Vision 2030

काजू अनुसंधान निदेशालय

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दर्बे पोस्ट, पुत्तूर 574 202, दक्षिण कन्नड, कर्नाटक

DIRECTORATE OF CASHEW RESEARCH

(Formerly National Research Centre for Cashew)

(Indian Council of Agricultural Research)

PUTTUR - 574 202, DAKSHINA KANNADA

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Compilation:
Dr. P.S. Bhat
Dr. T.R. Rupa
Dr. T.N. Raviprasad
Dr. M.G. Bhat

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Dr. M. G. Bhat, Director
Directorate of Cashew Research
Puttur - 574 202, DK, Karnataka
Tel No : 08251-231530 (O), 230992(R), 233490 (R)
EPABX : 08251-230902, 236490
Fax : 08251 - 234350
Gram : CAJUKENDRA
E-mail : dircajures@rediffmail.com / dircajures@yahoo.com / dircajures@gmail.com
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Foreword

The diverse challenges and constraints as growing population, increasing food, feed and fodder needs, natural resource degradation, climate change, new parasites, slow growth in farm income and new global trade regulations demand a paradigm shift in formulating and implementing the agricultural research programmes. The emerging scenario necessitates the institutions of ICAR to have perspective vision which could be translated through proactive, novel and innovative research approach based on cutting edge science. In this endeavour, all of the institutions of ICAR, have revised and prepared respective Vision-2030 documents highlighting the issues and strategies relevant for the next twenty years.

Cashew since its introduction by Portuguese travellers in 16th Century has adapted to the Indian climatic conditions and at present is annually grown on an area of about 1.0 million hectares with production of about 0.7 million tonnes. The Directorate of Cashew Research (DCR), Puttur alongwith other cashew research centres of AICRP - Cashew and SAUs has released 40 varieties of which, 24 have the export grade kernels. Softwood grafting technique developed by DCR and AICRP-Cashew has revolutionized the production of quality planting material of improved and high yielding varieties of cashew.

It is expected that the analytical approach and forward looking concepts presented in the *' Vision 2030 '* document will prove useful for the researchers, policymakers, and stakeholders to address the future challenges for growth and development of the agricultural sector and ensure food and income security with a human touch.

29th June, 2011
New Delhi

(S. AYYAPPAN)
Secretary, Department of Agricultural Research and Education (DARE)
and Director General, Indian Council of Agricultural Research (ICAR),
Krishi Bhavan, Dr. Rajendra Prasad Road,
New Delhi - 110 114, India

Preface

Cashew after its introduction by Portuguese travellers in 16th century has very well adapted to the Indian climatic conditions and is presently grown in an area of 0.923 million hectares with production of about 0.700 million tonnes. Considerable progress has been made in cashew research since 1950. The first systematic effort to visualize the challenges and opportunities, and formulate its own strategy was undertaken in the year 1997 by preparing Vision 2020 - NRC Cashew Perspective Plan. The next attempt was after a decade by preparing Vision 2025 - NRC Cashew Perspective Plan to address the changes that had taken place. In March 2009, NRC for Cashew was upgraded as Directorate of Cashew Research (DCR). The present document, Vision 2030 - DCR enlightens the strategies to meet the challenges and tap the opportunities by harnessing the power of science to maintain premier position in international cashew trade.

In the WTO regime, events of far reaching implications have taken place in the last one decade. Research in frontier areas has shown enormous opportunities; frontier sciences such as biotechnology and bioinformatics have progressed very fast and new protection regime has emerged. There is a need to harness the new opportunities available with the progress of science. Considering these developments, the specific issues suggested by Director General, ICAR, suggestions emerged during discussion meeting with Deputy Director General (Hort.) in January 2005 and during 9th meeting of Research Advisory Committee of the Centre during February 2005, the Perspective Plan Vision 2020 of National Research Centre for Cashew, Puttur was revised in April 2005 and Vision 2025 NRC Cashew Perspective Plan was published. ICAR has published Vision 2030 in January 2011. As per the decision taken at the level of ICAR, all institutes were asked to prepare Vision 2030 document. Accordingly, keeping in view the growing demand for cashew, the likely change in the cashew scenario in years to come and to meet the challenges of attaining self sufficiency in raw cashewnuts production, the Vision 2030 - DCR has been prepared.

Our grateful thanks are due to organizations like Food and Agricultural Organisation (FAO), Cashew Export Promotion Council of India (CEPCI) and Directorate of Cashewnut and Cocoa Development (DCCD) for the published information on production, productivity, as well as data on export and import.

Thanks are also due to all the Scientists of this Directorate for providing the necessary inputs for this compilation. It is hoped that if all the strategies identified are implemented successfully, India would be able to attain self-sufficiency in raw cashewnuts production and maintain its supremacy in the international market.

29th June, 2011
Puttur

(M. G. BHAT)
Director,
Directorate of Cashew Research
Puttur - 574 202, D.K. Karnataka

Preamble

Cashew is an important plantation crop of India. This crop was introduced to India during the 16th century. The potential of this crop in the international trade was first realized by India in the early 1900s through the export of cashew kernels. Since cashew was considered as suitable for afforestation and soil conservation, the cashew plantations raised till recently received very little attention. Further, cashew was generally planted in the wasteland and marginal lands with poor fertility status. Now, India has the largest area under cashew and stands as the second largest producer of cashew in the world. Vietnam, Ivory Coast and Brazil are the competitors to India for cashew production and export.

However, in India the large number of cashew processing units need about 1.3-1.4 million tonnes of raw cashewnuts per annum. In order to meet the requirement of the processing industry, India imports annually about 0.60 - 0.70 million tonnes of raw cashewnuts from African and other countries. As these countries have started their own processing units, the availability of raw cashewnuts for import is reducing gradually.

Most of the area under cashew is in east coast and west coast regions of the country. However, cashew is being grown to a limited extent in non traditional areas such as Bastar region of Chattisgarh state and also Kolar region of Karnataka state. About 40,000 ha of area can be brought under cashew in Chattisgarh state. Soft-wood grafting technique has revolutionized the availability of elite planting material of cashew in the country. There are about 100 Regional Cashew Nurseries under public and private sector catering to the needs of graft requirement in addition to large number of small to medium cashew nurseries. About 50,000 ha of area are brought under cashew every year in the country by planting over 10 million cashew grafts at the rate of 200 plants per ha. The cashew graft production has increased to over 15 million per annum in XI Plan period and is expected to double in next 10-15 years. Besides increasing the area, productivity per unit area also has to be increased in order to make India self-sufficient in production of raw cashewnuts.

India has been exporting cashew kernels since the early part of the 20th century. The country exports about 0.100-0.115 million tonnes of cashew kernels annually worth over Rs. 2,905 crores. Cashew kernels are exported to

more than 65 countries of which the largest buyers of Indian cashew kernels are USA and The Netherlands.

Cashew kernels are highly nutritious containing protein (21%), fat (47%), carbohydrates (22%), minerals and vitamins. Cashew kernel protein contains all the essential amino acids and are comparable with milk protein casein. Cashew kernels do not contain any anti-nutritional factors. Cashew kernels are free from bad cholesterol and are quite rich in unsaturated fatty acids. Thus, cashew kernel is a safe food.

With the growing importance in the export trade, research attempts were initiated in the early 1950s by the Indian Council of Agricultural Research by sanctioning ad-hoc schemes. Later, ICAR also sanctioned the All India Coordinated Spices and Cashewnut Improvement Project (AICS and CIP) in 1971.

The Quinquennial Review Team of CPCRI recommended delinking of cashew and spices research from CPCRI in 1982 and starting of the National Research Centres for Cashew at Puttur (Karnataka) and for Spices at Calicut (Kerala). AICS and CIP was also bifurcated and the headquarters of independent All India Coordinated Research Project on Cashew (AICRP-C) was shifted to NRCC, Puttur in 1986. Presently, the total number of centres under AICRP-C is 11. Three voluntary centres / cooperating centres have also been approved. National Research Centre for Cashew was upgraded and renamed as Directorate of Cashew Research (DCR) under XI Plan by ICAR in 2009.

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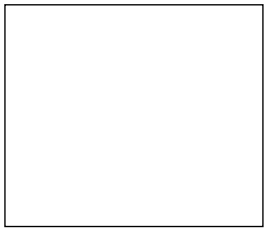

Cashew Scenario

Global Scenario

Presently, Vietnam is the single largest producer of cashewnuts (0.958 million tonnes) followed by India (0.613 million tonnes) during 2009-10 and with highest ever of 0.700 million tones during 2008-09 (Annexure-I). The other major producing countries of cashew are Ivory Coast (0.246 million tonnes), Brazil (0.221 million tonnes), Tanzania (0.079 million tonnes) and Mozambique (0.068 million tonnes). Area under cashew in the world is 4.103 million hectares and production is 3.351 million tonnes.

Vietnam has registered over four fold increase (481%) of raw cashewnuts production over the last 10 years. The increase in the raw cashewnuts production in India was 36.2 per cent during this period. Steady growth rate in production of raw cashewnuts in South-East Asian countries, particularly Vietnam is of serious concern to India. Ivory Coast, Brazil and Mozambique have also registered considerable increase in the raw cashewnuts production of 230.5, 51.6 and 15.5 per cent, respectively during 2009-10. The world production of raw cashewnuts for the last 10 years has increased from 1.73 million tonnes (1999-2000) to 3.35 million tonnes (2009-10) amounting to 93.6 per cent. Assuming 20 per cent as the kernel outturn, the kernel production in 2009-10 was estimated as 0.670 million tonnes.

India's raw cashewnuts production is not sufficient to sustain the processing capacity established in the country. To bridge the gap between processing requirement and domestic production, India has been importing raw cashewnuts from African countries to the tune of 0.753 million tonnes during the year 2009-10. As many of these African countries have started strengthening their processing capacities, and the increased production of raw cashewnuts by South-East Asian countries, it is imperative that India has to increase its raw cashewnuts production to sustain itself in the international market.

In the international trade, USA is the major consumer of processed kernels. Vietnam and India are the major exporters of processed kernels. As most of the cashew producing African countries have started strengthening their processing capacities, and the increased production of raw cashewnuts by South-East Asian countries, it is imperative that India has to increase its raw cashewnuts production to sustain itself in the international market.

In 2009-10, India accounted for over 26.8 per cent world exports of cashew kernels worth Rs. 2,906 crores. Between 2000 and 2010, raw cashewnuts production in India increased by 36.2 per cent. In order to keep pace in the international market, India has to achieve the raw cashewnuts production of atleast 2.50 million tonnes by 2030 and at a competitive cost.

National Scenario

India was the first country in the world to exploit the international trade of cashew kernels in the early part of 20th century. India's share in world cashew area is 22.50 per cent and share in world cashew production is 20.74 per cent. Cashew is presently grown in an area of 0.923 million hectares with annual production of about 0.613 million tonnes of raw cashewnuts in the country (DCCD, 2011). The highest production of about 0.700 million tonnes was achieved in 2008-09. Most of the area under cashew is in east coast and west coast regions of the country. In India, cashew is grown mainly in Maharashtra, Goa, Karnataka and Kerala along the west coast and Tamil Nadu, Andhra Pradesh, Orissa and West Bengal along the east coast. It is also grown to a limited extent in non-traditional areas such as Bastar region of Chattisgarh and Kolar (Plains) region of Karnataka, Gujarat, Jharkhand and in North Eastern Hilly (NEH) region. Andhra Pradesh has largest area under cashew, however, Maharashtra is ranking first in production and productivity of cashew in the country.

The productivity level is not increasing over the years as expected as against the new technologies available for adoption. There are two ways of increasing production of raw cashewnuts in the country - increasing area and increasing productivity. Cashew being a snack food crop, country can not divert more area for cashew as food crop gets priority in the government sponsored programmes. However, some more area which fall under neglected / degraded soil conditions where other crops can not come up is available for cashew in different cashew growing states. Traditionally, cashew has been an important crop in the coastal region (western and eastern) of the country but has been recently spreading to non-traditional areas as well. There is great scope for expanding area under cashew in the plains of Karnataka, Chattisgarh and non-traditional areas of Gujarat, Jharkhand, north eastern hilly region and Andaman and Nicobar Islands. About 40,000 ha of area can be brought under cashew in

Chattisgarh state while the present area under cashew is too low in that state. About 0.71 million ha of potential area for cultivation of cashew is available in different cashew growing states. About 50,000 ha of area are brought under cashew every year in the country by planting about 10 million cashew grafts at the rate of 200 plants per ha. Increasing area as well as increasing productivity through adoption of technologies would hopefully make India self-sufficient in production of raw cashewnuts.

India requires about 1.3-1.4 million tonnes of raw cashewnuts to cater the needs of large number of cashew processing units (1800 medium to large, and 1850 on-farm processing units) engaging over 5 lakh workers especially women. India is producing about 0.70 million tonnes of raw cashewnuts annually, the balance of 0.60 to 0.70 milliion tonnes of raw cashewnuts is imported annually by India from African and South East Asian countries. India exports about 0.11 million tonnes of cashew kernels to over 65 countries of the world. About Rs. 2,906 crores is earned as foreign exchange through export of cashew kernel, and an additional Rs. 24 crores by export of the Cashew Nut Shell Liquid (CNSL).

There is an ever increasing demand for cashew kernel both in international market and also in the domestic market. Countries such as Vietnam and Brazil are competing with India in the international market. Since, African countries have started processing raw cashewnuts themselves, availability of raw cashewnuts for importing by India may gradually decline or may altogether stop. This situation calls for increasing the domestic raw cashewnuts production and become self sufficient to provide adequate raw cashewnuts to the processing industries. Further, the raw cashewnuts have to be produced at cheaper rate in order to compete with other cashew growing countries of the world. It is also important to develop and expand domestic market for cashew kernels so that there will be continued good price for the nuts and thereby farmers are encouraged to grow cashew. Unless remunerative price is offered to the raw cashewnuts, farmers might switch over to other plantation crops such as rubber, which fetches very high price for its product. Efforts are being made for reviving cashew cultivation in Kerala through the efforts of Kerala State Agency for Expansion of Cashew Cultivation (KSACC). Value addition to cashew kernel is being attempted by Kerala State Cashew Development Corporation (KSCDC).

With the efforts of DCR and Co-ordinating centres of AICRP-Cashew and SAUs, over 40 high yielding cashew varieties were developed and released. Production of planting material of high yielding varieties through softwood grafting technique has been greatly successful. This has made tremendous impact in improving cashew productivity in Maharashtra and Orissa. Various improved cashew production technologies such as nutrient management, canopy management, intercropping, irrigation including drip irrigation, soil and water conservation techniques, high density planting system, pruning technique, rejuvenation of senile orchards, insect pest management etc. have been developed and are available to farmers. Department of Horticulture / Agriculture of several cashew growing states are transferring the technologies through Central Sector Schemes including National Horticulture Mission (NHM). Due to the efforts of all the concerned both in research and development, the status of cashew has now been changed from a crop suitable for soil conservation and afforestation purpose into a commercial plantation crop.

Directorate of Cashew Research

The recommendations made by the Quinquennial Review Team (QRT) constituted by ICAR in 1982 on Central Plantation Crops Research Institute, Kasaragod, Working Group on Agricultural Research and Education constituted by the Planning Commission for VII Plan Proposals and the Task Force on Horticulture constituted by ICAR had resulted in the establishment of National Research Centre for Cashew at Puttur on 18 June, 1986. During the XI Plan in the year 2009, ICAR approved upgradation of NRC for Cashew into Directorate of Cashew Research. Accordingly, NRC for Cashew was renamed as Directorate of Cashew Research (DCR).

Directorate of Cashew Research is located at Puttur, Dakshina Kannada, Karnataka. The main campus is situated 5 km away from Puttur town (at Kemminje: 12.45°N latitude, 75.42° E longitude and 90 m above MSL). The main campus has an area of 68 ha with field experiments and Laboratory-cum-Administrative Block including Library- cum-Conference Hall and Engineering Workshop. Experimental Station at Shantigodu, which also forms part of the Directorate is 13 km away from the main campus and has an area of 80 ha and has Entomology and Soil Science laboratory buildings in addition to number of field experiments.

The All India Coordinated Spices and Cashewnut 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 in 1986. 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 ten centres and one sub-centre; of which four were started at the inception of AICS & CIP in the year 1971 [Bapatla (ANGRAU, formerly APAU); Madakkathara (KAU, shifted from Anakkayam); Vengurla (BSKKV the then KKV) and Vridhachalam (TNAU)]. During the V Plan, one centre at Bhubaneswar (OUAT) and in the VI Plan, two centres, one at Jhargram (BCKVV) and another at Chintamani (UAS) were added. During VIII Plan, one centre at Jagdalpur (IGAU) and a sub-centre at Pilicode (KAU)

were also started. In XI Plan, two centers were added - one in Gujarat (Paria) and other in Jharkhand (Darisai). These centres of AICRP on Cashew are located in ten cashew growing states of the country and are under the administrative control of different State Agricultural Universities. Further, there are three voluntary co-operating centres (Arabhavi in Karnataka, Goa and Barapani in Meghalaya) under AICRP Cashew.

With combined efforts of Directorate of Cashew Research, Centres of AICRP-Cashew and SAUs, over 40 high yielding cashew varieties were developed and released in the country (Bhat *et.al.* 2010). As cashew is a cross pollinated crop, propagation by vegetative means was attempted. Among the various methods tried, softwood grafting was found to be the best for vegetative propagation of cashew (Swamy *et.al.* 1993). It has also been shown that the softwood grafting is feasible for commercial multiplication. Based on these results, India has been producing over 15 million grafts annually under government and private sectors. This has enabled to increase area under cashew with recommended varieties both in traditional and non-traditional regions which already has large impact on the increase in production and productivity and will also enable the country to achieve self sufficiency in cashewnut production in next years and beyond.

DCR 2030

The Directorate of Cashew Research (DCR) (formerly National Research Centre for Cashew) was established in 1986 at Puttur, Karnataka with the main purpose of giving thrust on increasing the production and productivity of cashew in the country. All India Coordinated Research Project on Cashew (AICRP-Cashew) was also initiated as an independent project in 1986 with the main purpose of giving thrust on increasing the production and productivity of cashew in the country by addressing location specific problems. Since then India has progressed substantially in research front in cashew.

Vision

a) DCR

- To make the Directorate of Cashew Research, a premier internationally recognized institution for cashew research.
- To make the country self sufficient with respect to raw cashewnut production and to maintain top position in the world as largest producer / processor / exporter.
- To develop technologies to utilize by-products effectively in order to increase the income of cashew farmers.

b) AICRP-Cashew

- To collect, conserve and utilize the locally available cashew germplasm to develop hybrids with desirable yield traits.
- To develop varieties which are region specific and to evaluate production techniques to maximize raw cashewnut production and ensure profitability for the cashew farmers.
- To develop technologies for optimizing various inputs such as fertilizers, pesticides etc. and also to enhance productivity levels by advocating region-specific techniques, *viz.*, intercropping during early cropping period, adoption of drip irrigation in places having water availability, cashew cultivation under organic management practices etc.

Mission

- Increase in productivity by developing high yielding dwarf and compact cashew types suitable for high density planting and also by developing other cashew production technologies and their adoption by farmers and cashew corporation / forest corporations.

Mandate

a) DCR

- To conduct mission-oriented research on all aspects of cashew for improving productivity and quality with special reference to export.
- To serve as a national repository for cashew germplasm and a clearing house for research information on cashew.
- To act as centre for training in research methodologies and technology updating of cashew and to coordinate national research projects.
- To provide consultancy on cashew production technology.
- To generate quality planting material.
- To collaborate with national and international agencies for achieving the mandate.

b) AICRP-Cashew

- Evolving high yielding varieties with good kernel quality and tolerance to biotic and abiotic stresses.
- Standardizing agro-techniques for the crop under different agro-climatic conditions.
- Evolving cost effective and efficient pest and disease management practices.

Harnessing Science

The requirement of raw cashewnuts shall be at least 2.5 million tonnes by 2030. This target can be achieved by area expansion of cashew in many states, especially in non-traditional potential areas. Also the low yielding cashew plants of senile and non-descript origin need to be replaced by cashew grafts of high yielding varieties with adoption of improved production technologies. It is expected that India will be able to keep pace with the requirement of raw cashewnuts from cashew processing industries and will be self sufficient by 2030 in its raw cashewnuts requirement to meet both export and domestic requirement by the cashew processors.

In this context, modern scientific approaches to enhance the productivity of cashew are being developed by this Directorate.

Cashew gene bank

National Cashew Field Gene Bank (NCFGB) has been established at this Directorate with a mandate to collect and conserve the available diverse cashew germplasm. The Directorate has the largest germplasm collection of cashew in the country with 527 accessions. A total of 433 cashew accessions have been assigned with National Collection numbers (IC Nos.). A total of 285 accessions have been characterised as per IPGRI descriptors. Three germplasm catalogues for 255 accessions have been brought out (Swamy *et al.* 1997, 1998 and 2000). In addition, over 1200 cashew accessions are conserved in Regional Cashew Field Gene Bank in centres under AICRP on Cashew. They are being utilized in crop improvement programme for developing new high yielding varieties. A total of 40 varieties have been released so far, most of which are popular among farmers. Collection, conservation, evaluation and cataloguing of both exotic and indigenous cashew germplasm especially, dwarf and compact cashew types would be further emphasized. Hybridization programme using germplasm having desirable traits

Cashew apples of variety "Bhaskara"

such as higher number of panicles/m^2, better nut weight and high yield as parents would be focused.

Genetic improvement of cashew

Varieties with high yield, resistance to biotic and abiotic stresses, better flowering behaviour (synchronized and staggered) and better kernel quality for internal consumption and export would be evolved. Critical areas to be addressed include development of dwarf and compact high yielding cashew varieties suitable for high density planting. Systematic efforts would be made for releasing improved varieties in terms of yield, nut quality and processing parameters. Characterisation of the released varieties or hybrids would be done for various physiological and other growth characters to suit the agro-ecological requirements.

Biotechnology approaches

Micropropagation studies have been undertaken for developing the multiplication protocol from cashew explants. However, the regeneration protocol from matured explants needs further standardization. Attempts on field establishment of micropropagated cashew plants regenerated from young cashew nodal cuttings would be strengthened. Molecular characterization of germplasm and varieties through DNA finger printing and isozyme markers would be attempted. Molecular markers linked to economic characters in cashew would be identified and genetic maps would be constructed.

High density planting system

Adoption of high density planting system is the best method to increase the productivity of cashew. This however needs suitable dwarf and / or compact cashew varieties so that overlapping of canopy is minimised. Limb pruning and diagonal thinning would be evaluated for their effectiveness in high density planting systems. In India, suitable dwarf and compact types with high yield are not yet available. It is reported that, Brazil which is the home of cashew has dwarf and compact cashew varieties with good yield. Earlier efforts to obtain these dwarf and compact types to India did not succeed since the dwarf genotypes were not spared by the Brazilian authorities. Fresh efforts are needed through Memorandum of Understanding (MOU) or Work Plan between Indian Govt. and Brazilian Govt. to introduce these special cashew types to India.

Nutrient and irrigation management

Integrated nutrient management in cashew cropping systems would be evolved to maximize productivity. Nutrient dynamics in relation to growth stages of cashew would be assessed with a view to develop holistic nutrient management. More attention would be given for recycling of recyclable cashew biomass, *in situ* compost production, green manuring etc. Organic farming research in cashew would be intensified for producing quality nuts especially for international market. Drip irrigation and fertigation requirements for different plant density system would be standardized.

Climate change

The shift in climate *viz.*, rainfall pattern, heat waves, cold waves, irregular temperature fluctuation and other extremes of climate may affect cashew productivity significantly. This leads to stagnation / decline in nut production across various agro-climatic zones. To cope up with anticipated impacts of climate change, mitigation and adaptation strategies would be developed.

Canopy management

Beheading (de-crowning) the canopies of low yielding trees to rejuvenate the growth was the most promising in enhancing yield performance of such trees. Canopy architecturing and limb pruning techniques would be standardized to suit the requirement of different plant densities and system of planting. The work on inducing dwarfing through use of dwarf rootstocks and chemical intervention particularly, paclobutrazol which has been extensively used in containing the canopy growth of mango would be intensified.

Integrated pest management

Cashew stem and root borers (CSRB) and tea mosquito bug (TMB) are the major pests of cashew leading to economic losses. Usage of pesticides would be optimized for pest management in cashew. Attempts would be intensified regarding suitable eco-friendly integrated pest management (IPM) approaches involving pheromone and kairomone technology for control of major insect pests. Strategies for management of potential minor pests would be evolved.

Tea mosquito bug - a major pest of cashew

Post harvest and value addition

Raw cashewnut is subjected to various processing operations to extract edible kernel. Various methods such as drum roasting, steam boiling and oil bath roasting have been employed for processing of cashewnuts. In recent times, drum roasting and steam roasting methods are predominant in coastal regions of India and oil bath roasting became obsolete. Processing machinery would be refined for improving whole kernel recovery / increasing the processing efficiency. Value added products would be developed for the primary and by-products of cashew industry.

Concentric drum type rotary sieve grader

Cashew by-products

Cashew apple which is mostly wasted in India needs to be utilized effectively for the preparation of syrup, juice, candy etc. Cashew apple juice can be utilized for preparation of feni as being done in Goa. Production of bio-ethanol from cashew apple to be used as biofuel is also possible. Cashewnut shell liquid (CNSL) is another important by - product, which earns considerable foreign exchange. There is immense scope for utilization of CNSL for different industrial uses including nanotechnology. Technologies for alternate use of by-products of cashew processing industry such as cashew kernel rejects, CNSL, cashew shell cake and cashew kernel testa need to be developed. The possibility of cashew apple utilization for production of industrial alcohol / biofuel on commercial scale and extraction of nutraceuticals would be explored.

Technology transfer systems

Intensifying extension efforts to bridge the gap between actual yield and potential yield. Information communication technologies (ICTs) leads to better technology adoption in field and transfer of technology with increased reach and efficiency. Formation of cashew farmer groups can aid participatory transfer of advanced cashew production technologies. Identification of sustainable cashew based farming systems would provide better farm - gate price for the produce and would aid sustainable cashew cultivation.

Strategy and Framework

Increasing productivity and expansion of area under cashew are the main strategies for enhancing raw cashewnuts production in the country. Increasing productivity is the main aim of research activities such as this Directorate and AICRP-Cashew. More research effort is needed in order to generate cost effective cashew production technology. There is immediate need to double the production in order to meet the raw cashewnuts requirement of the cashew industries by increasing productivity. By also increasing the area under cashew production can be improved which is the responsibility of the Development Departments. Various technological approaches such as high yielding varieties, high density planting, drip irrigation, optimum use of fertilizers etc., are being evaluated for their suitability in the various cashew growing tracts and being recommended to enhance productivity. Research strategies for increasing productivity with priority are given in Annexure - II.

There are some constraints in cashew production in the country which limits the productivity of cashew per unit area.

- Senile and seedling origin plantations of non-descript types with low yield. This situation is mostly existing in cashew plantations under Govt. owned cashew corporations and forest corporations.
- Cashew is a neglected plantation crop among the farmers and generally grown under neglected condition.
- The land which is not suitable for other plantation crops only are available to cashew crop. Hence, the land which is available for cashew is usually eroded and degraded with poor soil fertility.
- Farmers are not fully aware of the latest cashew production technologies due to inadequate transfer of technology.
- Even if farmers are aware of the latest cashew production technologies, non adoption of recommended package of practices to the extent required.
- Absence of compact and dwarf high yielding varieties, because of which high density planting cannot be adopted to realize the full potentiality of high density planting technology.

- Though cashew apple production in the country is about ten times that of nut production by weight, most of the cashew apple is not utilized in India. A small quantity of cashew apple is utilized only in Goa for feni preparation.

Possible solutions and strategies to overcome cashew production constraints

- Development of compact and dwarf high yielding cashew variety suitable for high density plantation.
- Development of cost effective cashew production technologies.
- Massive replanting programme to replace senile and unthrifty orchards
- Increasing productivity by adopting improved cashew production technologies.
- Enhancing the production of raw cashewnuts to reduce the imports by expansion of cashew area both in traditional and non-traditional areas.
- Effective pest control measures for tea mosquito bug (TMB) / cashew stem and root borers (CSRB).
- Development of cashew based integrated farming systems.
- Declaration of plantation crop status to cashew by all cashew growing states.

Epilogue

The technologies developed through implementation of research programmes contemplated help in enhancing the productivity of cashew resulting in increased production and lesser dependence on import of raw cashewnuts with self reliance on indigenous raw cashewnuts for processing. This Directorate would develop and disseminate technologies to help cashew farmers in terms of realization of higher returns. Further, large tracts of potential area is likely to be brought under cashew cultivation even in non-traditional areas. Increasing productivity and expansion of area under cashew through developmental agencies will have strong impact on cashew development, in general, and increased production of raw cashewnut in the country, in particular. With the concerted effort of all the concerned, namely, cashew research institutions, development departments, farmers and cashew industries, it is expected that the production of raw cashewnuts would rearch 2.5 million tonnes by 2030 in the country and thereby India can become self sufficient in raw cashewnut production and continue to maintain a leading position in the international cashew trade inspite of stiff competition from other cashew growing countries.

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ANNEXURE I : Cashew scenario in India

Year	Area (million ha)	Production (in '000 tonnes)	Productivity* (kg/ha)	Import of raw cashew nuts (in '000 tonnes)	Export of cashew kernels (in '000 tonnes)	Export earnings (million ₹)
1955-56	0.110	79.0	720	63	31	12.9
1956-57	0.110	80.0	730	51	31	14.5
1957-58	0.121	93.0	770	99	36	15.1
1958-59	0.130	99.0	760	125	41	15.8
1959-60	0.140	107.0	760	95	39	16.1
1960-61	0.176	111.0	630	118	44	18.9
1961-62	0.185	113.0	610	102	42	18.1
1962-63	0.212	120.0	570	155	49	19.3
1963-64	0.224	133.0	590	157	51	21.4
1964-65	0.232	141.0	610	191	56	29.0
1965-66	0.241	103.0	427	161	51	27.4
1966-67	0.249	114.0	458	141	51	42.8
1967-68	0.257	119.0	463	168	51	43.0
1968-69	0.266	120.0	451	196	63	60.9
1969-70	0.281	123.0	438	163	60	57.4
1970-71	0.303	127.0	419	169	50	52.0
1971-72	0.320	130.0	406	169	60	61.3
1972-73	0.328	130.0	396	197	66	68.8
1973-74	0.351	135.0	385	150	52	74.4
1974-75	0.361	144.0	399	160	65	108.1
1975-76	0.375	162.0	432	137	54	96.1
1976-77	0.376	162.0	431	74	52	105.9
1977-78	0.386	165.0	427	60	40	147.6
1978-79	0.420	172.0	410	20	27	80.0
1979-80	0.447	180.0	403	24	38	118.0
1980-81	0.464	185.0	400	16	32	140.0
1981-82	0.481	196.0	410	16	31	181.0
1982-83	0.492	201.0	409	1	31	135.0
1983-84	0.502	211.0	420	27	37	151.0
1984-85	0.510	221.0	433	33	32	180.0

Year	Area (million ha)	Production (in '000 tonnes)	Productivity* (kg/ha)	Import of raw cashew nuts (in '000 tonnes)	Export of cashew kernels (in '000 tonnes)	Export earnings (million ₹)
1985-86	0.518	234.0	452	23	35	215.0
1986-87	0.523	246.0	470	40	42	334.0
1987-88	0.527	260.0	490	550	35	112.9
1988-89	0.529	274.0	518	30	34	2739.3
1989-90	0.531	286.0	540	59	45	3650.7
1990-91	0.532	295.0	550	833	49	4422.4
1991-92	0.534	305.0	570	106	48	6690.9
1992-93	0.560	349.0	623	135	56	7454.9
1993-94	0.565	348.0	616	190	69	10451.4
1994-95	0.577	322.0	558	231	77	12449.6
1995-96	0.635	418.0	660	222	68.0	12829.5
1996-97	0.659	430.0	652	192	68.7	12855.0
1997-98	0.701	360.0	513	225	76.6	13961.0
1998-99	0.706	460.0	652	181	75.0	16100.0
1999-2000	0.686	520.0	758	201	92.5	24514.0
2000-01	0.720	450.0	625	249	81.7	18785.0
2001-02	0.770	470.0	610	355	97.6	17768.0
2002-03	0.770	506.0	657	401	127.2	20064.0
2003-04	0.780	535.0	686	452	100.8	18546.0
2004-05	0.820	539.0	657	578	127.0	27092.0
2005-06	0.855	573.0	670	565	114.1	25149.0
2006-07	0.854	620.0	820	593	118.5	24551.5
2007-08	0.868	665.0	860	606	114.3	22889.0
2008-09	0.893	695.0	778	606	109.5	29884.0
2009-10	0.923	613.0	675**	753	108.1	29058.2

* Productivity on total area basis

** Productivity is 815 kg/ha on productive area basis

Source : CEPCI, Kochi, Kerala; DCCD, Kochi

ANNEXURE II : Strategic Framework

Goal	Approach	Performance measure
Conservation and utilization of genetic resources	Collection, conservation, evaluation and cataloguing of both exotic and indigenous germplasm accessions (including from non-traditional areas)	Development of cashew germplasm data base for sharing information
	Promote access to cashew germplasm	Utilization of cashew germplasm
Genetic improvement of cashew	Introduction of dwarf and compact cashew types from Brazil, home of cashew and African countries through NBPGR	Introduction of exotic collections from Brazil and Africa
	Development of dwarf and compact cashew varieties suitable for high density planting	Development of varieties suitable for high density planting system
	Collection of tolerant types to tea mosquito bug(TMB)/cashew stem and root borer (CSRB), drought and saline soils etc., and related species and genera from cashew growing regions	Identification of cashew genotypes tolerant to TMB and CSRB
	Evolving varieties with high yield, resistance to biotic and abiotic stresses with better flowering behaviour / characters (synchronized and staggered) and better nut and kernel quality for internal consumption and export	Development of varieties with desired traits
	Establishment of long-term conservation field block of germplasm.	Conservation of germplasm accessions

Application of biotechnology tools in cashew	Standardization of micro propagation technique	Multiplication of cashew elite lines/rootstocks
	Molecular characterization of germplasm through DNA (RAPD / ISSR / SSR) and isozyme markers	Diversity, estimation and finger printing
	Identification of molecular markers linked to economic characters in cashew and construction of genetic maps	Number of markers identified and validated
	Transformation studies for biotic and abiotic insect resistance and testing and evaluation of transgenics	Imparting biotic and abiotic resistance in cashew
Improving soil health, nutrient and water use efficiency and climate risk management	Management strategies to improve nutrient and water use efficiency	Improved nutrient and water use efficiencies
	Nutrient dynamics in soils and plants	Establishment of nutrient norms and improved quality
	Management options for organic farming in cashew	Development of techniques for organic farming
	Approaches for Integrated cashew based farming system	Development of management practices for Integrated cashew based farming system
	Approaches for managing climate change in cashew	Development of adaptation and mitigation strategies for climate change effects
Enhancing cashew productivity through horticultural interventions	Studies on compatibility of rootstocks and scions, and stionic effect	Rootstocks screened for desired dwarfness
	High density planting system to increase productivity of cashew	

	Screening of rootstocks for dwarfing and biotic and abiotic stresses Canopy architecturing and management to suit the requirement of different plant densities and system of planting Manipulation of canopy size through chemical interventions Canopy management, rejuvenation of old cashew plantations /orchards	Standardized canopy architecturing techniques
Standardization of alternate techniques for management of pests and minimizing the usage of pesticides	Studies on kairomones and pheromones for effective and economic control of Tea Mosquito Bug (TMB) and Cashew Stem and Root Borer (CSRB) - Network project Development of eco-friendly IPM strategies including Entomo Pathogenic Nematodes (EPN) for management of major insect pests Standardization of mass rearing of CSRB, flower and fruit pests and their natural enemies Standardization of Semi-synthetic diet (SSD) for CSRB Etiology and transmission studies on yellow leaf spot disease	Developed Integrated pest management (IPM) strategies for management of major insect pests of cashew

	Investigations on panicle drying (in absence of TMB). Analysis of pesticide residues in cashew produce and cashew ecosystem to address concerns of food quality standards	
Improving cashew processing system through mechanisation	Modifications / altering existing processing machinery for better efficiency	Development of efficient cashew processing machinery
Optimisation of processing parameters for better whole kernel recovery towards better economic benefits	Processing parameters related to various mode of processing suitable to Indian conditions need to be optimized for improving economic benefit to end users. Institute - Industry collaboration to resolve problems on methods of processing	High performance processing system
Value addition to cashew and its by-products	Developing technologies for alternative use of by-products of cashew processing industry such as Cashew Nut Shell Liquid (CNSL), cashew shell cake and cashew apple pomace	Development of value added products
Development of Cashew sector through efficient transfer of advanced production technologies	Utilizing advances in ICTs for wider farmer reach and efficient transfer of advanced cashew production technologies	Area / number of farmers covered and adoption rate
	Area expansion through increased number of demonstration plots and demand based supply of planting materials	Area increase under cashew and planting materials supplied
	Identification, analysis and popularization of sustainable cashew based farming systems for different cashew growing areas of the country	Cashew based farming systems identified and popularized for different cashew growing areas of the country / farm gate price /cashew farmer livelihood status
	Promote innovations and improve human resource capacity by involving all stakeholders in the cashew supply chain.	Innovations identified and HRD/Trainings conducted for trainers and farmers