STATUS OF COCOA RESEARCH AND FUTURE NEEDS

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History

Cocoa was introduced into India around late eighteenth century. It was grown to a limited extent in the 19th century by the Roman Catholic Missionaries in Malabar. Yet another view shows that the first introduction was in 1798 when eight Criollo cocoa seedlings were introduced from Amboyan Islands of East Indies. Later in 1862, the Board of Revenue, Madras introduced cocoa to Kolli Millis of Salem and Nilgiris. In 1873, the GOI obtained 50 seedlings of Pentagonium (another variety of cocoa) from Guatemala. Similar small introductions of cocoa appear to have been made into India from Sri Lanka and Malaysia which were grown mainly in the Botanic Gardens and Government Farms.

Research on cocoa was initiated in the country in 1956 when work relating to development of vegetative propagation technique was carried out at the Fruit Research Station, Kallar, Tamil Nadu.

Germplasm

High yielding varieties identified by screening of germplasm and identification of high yielding mother trees based on high yield and desirable bean characters. The collection of CPCRI maintained at its Regional Station at Vittal was planted since 1970 in eight sets. The first of the collections were pods of 16 selected plants of Malaysian estates. The second set of 44 types planted in 1975 was again from pods of selected plants of the Cocoa Research Institute of Nigeria and other selected plants. The next set of five types planted in 1981 was brought in as budwood from the Royal Botanical Gardens, Kew. The forth set of nine types also had their origin from the Kew Gardens collected as budwood from the plants available at the Lalbagh Gardens, Bangalore and planted at Vittal in 1983. The fifth set of 12 types planted in 1986 was from the Cocoa Research Institute of Ghana. The next set comprising of 10 types of seedlings (Wyanad) and one seedling (Kallar) were planted in 1988. The seventh set of 12 types planted in 1991 were from U.K. through KAU, Thrissur and were collected as budwoods. The latest set of 19 types of budwoods planted during 1992 were from KAU, Thrissur. Thus total number of accessions available at Vittal is 128 and these include well known lines like Na 31, Na 33, ICS 1, ICS 6, IMC 67, SCA 6, SCA 12 etc.

Hybridization and Evaluation

Yield and bean quality triats were taken as criteria for selection of mother plants in the available accessions so as to pave way for further breeding programmes. This evaluation has led to the identification of 11 high yielders with more than two kg of dry beans per tree per year (50 pods/tree) from Malaysian lines. All these lines had bigger sized beans with the range being 0.86 to 1.50 g. On the basis of individual tree performance 10 trees of nigerian collections were identified whose mean yield per tree (average of 10 years) ranged from 3.51 to 5.94 kg dry beans (81-159 pods).

The phenomenon of gametophytic self-incompatibility in cocoa makes it compulsory to ensure the compatibility between the used component lines in cocoa breeding. Hence cross compatibility test was conducted among the accessions which revealed that majority of them are cross compatible.

Hybridization yielded several cross-combinations of which 42 combinations have been evaluated under four progeny trials. Under the Progeny-II trial 11 crosses showed positive heterotic effects over their parents in terms of their pod yield. The hybrid Amel × Na 33 has been performing well under progeny trial III with significantly heavy bean yield. Under the Progeny IV trial at Kidu the early indication through high vigour of hybrid seedlings of II-67 × NC 29/66 reveals of its superiority over the other combinations.

Clonal progeny of four crosses (hybrids) viz., I-14 × I-56, I-14 × NC 42/94, III-105 × I-56 & I-56 ×

NC 42/94 have been utilized in establishing seed gardens in Karnataka and Kerala for production of hybrid seeds for distributing to farming community. I-14, I-56 and III-105 make the better pod yielders from Malaysian accessions while NC 42/94 has got the drought tolerance—a desired trait in cocoa which is an established fact through convincing physiological studies at the Institute. Further crop improvement work by hybridization is in progress.

Vegetative propagation

Once the better performing cocoa lines are identified through the sequential breeding strategies then comes the time to find a way to perpetuate them with all the desired traits for maintenance and production. Clonal multiplication is the answer here as the plants produced through vegetative method are supposed to be true to type. The CPCRI at Vittal tried various methods of clonal multiplication starting with rooted cuttings, grafting (side & soft wood wedge) and budding (patch). Study has revealed the advantageous point of growing straight upright habit of the graft obtained using Chupons as scion materials. Earlier study has indicated that the period from June to August is the conducive time for grafting. Soft wood wedge grafting and patch budding of three month old cocoa seedlings will give on an average 70-80 percentage of success within a period of three weeks. Nursery technologies have been standardised over the years.

Improved Agro-techniques

In the Central Plantation Crops Research Institute, Regional Station, Vittal, the first test planting of cocoa as mixed crop in arecanut garden was taken up in 1964. Based on the initial success a systematic trial was planted during 1970 to cover spacing, manurial requirements and canopy architecture of these crops. The results of the trial show that cocoa can be grown profitably as a mixed crop with arecanut. The cocoa can be spaced at 2.7 × 5.4 m or 5.4 × 5.4 m in the existing arecanut gardens where the palms are planted at 2.7 × 2.7 m spacing. By growing cocoa, the income from the areca garden can be increased considerably.

At CPCRI, Kasaragod, cocoa was planted as a mixed crop with coconut in 1970. Two systems of planting viz., single hedge and double hedge of cocoa in between two rows of coconut were compared. The coconut trees were spaced at 7.5 × 7.5 m. Under the single hedge system, cocoa was planted at 3.5 m apart in between two rows of coconut trees whereas under double hedge system, the spacing between plants within the rows was 3.5 m and between rows 3.0 m. Planting cocoa in between coconut rows increased the yield of coconuts over 100 per cent besides the 430 kg dry cocoa beans per hectare.

Manuring and irrigation

An annual application of 100 g N, 40g P_2O_5 and 140 g K_2O per tree will have to be applied separately to cocoa. Summer irrigation is one of the important aspects in cocoa cultivation. Cocoa plants require continuous supply of moisture for optimum growth and yield. During summer the plants will have to be irrigated at weekly intervals. The later study with drip system has indicated that the minimum quantity of 20 litres of water per tree per day will suffice for the sustenance of cocoa.

Pruning

Cocoa grows in a series of stories. The chupon or vertical branch of the seedlings terminates at the jorquette when four or five branches develop. Further chupon develops just below the jorquette and continues its vertical growth till another jorquette develops and so on. When the first jorquette develops at a height of 1.5 m the canopy will form at a height convenient for harvesting and other operations It is desirable to limit the tree at that level by periodical removal of chupon growth. The second jorquette may be allowed to form if so desired. Generally three to five fan branches develop at each jorquette. When more fan branches develop one or two weaker ones have to be removed. Similarly overlapping branches are also have to be removed for facilitating uniform light penetration to every part of canopy.

Identification of drought tolerance

Sixty three cocoa lines from Nigerian collections were screened for morphological and physiological characteristics. From a preliminary screening 14 accessions were selected for detailed studies. The water relation components, stomatal behaviour and biochemical parameters were determined. Based on parametric relationship with drought tolerance the rank sums of these accessions led to a selection of 6 accessions (NC 23, NC 29, NC 31, NC 39, NC 42 and Amel × Na 33). These drought tolerance accessions had effective stomatal regulation resulting in decreased transpirational water loss which seems to be a major adoptive feature of cocoa.

Pest

Though more than 50 insects have been recorded on cocoa from India only few cause primary damage. Non insect pests like rats, squirrels and monkeys cause greater damage (8-51%) to the pods. Among the insect pests sap sucking insects like mealy bugs (Planococcus lilacinus and P. citri) are of significance. Mealy bugs attack all the tender parts like tender shoots, flower cushions, flower buds, cherelles and pods. In addition to the natural predating ants a spot spray with monocrotophos @ 125 ml in 100 l of water during summer season will take care of this pest. Tea mosquitoes attack cherelles, tender shoots and pods resulting in wilting and rusty like pustular lesions over the pods. Avoiding the oviposition by adult bug by harvesting the ripe pods at regular interval of time can easily control the cocoa infestation with this insect. Intensive work on controlling the damage due to rodents has be[redacted]one and method for bringing down the loss has been worked out.

Diseases

Black pod

Among the main pathogens of *phytophthora spp., Colletotrichum gloeosporioides* and *Botrydiplodia theobromae* reported to account for serious proportion in causing cocoa diseases in India, the greater degree of loss is encountered with *Phytophthora,* Detailed study has revealed the possible involvement of three species of *P. palmivora, P. capsici* and *P. citrophthora* in causing black pod diseases the most common hurdle in cocoa production, In India *P. palmivora* is the most destructive of all the other fungal pathogens of cocoa.

The disease occurs in rainy season (June-Sept.) when the humidity is high with a constant low temperature. Pods of all ages are susceptible to the disease. The infection appears as one or more small, brown, circular lesions anywhere on the pod surface. They increase rapidly and cover the whole surface of the pod. Ultimately the whole pod and beans are invaded and the pod turns black in colour.

Since the infected pods will form the main source of further infection of healthy pods, they should be removed from the gardens at weekly intervals. Since the high humidity and low temperature are favourable for disease development, cocoa should not be planted very closely. Proper pruning of cocoa tree is also very essential to minimise the shade. In addition, spraying of Bordeaux mixture (1%) at frequent intervals depending on the severity of the disease will give good control of the disease. Detailed study has indicated the possibility of exploiting the tolerance found with an accession—NC 51.

Stem canker

The disease often develops from the pods infected with *P. palmivora.* The infection from the pods spreads to the peduncle and then to the cushion and bark causing canker. The internal tissue beneath the outer grayish-brown lesions appear as reddish brown which can be easily distinguished from healthy tissue. When the canker girdle the trunk the plant or branches show symptoms of dieback and eventually the portion above the point of attack dies.

This can be controlled in the early stage of infection by excision of diseased bark followed by wound sealing with Bordeaux paste.

Harvesting and Processing

Cocoa flowers from the second year of planting and the pods take about 140-160 days to mature and ripen. Each pod will have 25-45 beans embedded in white pulp (Mucilage). Generally cocoa gives two main crops in a year during September-January and April-June, though off-season crops may be seen almost all through the year specially under irrigated condition.

Only ripe pods have to be harvested without damaging the flower cushions by cutting the stalk with the help of knife. The harvesting is to be done at regular intervals of 10-15 days. The damaged, unripe and infected pods have to be separated out to ensure better quality of beans after processing. The harvested pods should be kept for a minimum period of two days before opening for fermentation. However, the pod should not be kept beyond four days.

Fermentation involves keeping the mass of cocoa beans well insulated so that heat is retained, while at the same time air is allowed to pass through the mass. The process lasts upto seven days and is followed immediately by drying. Cocoa bean mass under the process of fermentation has to be overturned regularly to maintain the uniform specified temperature all over the mass.

Development (Commercial cultivation)

There was practically no attempt to grow cocoa in the country on a scale worth mentioning until independence in 1947. In 1960 the area under cocoa in India was estimated to be around 80 ha with the sole variety of Criollo. The first scheme to develop cocoa cultivation in the Southern States of Kerala, Karnataka and Tamil Nadu was approved by the GOI during the III Plan (1962-67) period.

The initial encouragement and success met within the attempt to raise cocoa under arecanut and coconut gardens pave way for further expansion of cocoa as a mixed crop with arecanut and later under coconut in the West Coast of the country. During 1967-73, India imported about 7300 kg seeds from Malaysia. These seeds were distributed to various State agencies for raising seedlings and distribution to farmers. The Cadbury Fry India Ltd. played a significant role in promoting cocoa cultivation during this period. The favourable price that prevailed for cocoa around seventies along with aggressive promotional activities taken up by the State Department gave an impetus to cocoa cultivation. After 1974 there was practically no import of seeds for large scale cultivation. Later distribution of seedlings has been carried out by respective State Governments as well as Directorate of Cocoa. Arecanut and Spices Development using seeds and grafts produced within the country. The present area under cocoa is estimated to be about 16,500 ha with an annual production of about 6000 tones dry beans. More than 90 per cent of this is planted as mixed crop either with arecanut or coconut. The poor demand and price fall in first half of 1980 had a set back in the production. Later from 1982, the interest regained when the CAMPCO entered into the market.

With the proper management practice (crop husbandry like pruning and training, manuring etc.) and adequate measures for controlling diseases and pests the yield or production of dry beans can be substantially increased. There is vast scope for increasing area under the arecanut gardens available in the three important districts viz. Dakshina Kannada, Uttara Kannada and Shimoga of Karnataka and five districts viz. Cannanore, Kasaragod, Kottayam, Quilon and Trivandrum of Kerala. These districts together have about 60,000 ha under arecanut. The situation then will be one of facing the surplus production of cocoa beans.

Future programme

The challenge will be when the country reaches surplus production and we think of export market. The international markets prefer beans weighing more than one gram with low acidity (i.e. pH being more than 5.0), high fat content (more than 50%) and high shelling percentage besides other qualities. These qualities largely depend on genetic make up of the plant. Hence the aim should be to identify and propagate plants which will produce quality standard beans suitable for export market. It is for this purpose that CPCRI has programmed to collect more varieties (accessions) available within and outside the country. Efforts to identify plants with desirable characters will be intensified. In addition to establishing poly clonal seed orchards for generating superior planting material, efforts will also be intensified to propagate vegetatively high yielding trees with desirable traints. A third item in the programme is evolving resistant/tolerant strains of cocoa against diseases like black pod and canker.

Then net income of the farmer can be increased by proper utilization of by-products like pod husks, mucilage or pulp and sweatings. Every tonne of cocoa beans produced will have 8 to 9 tonnes of pod husk available which can be converted as cattle feed, manure or even for production of biogas. The mucilage or pulp can be used in the preparation of jams, jellies and vinegar. From sweatings collected during fermentation of beans, acctic acid can be produced.