment. At Vridhachalam, swabbing coal tar thrice with application of lindane was found to be most effective. Under curative control trials also removal of grubs followed by the above treatments were found effective. The treatment with antagonistic fungus *Metarrhizium anisopliae* was under refinement at Bhubaneswar, Madakkathara, Vengurle and Vridhachalam centres.

15. The bio-ecology of more than twenty important pests were recorded. Their occurrence and peak population periods were recorded along with the weather parameters at various AICRP Centres.
16. Screening of germplasm to locate tolerant/resistant types for major pests of the region was carried out. It was found that H 1610 at Bhubaneswar, T No.40 followed by H 1610 at Chintamani, H 8-8 and H 1598 at Madakkathara, V-1 at Vengurle and hybrid M 23/2 x M 26/1 at Vridhachalam were moderately resistant to TMB attack in caging trials.
17. More than 2,91,000 grafts were produced during the year at different AICRP centres. 85 demonstration plots are also being maintained at different States by the Centres. The Scientists from various centres were involved in training of farmers in Cashew Production Technology including production of grafts, cultivation practices and pest control methods. Various officials from the State Government Department of Agriculture/Horticulture as well as non-governmental organizations were also trained by the Scientists of the Centres regarding the improved cashew cultivation practices. The Scientists were also participated in AIR/TV programmes on cashew cultivation practices.

(b) Transfer of Technology Efforts

Following number of grafts were produced and distributed to various governmental/non governmental agencies and farmers during the year.

Grafts produced:

CENTRE	Number of grafts produced
Bapatla	15,000
Bhubaneswar	32,000
Chintamani	40,000
Jagdalpur	500
Madakkathara	25,673
Pilicode	8,500
Vengurle	1,70,000
TOTAL	2,91,673

Bhubaneswar

Pest campaigns were organized at five different villages, viz. Kapadala, Sisunda, Gondayotha, Talapatma, Majhiapasi. 160 farmers have taken part in these campaign. Besides, scientists have participated in six training programmes at Puri, Cuttack and Dhenkanal districts. One television programme in two parts was telecast by Doordarshan in which scientists took part. 22 demonstration plots are being maintained at different farmers plots.

Chintamani

The scientists took part in programmes organized by Directorate of Cashewnut and Cocoa Development, Kochi. Two training programmes were conducted for the benefit of farmers on improved cashew cultivation practices. 46 Modal Clonal Cashew Orchards are being maintained in the farmers fields.

Jhargram

Training programme on Vegetative Propagation was organized at Jhargram. Training on Cashew Production Technology was also conducted at Jhargram as well as at Pukuria. Twenty six farmers were trained for production of grafts and improved cultivation.

Madakkathara

A national training programme on Cashew Production Technology for senior officials was conducted. Three one-day training programmes for Department of Agriculture officials of Kerala State were conducted in which 76 officials participated at Pilicode, Feroke and Madakkathara. A state level two day training programme for Agricultural Officers and Assistants was conducted in which 40 officials participated.

The Scientists of the Centre gave two Radio Talks in AIR/Doordarshan. Besides, the Scientist-in-Charge was a member in many developmental committees and programmes for development of cashew in the State.

Pilicode

Ten cashew demonstration plots are being maintained in farmers plots.

Vengurle

Training programme on three items namely, Cashew Production Technology, Plant Protection and Post Harvest Technology were given to farmers at Ajara Tahsil and Kolhapur Dists. Two training programmes were organized at RFRS, Vengurle. Besides, Cashew Production campaigns for farmers were also conducted.

Seven model demonstration plots are being maintained in the Sindhudurg Dist.

Dr. M. G. Bhat, NRCC and Dr. B. Jayaprakash Naik, Pilikode, standing by the side of a dwarf cashew accession

(c) STAFF POSITION

HEADQUARTERS:

Project Coordinator	:	Dr. E.V.V. Bhaskara Rao
Technical Information Officer	:	Shri. H. Muralikrishna
Stenographer	:	Shri O.G. Varghese

PROJECT CENTRES:

Cashew Research Station, (ANGRAU), Bapatla 522 101, Andhra Pradesh.

Horticulturist	:	Dr. M. Lakshmi Narayana Reddy
Asst. Entomologist	:	Vacant
Astt. Agronomist	:	Vacant
Senior Tecnical Assistant	:	Mr. B. Krishnamurthy
Jr. Technical Assistant	:	Mr. K. Ranga Rao
Grafter	:	Mr. V. Kantha Rao

Cashew Research Station, (OUAT), Bhubaneswar 751 003, Orissa.

Horticulturist	:	Dr. P.C. Lenka
Jr. Horticulturist	:	Dr. K.C. Mohapatra
Jr. Entomologist	:	Mr. R.N. Mohapatra
Sr. Technical Assistant	:	Mr. P.C. Swain
Jr. Technical Assistant	:	Mr. R.C. Routray
Grafter	:	Mr. R.K. Pradhan

Agricultural Research Station, (UAS), Chintamani 563 125, Karnataka.

Horticulturist	:	Dr. Y. Raghuramulu
Jr. Entomologist	:	Mr. G.T. Thirumalaraju
Jr. Horticulturist	:	Mr. Vishnuvardhan
Sr. Technical Assistant	:	Mr. Shivappa
Sr. Technical Assistant	:	Mr. N. Janakiraman
Grafter	:	Vacant

Zonal Agricultural Research Station, (IGAU), Jagdalpur 494 005, Madhya Pradesh.

Jr. Entomologist	:	Dr. Sanjay Sharma
Jr. Horticulturist	:	Dr. O.P. Awasthy (from 03.11.99)
Sr. Technical Assistant	:	Mr. S. Das
Grafter	:	Mr. Jagdev

Regional Research Station, (BCKV), Jhargram 721 507, West Bengal.

Horticulturist	:	Dr. A. Bandyopadhyay (up to 25.11.99)
Jr. Horticulturist	:	Dr. S.B. Chattopadhyaya
Jr. Entomologist	:	Dr. B. Bandyopadhyay
Sr. Technical Assistant	:	Mr. S. Sarkar
Jr. Technical Assistant	:	Mrs. K. Bose
Grafter	:	Mr. Jagannath Shaw

Cashew Research Station, (KAU), Madakkathara, 680 656, Kerala.

Horticulturist	:	Dr. M. Abdul Salam
Jr. Entomologist	:	Dr. (Mrs.) Susanamma Kurien
Jr. Breeder	:	Dr. (Mrs.) V. Jeyalakshmi (from 01.12.99)
Sr. Technical Assistant	:	Abdusaboor, P (from 1.11.99)
Jr. Technical Assistant	:	Mr. K.S. Thankappan (from 1.11.99)
Grafter	:	Mr. S. Sasi

Regional Agricultural Research Station, (KAU), Pilicode 671 353, Kerala.

Jr. Horticulturist	:	Dr. B Jayaprakash Naik

Regional Fruit Research Station, (KKV), Vengurle 416 516, Maharashtra.

Horticulturist	:	Dr. B.B. Sapkal
Jr. Entomologist	:	Mr. A.Y. Munj
Jr. Breeder	:	Mr. S.B. Deshpande
Sr. Technical Assistant	:	Mr. P.G. Dhuri
Jr. Technical Assistant	:	Mr. R.L. Mayekar

Regional Research Station, (TNAU), Vridhachalam 606 001, Tamil Nadu.

Horticulturist	:	Dr. R. Sankaranarayanan
Jr. Horticulturist	:	Mr. V. Lakshmanan
Jr. Entomologist	:	Mr. V. Ambethgar
Sr. Technical Assistant	:	Mr. S. Manickam
Jr. Technical Assistant	:	Mr. T. Chinnadurai
Grafter	:	Mr. P. Gopalakrishnan

(d) BUDGETARY PROVISION AND ACTUAL EXPENDITURE DURING 1999-2000

ALLOCATION

(Rs. in Lakhs)

Centre	Pay & Allowances	TA	Recurring contingency	Non-recurring contingency	Total	ICAR Share
Bapatla	7.50	0.25	1.20	--	8.95	6.71
Bhubaneswar	7.50	0.25	1.20	--	8.95	6.71
Chintamani	7.50	0.25	1.20	--	8.95	6.71
Jagdalpur	2.50	0.25	0.80	--	3.55	2.66
Jhargram	6.50	0.20	1.20	--	7.90	5.93
Madakkathara	6.97	0.25	0.95	--	8.97	6.13
Pilicode	2.20	0.20	0.40	--	2.80	2.10
Vengurle	6.80	0.25	1.20	--	8.25	6.19
Vridhachalam	7.70	0.25	1.20	--	9.15	6.86
TOTAL	55.17	2.15	9.35	--	66.67	50.00

ACTUAL EXPENDITURE

(Amount in Rupees)

Centre	Pay & Allowances	TA	Recurring contingency	Non-recurring contingency	Total	ICAR Share
Bapatla	4,23,803	14,513	1,19,998	--	5,58,314	4,18,735
Bhubaneswar	6,90,727	20,000	1,20,000	--	8,30,727	6,23,045
Chintamani	5,73,941	19,271	1,15,358	--	7,08,570	5,31,428
Jagdalpur	2,87,481	4,897	81,430	--	3,73,808	2,80,356
Jhargram	6,38,222	20,000	1,20,000	--	7,78,222	5,83,667
Madakkathara	8,00,998	24,571	95,307	--	9,20,876	6,90,657
Pilicode	1,53,500	18,400	44,700	--	2,16,600	1,62,450
Vengurle	7,04,302	21,976	1,08,589	--	8,34,867	6,26,150
Vridhachalam	9,64,062	24,769	1,23,258	--	11,12,089	8,34,067
TOTAL	**52,37,036**	**1,68,397**	**9,28,640**		**63,34,073**	**47,50,555**

(e) MONITORING OF PROJECT BY COORDINATOR

The details of the visit by Project Coordinator to review the programmes being implemented at different centres is as follows:

22.01.2000	:	Madakkathara
01.02.2000	:	Vengurle
03.02.2000	:	Chintamani
11.02.2000	:	Pilicode
22.02.2000	:	Bhubaneswar
24.02.2000	:	Jhargram
28.02.2000	:	Bapatla

During the visit to these centres, the technical programmes allotted to each of the centres and the progress made so far was reviewed along with inspection of the field experiments. University authorities were met to appraise the progress of work in the centres.

Dr. E.V.V. Bhaskara Rao observing a cluster bearing bunch of Kanaka cashew hybrid (H-1598) at Pilicode

(f) FUNCTIONING OF EACH CENTRE

BAPATLA

It was suggested for laying out of demonstration plots of high density planting atleast in one hactre area. Permission for cutting the concluded NPK trial was sought from the University. In the net-working programme on cashew germplasm collection, Dr. KRM Swamy, Principal Scientist, NRCC along with the Horticulturist from the Bapatla Centre suggested to collect germplasm accessions from the seedling progeny orchards.

BHUBANESWAR

The trees, which were uprooted during super cyclone, have flowered profusely in spite of damage to the taproots. However, these trees after current fruiting season have to be removed after collection of scion sticks for multiplication. The high density-cum-fertilizer trial may be taken up with the grafts of 2/16. The efficacy of *Metarhizium anisopliae* may be refined by placing eggs of CSRB and monitoring the field mortality. The performance of hybrid 2/16 in the demonstration high density planting at a spacing of 4x4m is found promising.

CHINTAMANI

Cataloguing of the germplasm according to minimum descriptors was suggested before the removal of seedling accessions in the germplasm plot. Priority in the hybridization programme was to improve the nut size of M 44/3 and V-5, which were found to perform well in the comparative yield trial. It was also suggested to collect Brazil 711/4 along with Kankadi and Vertore 56 for hybridization programme. Under the comparative yield trial experiment which was suggested to compare the yield data of Vengurle and Bapatla Centres with the performance of those varieties at Chintamani and to conclude the project after submission of final report. Soil and water conservation practices in high density planting trial which has already been planted was suggested for water conservation in low rainfall area. In MLT 86, the Centre has already generated 10 years yield data. The performance of NRCC-2, Hybrid 303 and Hybrid 320 were found good in MLT 92 experiment. It was suggested to continue the experiment for another two more years for knowing the consistency of performance of these varieties.

JAGDALPUR

Replanting of MLT 92 was suggested in order to over come mixing up of varieties and germplasm material, it was suggested to plant the entries already available in the collections of the centre. High density cum fertilizer trial may be taken up using BLA 39-4 as this variety performs well under Jagdalpur condition. The extensively branching V-4 variety which is not suitable for high density planting was suggested for utilization in entomological trials.

JHARGRAM

The replanting of MLT 92 may be done using the already collected grafts from Bhubaneswar as well as NRCC Puttur.

High density planting in Jhargram even without pruning was consistently yielding high.

MADAKKATHARA

The clonal material planted earlier may be cleared for facilitating taking up of new plantings. K 10-2 from the germplasm may be utilized in the breeding programme. In the Crop Management, the yield data of NPK experiment may be sent to NRCC for analysis. The intercropping trial, planting of tapioca and elephant foot yam may be done with necessary soil and water conservation measures to prevent soil erosion and water run-off. The accessions HC-17, H-718, H-1600, A 26/2 and Madakkathara-1 may be confirmed by field caging as well as preparing the grafts and testing them with multiple caging.

PILICODE

A new trial on high density planting of cashew grafts with different densities and different levels of fertilizer dosage has to commence at the centre. The land availability is being located out for this purpose by the Kerala Agricultural University.

VENGURLE

Hybrid V-4 x H 2/16 was found with fruit set and promising for Maharashtra. In the high density plot, soil and water conservation strategies may be taken up. The centre has almost completed germplasm details as per the NBPGR guidelines and the same may be utilized for obtaining national collection numbers. The centre was identified as one of the members in the networking project on germplasm. The problem of fungal infestation by Caladosporium is severe in the Centre since last two to three years. It was suggested to treat the cashew trees with phosalone instead of endosulfan.

VRIDHACHALAM

The centre has got highest number of germplasm accessions among the Regional Cashew Gene Banks. The performance of the centre was found to be good.

(g) PROBLEMS IN FUNCTIONING OF THE CENTRE

At Bapatla, the posts of Jr. Agronomist and Entomologist were vacant and there was failure to conduct all the experiments as per the technical programme properly. Lack of fencing and grazing problems also was one of the problems due to which the intercropping trial could not be carried out in the centre. Bhubaneswar centre was hit by super cyclone on 29th October due to which many fully grown up trees were broken and some have got uprooted. Replanting is the only solution left over to reform the plantations. At Jagdalpur the Horticulturist was appointed late during the year. The replanting programme to fill the gaps in germplasm plot as well as the multilocation trials is still left overdue.

Project Coordinator along with Professor & Head, Department of Horticulture, OUAT, estimating the flowering, watershoot development and revival in super cyclone affected experimental trees at Bhubaneswar for recommending course of action for replanting the plot.

(h) Meteorological Data of Centres 1999

Bapatla

Month	Temperature (°C)		RH (%)		Total rain (mm)	No. of rainy days
	Maximum	Minimum	AM	PM		
January	29.2	16.6	92	64		--
February	31.0	18.6	91	63	2.5	1
March	32.3	21.9	87	68	--	-
April	35.3	25.2	76	65	--	-
May	39.1	26.9	68	59	109.8	3
June	36.0	26.1	64	52	54.3	5
July	35.0	25.8	69	55	80.0	7
August	33.6	25.1	76	64	209.9	10
September	32.5	24.9	81	72	158	11
October	30.5	24.1	88	82	227.9	13
November	30.1	20.8	86	73	--	-
December	29.6	17.3	81	65	--	-

Bhubaneswar

Month	Temperature (°C)		Mean RH (%)		Total rain (mm)	No. of rainy days
	Maximum	Minimum	AM	PM		
January	28.4	13.5	90	39	1.5	1
February	33.5	18.1	94	39	--	--
March	37.3	22.0	94	38	--	--
April	38.5	26.2	91	50	--	--
May	36.5	25.7	90	62	189.0	10
June	33.9	25.6	92	71	173.8	16
July	32.2	25.0	90	75	262.6	16
August	31.9	24.9	93	74	445.8	20
September	31.6	25.0	93	77	238.6	20
October	31.4	23.3	94	74	745.5	13
November	30.1	17.6	91	49	19.3	3
December	28.9	14.9	87	43	--	--

Note : Super cyclone was hit the place on 29th October 1999.

Chintamani

Month	Temperature (°C)		RH (%)		Total rain (mm)	No. of rainy days
	Maximum	Minimum	AM	PM		
January	27.5	NA	64.0	47.5	--	--
February	30.1	NA	64.6	47.7	2.8	1
March	34.5	NA	69.8	35.4	--	--
April	36.0	NA	67.8	41.2	33.4	2
May	31.3	NA	89.2	56	71.5	8
June	29.8	NA	86.4	69.1	26.9	3
July	30.3	NA	86.0	57.4	6.1	2
August	28.9	NA	81.4	61.2	215.1	7
September	29.8	NA	82.5	71.4	92.2	6
October	29.1	NA	85.0	79.6	66.5	6
November	27.2	NA	86.3	82.3	62.4	5
December	25.8	NA	87.9	89.4	19.0	1

Jagdalpur

Month	Temperature (°C)		RH (%)		Total rain (mm)	No. of rainy days
	Maximum	Minimum	AM	PM		
January	27.0	6.7	94	31	--	--
February	31.5	13.6	87	32	--	--
March	36.1	17.7	71	17	--	--
April	39.9	22.8	62	13	2.5	1
May	34.5	24.1	73	41	113.5	11
June	30.6	23.3	79	60	273.3	8
July	28.2	22.6	88	72	189.3	13
August	27.3	22.0	93	77	553.4	19
September	27.9	20.8	93	75	169.1	11
October	29.3	20.7	93	61	92.0	6
November	27.8	14.9	95	45	1.8	1
December	26.0	7.6	94	33	--	--

Jhargram

Month	Temperature (°C)		RH (%)		Total rain (mm)	No. of rainy days
	Maximum	Minimum	AM	PM		
January	24.3	11.6	80.2	49.7	21.0	3
February	26.0	16.9	78.5	53.3	5.3	2
March	31.3	20.9	73.4	49.8	28.0	5
April	36.0	21.8	78.8	41.0	54.6	4
May	37.0	23.5	80.6	44.5	36.2	6
June	37.8	24.0	84.4	50.3	98.6	9
July	35.3	23.5	90.5	74.3	348.6	24
August	35.0	24.0	90.0	74.0	309.3	23
September	35.6	25.6	85.9	65.4	238.3	15
October	30.2	22.8	84.5	50.2	106.4	13
November	29.0	14.6	80.5	44.3	36.0	6
December	25.5	12.9	76.4	39.9	19. 2	4

Madakkathara

Month	Temperature (°C)		RH (%)		Total rain (mm)	No. of rainy days
	Maximum	Minimum	AM	PM		
January	32.4	21.5	76	40	--	--
February	34.5	23.3	77	35	22.8	1
March	35.5	25.6	88	48	--	--
April	33.4	24.5	88	58	39.0	4
May	30.7	24.7	92	72	430.5	18
June	29.4	23.0	94	75	500.2	23
July	28.4	23.0	96	82	823.3	28
August	29.8	22.9	94	73	260.1	12
September	31.6	23.4	89	63	28.4	3
October	30.5	23.2	94	75	506.2	15
November	31.4	22.7	81	57	9.1	1
December	30.7	22.7	72	48	--	--

Pilicode

Month	Temperature (°C)		RH (%)		Total rain (mm)	No. of rainy days
	Maximum	Minimum	AM	PM		
January	31.2	19.4	90.4	53.0	--	--
February	32.0	21.2	NA	NA	--	--
March	32.6	24.4	NA	NA	17.0	1
April	32.6	25.4	NA	NA	6.8	2
May	29.5	24.1	NA	NA	416.4	17
June	29.2	23.0	NA	NA	942.3	26
July	28.1	23.0	96.0	86.0	1042	29
August	29.0	22.7	97.0	84.0	444.1	23
September	30.5	23.2	92.4	71.3	72.5	9
October	30.2	22.7	95.6	75.2	505.0	20
November	31.3	22.4	87.9	63.5	6.4	2
December	32.0	20.1	93.5	54.5	1.6	1

Vengurle

Month	Temperature (°C)		Mean RH (%)	Total rain (mm)	No. of rainy days
	Maximum	Minimum			
January	33.5	15.2	82	--	--
February	32.9	18.1	83	--	--
March	32.2	21.0	82	--	--
April	32.8	23.6	77	--	--
May	31.7	24.7	80	2067	19
June	29.7	24.0	88	1513	30
July	29.3	25.0	87	1090	31
August	29.8	24.3	89	28	31
September	30.0	23.4	89	156	16
October	31.2	23.0	85	58	11
November	32.3	19.4	76	3	1
December	32.8	16.5	76	--	--

Vridhachalam

Month	Temperature (°C)		RH (%)	Total rain (mm)	No. of rainy days
	Maximum	Minimum			
January	30.3	19.1	77.9	--	--
February	33.1	20.4	59.7	--	--
March	36.1	18.0	53.4	--	--
April	39.8	13.2	63.2	--	--
May	40.0	NA	70.4	49.0	5
June	38.5	NA	62.6	63.6	6
July	37.4	26.2	58.5	46.0	5
August	35.2	26.2	69.0	99.2	5
September	35.5	24.8	57.8	160.8	9
October	32.0	25.5	67.0	177.6	12
November	29.4	23.5	67.5	198.4	9
December	28.0	23.0	75.7	377.4	9

i) RESEARCH PUBLICATIONS

JAGDALPUR

Gupta, C.R., Awasthi, O.P. and Shukla. (1999). Inter-cropping in cashew orchard under rainfed condition - A model for Bastar Plateau zone of Madhya Pradesh. *The Cashew*, **XIII** (2): 18-22.

MADAKKATHARA

Salam M.A. 2000. Cashew variety Vridhachalam-3 recommended for Kerala. *Cashew Bulletin*, **38** (2) February 2000 pp-3.

Salam M.A. 1999. Amrutha (H-1597) A New High Yielding Cashew Hybrid. *Cashew Bulletin* **38** (1) January 2000, pp-3.

Salam M.A. 1999. Production potential of cashew varieties sent to *Journal of Plantation Crops* on 13.12.99.

Salam M.A.1999. Two more decades to achieve todays cashew nut requirement sent to DCCD, Kochi on 8.12.99.

Salam M.A. 1999. Cashew varieties suitable for high density planting. *Cashew Bulletin* - Page No.3.

Susannamma Kurien 1999. *Kasumavil Sasyasamrakshanam - Thottandi Vyavasaya Purogathikku*. Paper presented in the 9th Swedeshi Science Congress 5-7 November 1999 at Fathima Matha College, Kollam.

Salam M.A. 1999. Elite cashew varieties to sustain cashew industry. Paper presented in the 9th Swadeshi Science Congress, 5-7 November 1999 at Fathima Matha College, Kollam.

Suma B. 1999. Soft wood grafting in cashew. Paper presented in the 9th Swadeshi Science Congress, 5-7 November 1999 at Fathima Matha College, Kollam.

Salam M.A. 1999. Cashew and Pepper live in harmony. *The Cashew*, **13**(3) July-September 1999, page No. 54-56.

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Salam M.A. 1999. *Kasumavil ninnum kai niraye panam. Karasshakan*, Page No. 58.

Salam M.A. 1999. *Kasumavinte Kombunakkavum Poonkula Karichilum, Kalpadenu* **26** (3-4) Jan - June 1999, Page No. 20-22.

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