

## THREE DECADE OF COCOA RESEARCH IN KERALA AGRICULTURAL UNIVERSITY, THRISSUR

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Cocoa, *Theobroma cacao* L. popularly known as 'Food of Gods', is the only source of chocolate. It is indigenous to tropical humid forests on the lower eastern equatorial slopes of the Andes in South America. Cocoa spread to all over the tropical regions of the world from 18th century onwards and is now grown in 58 countries covering 6.9 million ha. worldwide and producing 2.7 million tonnes of cocoa worth in excess of \$4 billion to the world economy annually. Though cocoa was introduced into India in the early 20<sup>th</sup> century, its exploitation as a crop of significant economic value is just five decades old. Though it is recommended as an inter crop in Kerala and Karnataka, cultivation as sole crop is also coming up in a big way on account of remunerative returns. After a severe set-back till 2001 owing to poor returns, the crop is now getting wide acceptability among the growers. The re-acceptance of the crop by the farmers of Kerala owes to its superiority as compared to other plantation crops. The merits of the crop are:-

1) It is a highly suited intercrop for coconut and arecanut plantations. Studies show that cocoa- coconut and cocoa - arecanut combinations complement each other and are mutually benefited. When coconut/ arecanut canopy protects cocoa from direct heat from the sun, litter fall from cocoa enriches the soil organic matter status of the plantation and leaf litter accumulation is estimated as 1-3 tonnes/ha.

- 2) Cocoa tolerates heavy shade to a level which is not tolerated by any other crop. This peculiarity makes it adaptable to extremely shaded environments of the homesteads of Kerala. The success of cocoa - rubber in farmer's field in Idukki and Kottayam districts now prompt the growers to accommodate @ 1 plant in the centre of 4 rubber plants in rubber tracts of the state. It also comes up well under forest trees, even under teak.
- 3) Cocoa ensures maximum utilization of solar energy through its fast spreading canopy.
- 4) In an intercropping system, the sunlight reaching the ground is significantly reduced and thus there is reduction in weed growth and cost of weeding.
- 5) As growth of cocoa is regulated by regular training and pruning practices, the height is restricted to 5-7 ft. This makes the cultural operations to be less labour intensive and women friendly.
- 6) The price is attractive at present with Rs. 45-50/-per kg of wet beans and Rs. 150-160/-per kg of cured beans. Intercropping with cocoa provides an additional /regular income of about Rs. 50,000/ ha/year.
- 7) Intercropping with cocoa reduces the risk of price fluctuation as experienced in a monocropping system.
- 8) The statistics of demand and supply scenario in India suggests that production of cocoa in the country meets only 1/3<sup>rd</sup> of its demand.

- 9) The consumption of cocoa has registered a rapid rate of about 5-20 per cent every year even in the midst of economic recession in the recent past. The consumption is likely to increase substantially in the coming years.
- 10) Cocoa has immense potential for export also. The quality of Indian cocoa is comparable to those produced in other major cocoa producing countries of the world.
- 11) The number of large and small manufacturers of chocolate and other cocoa based products have increased substantially recently and this enabled a tight competition for cocoa in the market. Thus the likelihood of non-procurement as experienced during the initial years is quite remote.
- 12) All parts of the plant are useful, nibs for chocolate industry; pod husks as mulch, manure, cattle feed; cocoa shells as mulch and manure for orchids, anthurium and ornamentals; cocoa sweatings for making soft drinks, jam, jelly etc. and timber as fire wood.

These indicate that the prospects of the crop in the state is immense.

### **Cocoa research in Kerala Agricultural University**

As cocoa is an introduced crop, technology for successful cultivation had to be developed for conditions prevailing in India. With the objective of evolving cocoa varieties and develop production technologies relevant to our country, cocoa research was initiated in Kerala Agricultural University main campus at Trichur in 1979, when a World Bank-aided research project, 'Kerala Agricultural Development Project (KADP)' was initiated. After the termination of this project in 1986, the projects were sustained by the Kerala Agricultural University through meagre resources. Proposal for funding to continue and strengthen the research programmes was submitted to M/s Cadbury India Ltd was accepted and cocoa research was

intensified from April 1987 with the establishment of Cadbury- KAU Co-operative Cocoa Research Project.

Research work to achieve projected goals has been taken up systematically, which led to significant breakthrough in cocoa production technology and processing. The important research findings are given below:

#### **1. Germplasm and its utilization**

Being an introduced crop, the genetic base of the crop is very narrow. A diverse assembly of germplasm is one of the pre-requisites for an efficient breeding strategy. As a result of elaborative survey work and import from the University of Reading, UK, the project succeeded in establishing the biggest germplasm of cocoa in India with 490 accessions. The collection contains very useful accessions like SCA 6, ICS 6 and IMC 67 and these are being fruitfully exploited in the breeding programmes.

Performance evaluation of the germplasm resulted in the identification of a total of 194 superior trees. These were multiplied clonally and evaluated in comparative yield trials. The results led to the release of seven varieties/clones (CCRP 1- 7), which excelled both in terms of yield and resistance to vascular streak die back disease.

#### **2. Hybridization**

##### **a) Yield improvement**

During the early years, the cultivation of cocoa did not pose any problem to the growers. Hence, initial breeding thrust was confined only to improvement in yield. From 1987 to 1993, 193 parents were selected, 303 crosses were made, 21819 F<sub>1</sub> hybrid seedlings were produced and based on vigour in the nursery 1135 hybrid seedlings were field planted from 1988 onwards. Evaluation of these hybrids over twelve years led to the release of 3 elite hybrid clones with very high yield, desirable pod and bean traits and resistance to vascular streak die back disease.

**b) Resistance to vascular streak die-back disease**

From 1990 vascular streak die back disease began to spread to all cocoa growing areas of the state. As this disease cannot be controlled by the use of fungicides, breeding programme for production of disease resistant planting materials received further thrust. Under this programme (from 1994-2002), 298 resistant parents were used in evolving 1012 crosses. The 45,000 F<sub>1</sub> hybrids thus derived from the crosses were screened for resistance to the disease by subjecting them to high inoculum load and also by keeping them in the midst of infected seedlings. The disease escapes (2546 Nos) were selected after one year and the vigorous seedlings (1177 Nos) were field planted from 1998 onwards in *three* separate plots.

Again it is worth mentioning that such a huge collection of VSD tolerant hybrids is not available in any of the cocoa breeding institutes in the world. Evaluation of these hybrids showed that there are a number of high yielding plants with resistance to VSD in this population.

**c) Improved bean size**

Small bean size often poses problems to the growers particularly during summer. Thus, breeding programmes to develop varieties with bold bean appeared to be essential and as such programmes were taken up during 2003 and 2007. Thirty parents with above 2.0g dry bean weight were selected and 136 crosses were made. Out of the 644 hybrid seedlings thus obtained, 120 seedlings were selected based on the vigour and were field planted. These hybrids are presently under evaluation.

**d) Improvement of bean quality**

Criollos are considered to yield cocoa with superior processing qualities. To combine the criollo quality to the superior clones, a programme was taken up during 2004 and 2005.

One hundred and fifty nine crosses were made using 46 parents which resulted in 514 F<sub>1</sub> hybrid seedlings. After screening for vigour, 240 hybrid seedlings were field planted. These hybrids are under various stages of evaluation.

**e) Resistance to *Phytophthora* pod rot disease**

This disease is of serious concern in many cocoa growing countries of the world and estimated to cause upto 40 per cent global crop loss. This disease is also very serious in India. Hence breeding programmes to tackle the disease through development of resistant planting material was initiated from 2005. Under this programme, 109 parents were selected, 108 crosses were made and produced 2166 F<sub>1</sub> hybrid seedlings. Out of these, 650 selected seedlings were field planted from 2007 onwards. These hybrids are under evaluation.

**3. Establishment of clonal gardens**

To meet the growing demand of hybrid seedlings for the area expansion programme in the country, clonal gardens with parents tested for GCA and SCA were established from 1989 onwards. Five poly clonal gardens and one biclonal garden were established using 86 prepotent parents. The total number of plants in these gardens comes to 3737. The anticipated seed pod production by the year 2010- 11 is 2.00 lakh, sufficient enough to produce 50 lakh hybrid seedlings.

**4. Inbreeding programme**

This programme with the objective of producing fully homozygous inbreds is probably unique in the world. This was initiated in 1987 using self compatible parents. The highly complex genetic nature of this crop makes production of inbreds a very difficult task and thus many of the breeding institutes dropped the programme after 2<sup>nd</sup> generation. However, the Kerala Agricultural

University has succeeded in producing the first ever fifth generation inbred in the world of one genotype after 21 years of continuous effort. At present, the University maintains  $S_4$  generation of two genotypes,  $S_3$  of 5 genotypes,  $S_2$  of 9 genotypes and  $S_1$  of 51 genotypes.

## 2. Crop Management

### i) Root activity pattern

Studies in rainfed crop receiving 32P revealed that the maximum absorption of applied 32P occurred from a depth of 30 cm which accounted for 42 per cent of the total root activity within the soil column of 2.5 m radius whereas the relative densities of active roots at 15 and 60 cm depths were 25 and 28 per cent, respectively. Beyond 60 cm depth, concentration of active roots declined sharply to about 5 per cent. Lateral spread of active roots was mainly restricted to one metre from the plant which accounted for 75 per cent of the total root activity. An area of 1.5 m radius around the plant accounted for about 90 per cent of the total root activity. Thus it was found that application of fertilizers upto 30 cm depth and 1.5 m radial distance will lead to maximum efficiency of applied nutrients.

### ii) Standardization of vegetative propagation

Patch budding was found to be the best among the different methods tried. To ensure higher rate of success the root stock portion above the bud patch needs to be cut half way and

snapped back after 21 days of budding. The percentage of success was around 80. This technique is now being followed for the large-scale production of planting materials in cocoa.

### iii) Response of cocoa to shade and irrigation

In a trial involving shade manipulation, there was near-consistent and steady improvement in growth and yield of cocoa with increasing levels of illumination. More than five times increase in yield was observed in the open compared to the highest intensity of shade level (25%) tried.

### iv) Training and pruning of cocoa

The trial field planted at Vellanikkara in 1981 showed that there were more or less consistent and statistically significant superiority of the unpruned control both in terms of growth and yield. When pruning was done systematically, there was increase in productivity as compared to unpruned control.

### v) Top working

This technique has been standardized for the first time in Kerala Agricultural University to rejuvenate old and unproductive cocoa plants and also to convert genetically poor yielders to high yielders. The top worked trees start yielding heavily from the second year onwards. About 50 per cent improved yield is obtained in the second year and about 100 per cent increase in the third year.

## 3. Crop protection

### i) Diseases

A massive survey was conducted in the major cocoa growing tracts of Kerala and the following diseases were identified as prevalent in Kerala.

Sl.No.	Disease	Causal organism
1.	Phytophthora pod rot	<i>Phytophthora palmivora</i>
2.	Charcoal pod rot	<i>Lasiodiplodia theobromae</i>
3.	Leaf spot	<i>Colletotrichum gloeosporioides</i>
4.	Colletotrichum pod rot	<i>Colletotrichum gloeosporioides</i>
5.	Phytophthora canker	<i>Phytophthora palmivora</i>

6.	Seedling die back	<i>Phytophthora palmivora</i>
7.	Vascular streak die back	<i>Oncobasidium theobromae</i>
8.	White thread blight	<i>Marasmius scandens</i>
9.	Horse hair blight	<i>Marasmius equicrinus</i>
10.	Pink disease	<i>Corticium salmonicolor</i>

Detailed studies on etiology, mode of spread and control have been done and results have been incorporated in the Package of Practices Recommendations of Kerala Agricultural University- Crops.

## ii) Pests

Research work to identify the pest complex was conducted and the following insects were identified.

SI. No.	Pest	Causal organism
1.	Mealy bugs	<i>Planococcus citri</i> , <i>Rastrococcus iceryoides</i>
2.	Mango mealy bug	<i>Drosicha stehbingi</i>
3.	Citrus aphid	<i>Toxoptera aurantii</i>
4.	Cow bug	<i>Gargara mixta</i>
5.	Tea mosquito	<i>Helopeltis antonii</i>
6.	Red banded thrips	<i>Scleothrips rubrocinclus</i>
7.	Red borer	<i>Zeuzera coffeae</i>
8.	Leaf feeders	<i>Olene mendosa</i> , <i>Argina cibraria</i> , <i>Oenospila quadraria</i>
9.	Stem girdler	<i>Sthenias grisator</i>
10.	Chaffer beetles	<i>Popillia complanata</i>
11.	Cockchaffer beetle	<i>Leucopholis sp.</i>
12.	Greenish weevil	<i>Mylloceris viridanus</i>
13.	Striped squirrel	<i>Funambulus tristriatus</i>
14.	Kats	<i>Rattus rattus</i>
15.	Civet cat	<i>Paradoxorus sp.</i>

Studies on evolving control measures against important pests were carried out and recommendations were made.

## 4. Post harvest handling

The technology for small-scale fermentation for quantities ranging from 2 kg to 50 kg wet beans was standardized. The methods of drying and storage were also standardized.

In order to safeguard the interests of the growers, studies were taken up to standardize technology for small scale secondary processing that can be taken up on home scale. The results pointed out that a number of cocoa based products could be at home level and that too with low investment. The first chocolate' product ever produced through home level processing from the beans in India was launched as "KAU Chocolate 4 U" in January 2008. Financial analysis of different

types of chocolates indicated that this venture to be very economically viable. This technology has been utilised for the establishment of a small agro-industrial unit on cocoa products under the Kerala Agricultural University. This unit provides employment for six educated unemployed women. Trainings on value addition of cocoa are being organized for farm women. So far 28 Self Help Groups have already entered into this venture.

Research on cocoa in the Kerala Agricultural University is rated as one of the best in the world. The major problems confronted by the cocoa growers in the country could be effectively tackled through development of appropriate technologies from time to time.