STATUS OF COCOA RESEARCH IN KERALA AGRICULTURAL UNIVERSITY - AN OVERVIEW

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Cocoa, *Theobroma cacao* L. popularly known as 'food of gods', the original source of chocolate, is indigenous to tropical humid forests on the lower eastern equatorial slopes of the Andes in South America. Cocoa research was initiated in Kerala Agricultural University main campus at Trichur in 1979. Pioneering works culminated in results of immense practical utility, which became the basis of the Package of Practices Recommendations of the crop. After the termination of this project in 1986, the cocoa research was intensified from April 1987 with the establishment of Cadbury-KAU Co-operative Cocoa Research Project. Major breeding activities undertaken by Kerala Agricultural University includes germplasm collection, characterization and utilization, selection and hybridization programmes for improving yield, quality, bold bean size, resistance against vascular streak die back disease, *Phytophthora* pod rot disease and inbreeding. As a result of this programme seven superior clones and three hybrids showing ample resistance to vascular streak die back diseases were released. Outstanding self incompatible hybrids with high cross compatibility are carried over to clonal gardens. Hybrid seedlings raised by using pods from this garden now rule cocoa plantations in India. This in turn helped to elevate average yield of cocoa to 2kg/plant/year. Self compatible parents are used for inbreeding with an objective to produce fully homozygous genotypes. Kerala Agricultural University has succeeded in producing the first ever fifth generation inbred in the world.

Introduction

Cocoa, *Theobroma cacao L.* 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 3.5 million tonnes of cocoa worth in excess of $4 billion to the world economy annually. Though cocoa was introduced into India in the early 20th century, its exploitation as a crop of significant economic value is just five decades old. In India, it is a new crop of less than 40 years. From the cocoa boom in 1982, the crop suffered severe setback due to collapse of marketing system. After about 20 years of stagnant growth, the crop began to revive in a big way. This success is due to the systematic exploitation of agricultural research. 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.

Cocoa, a crop of immense potential and 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

- 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

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the sun, litter fall from cocoa enriches the soil organic matter status of the plantation and leaf litter accumulation is estimated as 1-3 tones/ha.

- 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.
- Cocoa ensures maximum utilization of solar energy through its fast spreading canopy.
- In an intercropping system, the sunlight reaching the ground is significantly reduced and thus there is reduction in weed growth and cost of weeding.
- 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.
- 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
- Intercropping with cocoa reduces the risk of price fluctuation as experienced in a mono cropping system.
- The statistics of demand and supply scenario in India suggests that production of cocoa in the country meets only 1/3rd of its demand.
- The consumption of cocoa has registered a rapid rate of about 15- 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.
- 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.
- 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.
- 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 points stress that the potential for the crop is immense in the state. The total area under cocoa in the country is presently 52,556 ha, which comes to only about 3.0% of the coconut and arecanut area in India. In terms of area, Kerala is the leading cocoa growing state in the country, but there is scope for area expansion in the southern states of India. At present, Kerala accounts for about 41 per cent of the area, Andhra Pradesh 25 per cent, Karnataka 9.7 per cent and Tamil Nadu 23 per cent respectively. Kerala is the leading cocoa growing state in the country with 60 per cent of production. The productivity of cocoa in the state is above 1 kg dry beans/ tree/ year and this is one of the highest in the world.

The annual production of cocoa in India is about 12000 to 14000 tonnes, whereas the annual requirement to run the chocolate factories throughout the year is estimated at 30000 tonnes. Thus the production of cocoa meets only 30 per cent of the projected demand of the processing companies in India and 70 per cent is met through import as beans and primary products. Added to this the fact that the demand for cocoa based products is registering a steady increase of about

12 per cent every year and the projected demand by 2020 comes to 50,000 tonnes. The highest producing African countries like Ivory cost and Ghana, most of the plantations are old and senile and only limited scope for replanting. Hence there is immense scope for bringing more area under this crop in the coming years.

As cocoa is an introduced crop, the technology for successful cultivation had to be developed for conditions prevailing in India. Cocoa cultivation was comparatively problem-free during the initial years of its introduction. As cultivation intensified, problems arose one by one in due course necessitating organized research. With the objective of evolving cocoa varieties and to 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. Pioneering works culminated in results of immense practical utility, which became the basis of the Package of Practices Recommendations of the crop. 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. The project is instrumental for elevating the status of cocoa, increased yield levels and re-establishing self confidence of growers.

I. Crop improvement

1. Germplasm and its evaluation

Early plantations of cocoa in Kerala were derived from seeds of illegitimate origin and this resulted in unremunerative stands with large proportion of poor yielders with undesirable pod & bean traits. The yield levels continued to be stagnant or low, if intercrossing among the limited genetic stock continued for a long period. A break through in the yield levels can be attained only if sufficient diversity is introduced into the system. This emphasizes the relevance of a germplasm with diverse characters. Being an introduced crop, the genetic variability of cocoa in this country is very limited. Germplasm forms an irreplaceable/reservoir of genetic diversity and this forms an integral part of breeding. Cocoa cultivation in major cocoa producing countries is under the grip of severe threats like witches' broom, cocoa swollen shoot virus, Phytophthora pod rot and Vascular streak die back. In these countries, germplasm collections have contributed significantly to safeguarding the crop with resistance to diseases and pests.

As on 1987, the Kerala Agricultural University had a collection of germplasm maintained in four sets. Germplasm I included 155 plants from pods of 15 selected trees introduced from Cocoa Research Institute of Ghana in 1978 and field planted in 1979. Germplasm II, III and IV established in 1980 included seedling populations of 80 types collected from promising plants of various plantations of Kerala. Superior plants from these populations were selected and multiplied as clones and included in GVI and the plants were top worked during 1994. The number of exotic accessions maintained as budded plants in GVI under the World Bank aided project, KADP was 126.

After the establishment of CCRP in 1987, attempts were made to collect variable types from the farmer fields of Kerala. Import of budwood from the Quarantine Station of the Unitersity of Reading was commenced from December 1990. Budded plants from these are being field planted from June 1991 after quarantine. Thirty four consignments of bud wood were received from Reading Out of the total of 790 clones introduced, 285 could be successfully field established.

The accessions are evaluated for initial vigor and growth. Upon flowering they are evaluated for flower intensity, floral characters and availability and fertility of pollen grains. Upon fruiting they are evaluated for yield and pod and bean characters. Number of pods produced in each tree/month is recorded. Observations on pod weight (g), pod length (cm) and breadth (cm), wet bean weight/pod (g), husk thickness (cm), dry bean weight (g), bean colour, length/breadth ratio of dry bean are also recorded. The accessions are also screened for pest and disease resistance. Incompatibility position is also checked.

From the germplasm collection, selection is done based on the criteria like;

1. More than double the average plot yield
2. Pod weight > 350g
3. Wet bean weight > 120g
4. Dry bean weight > 1g
5. Number of beans /pod > 35
6. Husk thickness < 1cm

Selected self incompatible ones are directly released as varieties after evaluation in CYT's, or used in various breeding programmes or carried over to clonal gardens after assessment of combining ability. Self compatible ones are used in inbreeding programmes.

The project maintains biggest germplasm assembly of the country, with a total of 564 accessions. This includes 336 exotic, 153 from farmers field and 75 from CPCRI. The collection includes 41 accessions from Brazil, 15 from Costa Rica, 9 from Mexico, 32 from Peru, 44 from French Guiana, 13 from Colombia, 87 from Trinidad and Tobago, 50 from Ecuador, 13 from West African countries and 21 from South East Asian countries.

These accessions are also classified based on (Table-1) economic characters and the types with specific traits have been utilized in different breeding programmes.

II. Selection

Performance evaluation of germplasm resulted in identification of 194 clones and these were clonally multiplied and evaluated under five comparative yield trials from 1989. This led to the release of seven superior varieties (CCRP 1-7) with excellent yield and reasonable level of tolerance to vascular streak die back diseases.

III. Hybridization

a. Yield improvement

During the initial years cocoa cultivation was comparatively problem free and hence the breeding thrust was to evolve varieties with high yield. The programme was initiated during 1983 and continued up to 1993. During this period, a total of 159 parents were included in this programme. Using these parents 239 crosses were made which resulted in production of 187 hybrid pods (Table. 2). From these pods, 21,819 seedlings were obtained. These were subjected to screening in nursery based on HD^2 value. 3126 seedlings found superior were field planted in series I, II, III, IV and progeny trials I, II, III, IV.

Based on the performance evaluation of these hybrids 163 superior hybrids were selected. They are utilized in various breeding programme, released as hybrids or used as better combiners in clonal garden. The result of this programme includes release of 3 superior hybrids (CCRP 8,9,10) with high yield and good level of tolerance to VSD.

b. Resistance to Vascular Streak Die Back disease

Vascular streak die back (VSD) was reported in Kerala during 1990 and it began to spread to all cocoa growing areas of the state. As this disease cannot be controlled effectively by the use of fungicides, breeding programme for production of disease resistant planting materials was initiated in 1994 and continued up to 2010.The

details are furnished in Table 3. Under this programme a total of 298 parents were selected and utilized. 1012 crosses were made and came out with 45,000 hybrid seedlings. The seedlings were screened in the nursery subjecting them to high inoculum load by keeping them in the midst of infected seedlings. The tolerant seedlings (2546 number) were selected after one year and among them 2435 vigorous seedlings were field established, from 1998 onwards in three separate plots VSD I, II, and III. Evaluation of these hybrids resulted in 7 superior plants and these are now field established in comparative yield trial. 65 superior hybrids are selected as parents for further breeding programme and 5 as better combiners in clonal garden.

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, 26 parents, 7 from germplasm and 19 from hybrid progeny trials with large bean size > 2.5g were used for the breeding programme. 137 crosses made to obtain 644 seedlings. After thorough screening 120 plants were field planted. Upon evaluation, a wide range of bean size from 0.75g to 2.5g was recorded (Table 4). 21 hybrids with high yield and bean size more than 2.5g were identified and now subjected to further evaluation.

d. Breeding for bean quality (2004 & 2005)

Criollos are considered to yield quality 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, 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 about 40% 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. Since 2010, 128 parents were selected and 162 crosses made to produce 2867 hybrid seedlings. 615 numbers were field planted during 2007 onwards after initial screening and there are under evaluation (Table.6). These hybrids are under evaluation.

4. Establishment of clonal gardens

To meet the growing demand of hybrid seedlings for the area expansion programme in the country, the Kerala Agricultural University has taken a lead in establishing clonal gardens from 1989 onwards. Cocoa is blessed with self incompatibility and this phenomenon is exploited here. 100 self incompatible clones with good combining ability and cross compatibility were identified, vegetatively multiplied and established in scientifically laid out clonal garden. Hybrid pods from the garden are used to raise hybrid seedlings and are supplied to farmers by Kerala Agricultural University or through Cadbury India Ltd. Studies had shown that hybrid seedlings are superior to budded plants with respect to right architecture, ease in management, low cost for establishment and resistance to biotic and abiotic stresses.

Inbreeding

The programme with the objective of producing fully homozygous inbreds is probably unique in the world. This was initiated during 1987 by selfing self compatible plants. It was designed based on the principle that when fully homozygous unrelated inbreds crossed together, an increase in hybrid vigour obtained. Due to the complex genetic structure of cocoa, many of the breeding institute dropped the programme after

2nd generation. However the Kerala Agricultural University has succeeded in producing the first ever 5th generation inbred in the world after 21 years of continuous effort. At present University maintains two genotypes of S4 generation, 5 of S3, 9 of S2 and 51 genotypes of SI (Table 8).

7. Micropropagation of cocoa

The protocol for micropropagation of cocoa was standardized. The tissue culture derived cocoa plants were planted in the field and these were found to be high yielding. The protocol for recovery of plantlets through somatic embryogenesis was developed. The technique of micrografting was perfected in this crop. Studies on another culture for production of haploid lines were also conducted

Table 1: Classification of germplasm based on economic characters

Character	Accessions
High yield	229
Large beans	53
Thin pericarp	38
Self compatible	15
Resistant to Phytophthora pod rot (Ppr)	53
Resistant to Vascular Streak Die back (VSD)	6
Resistant to Witches' broom (WB)	38
Resistant to Cocoa Swollen Shoot Virus (CSSV)	2
Resistant to red squirrel	1
Criollo	5
Trinitario	18
Nacional	3
Amelonado	5
Forastero	533

Table 2: Details of breeding programme for yield improvement

No. of parents	159
No. of crosses made	239
No of crosses obtained	187
No. of seedlings produced	21819
No. field planted from 1989 to 1994	3126

Table 3: Details of breeding programme for resistance to Vascular Streak Die Back disease

Parents	298
Crosses made	1012
Flowers pollinated	72,500
Seedlings obtained	45,000
Tolerant seedlings	2546
Field established	2435

Table 4: Details of breeding programme for improved bean size

No. of parents	26
No. of crosses made	137
No of crosses obtained	26
No. of seeds sown	1165
No. of seedlings produced	644
No. field planted	120

Table 5: Details of breeding programme for bean quality

No. of parents	17
No. of crosses made	54
No of crosses obtained	6
No. of seeds sown	682
No. of seedlings produced	514
No. field planted	240

Table 6 : Details of breeding programme for resistance to *Phytophthora* pod rot disease

No. of parents	128
No. of crosses made	162
No of crosses obtained	26
No. of seeds sown	3795
No. of seedlings produced	2867
No. field planted	615

Table 7 : Clonal gardens of cocoa in CCRP

	No. of parents	No. of plants	Year of planting
Polyclonal garden I	12	120	1989
Polyclonal seed garden II	38	228	1993
Biclonal Seed garden	6	1243	1996
Polyclonal Seed garden III	5	100	2000
Polyclonal Seed Garden IV	8	1100	2005
Polyclonal Seed Garden V	7	946	2006
Polyclonal Seed Garden VI	10	400	2010
Total	86	4137	

Table 8: Inbred population field established (1987-2010)

Genera-tion	Geno-types	Plants selfed	Flowers selfed	Pods obtained
S0	102	102	25052	147
S1	51	178	6263	163
S2	9	41	693	24
S3	5	55	1720	48
S4	2	17	428	9
S5	1	1	132	0
Total	75	394	34288	391

2. Crop Management

1. Root activity pattern

Studies in rainfed crop receiving ^{32}P revealed that the maximum absorption of applied ^{32}P occurred from a depth of 30 cm. This soil layer 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.

2. Standardization of vegetative propagation

Patch budding was found to be the best among the 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.

3. Response of cocoa to shade and irrigation

Cocoa is a plant that has originated under shade and this crop is most often cultivated under shade. In a trial involving shade manipulation, there was near-consistent and steady improvement in growth and yield of cocoa with increasing levels of illumination, it being more conspicuous in case of yield. The trial was continued for ten years and the results indicated that there is increase in the growth of the plants and yield 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.

4. Training and pruning of cocoa

The objective of the trial field-planted at Vellanikkara in 1981 was to assess the extent of pruning required for the crop. The results showed that there were more or less consistent and statistically significant superiority of the unpruned control both in terms of growth and yield. The study also showed that pruning did not decrease yield of cocoa. When pruning was done systematically, there was increase in productivity as compared to unpruned control.

5. 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 first step of the technique consists in cutting the trees halfway below jorquette height and snapped back. This induces development of chupons from below this region. Patch budding is done on three to four vigorous and healthy shoots using scions from high yielding, disease resistant clones and the rest are removed. The polythene tape is removed three weeks after budding and the stock portion above the bud union is snapped back. The snapped portion is removed after two hardened leaves develop from the bud. When sufficient shoots are hardened, the canopy of the mother tree can be completely removed. Though this can be done on all seasons, it was preferable to take up in rainfree period under irrigated gardens. For rainfed situations, it may preferably be done after the receipt of pre-monsoon showers.

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. Loss of crop for one year during the operation is compensated by bumper crops realized in the subsequent years. The main stem will continue to belong to the older plant and the fruits borne in this area belong to the poor yielder. Better yields are however obtained from the fan branches of the high yielding clone used for top working.

3. Crop protection

1. Diseases

Survey on diseases prevalent in Kerala

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	*Phytophthora palm ivora*
2.	Charcoal pod rot	*Lasidiplodia theobromae*
3.	Leaf spot	*Colletotrichum gloeosporioides*
4.	Colletotrichum pod rot	*Colletotrichum gloeosporioides*
5.	Phytophthora canker	*Phytophthora palm ivor a*
6.	Seedling die back	*Phytophthora palm ivor a*
7.	Vascular streak die back	*Oncobasidium theobromae*
8.	White thread blight	*Marasmius scandens*
9.	Horse hair blight	*Marasmius equicrinis*
10.	Pink disease	*Corticium salmonicolor*

Among these, the most serious were phytophthora pod rot and vascular streak die back. Phytophthora pod rot is of universal occurrence. Occurrence of vascular streak die back was first noticed at Kottayam during 1981. This disease then started spreading at a fast rate and a detailed survey conducted during 1988-93

showed that nearly all the cocoa growing areas of Kerala had this disease except in isolated patches. None of the common fungicides including the systemic ones tested were found to offer protection against this disease. It was concluded that the only effective method of controlling this disease will be through the genetic means. Work on identification'of resistant/ tolerant clones was initiated in 1990 and evolution of such hybrids was started at Vellanikkara during 1996. In order to identify superior clones tolerant to this disease, a survey covering all the major cocoa growing areas of Kerala State was conducted. The survey resulted in 28 collections. These clones'along with 11 of the introduced clones with reported field tolerance were field planted as a comparative yield trial during June 1994 to assess their yield performance. A second line of approach was to screen all the identified high yielding clones in farmers' fields with heavy disease load. Based on the latter, a total of seven clones were tentatively selected as high yielding and vascular streak tolerant.

Among the nursery diseases, seedling blight caused by *Phytophthorapalmivora* was found to be the most serious. Continuous rains leading to high atmospheric humidity or very frequent watering were found to be the necessary conditions for the occurrence of the disease and its severity. Fungicides like potassium phosphonate, Bordeaux mixture and copper oxychloride were effective in checking the disease. Reducing shade level, increasing aeration of nursery plants and low frequency of watering are to accompany the above fungicidal treatments for most effective control of the disease.

2. Pests

Survey on pest complex

Research work to identify the pest complex of this crop was initiated in 1976 at Vellanikkara and the following insects were identified as pests.

Insect pests

Sl. No.	Pest	Causal organism
1	Mealy bugs	*Planococcus citri*
2	Mango mealy bug	*Drosicha stebbingi*
3	Citrus aphid	*Toxoptera aurantii*
4	Cow bug	*Gar gar a mixta*
5	Tea mosquito	*Helopeltis antonii*
6	Red banded thrips	*Sclenothrips rubrocinclus*
7	Red borer	*Zeuzera coffeae*
8	Leaf feeders	*Olene mendosa* *Argina cibraria* *Oenospila quadraria*
9	Stem girdler	*Sthenias grisator*
10	Chafer beetles	*Popillia complanata*
11	Cockchafer beetle	*Lencopholic sp.*
12	Greenish weevil	*Myllocerus viridanus*
	Non insect pests	
13	Striped squirrel	*Funambulns tristriatus*
14	Rats	*Rattus rattus*
15	Civet cat	*Paradoxurus sp.*

Research in subsequent years was concentrated on evolving control measures against important pests and also to locate new occurrences, if any. The important observation, consistently made from these studies was that the mammalian pests were the most serious and difficult to control. Attempts to protect the pods using repellents have been attempted since early days of cultivation. They were only partially effective and were found to break down under conditions of severe infestation. The only effective method of bringing down damage by these pests was the use of integrated methods of checking population build up. These included use of traps and poison baits. Experimental observations and experience over the years have shown that the

degree of damage can range from as low as five to as high as 100 per cent depending upon the control measures adopted.

Among the insect pests, red borer and stem girdler were found to be the serious ones. Insecticidal application was effective against both these pests. An insect pest that has become serious since the last few years was tea mosquito causing damage mainly on developing pods. Attack of red banded thrips was also of some significance during the winter and rain free summer months causing damage to leaves.

CONCLUSION

In recent years, cocoa has become a favorite crop of the farming community and been receiving a lot of demand due to the fair returns received. The Kerala Agricultural University has played a major role in the development of the crop in the country by way of genetic up gradation of the planting stock, by standardizing package of practices and recommending the appropriate agrotechniques for profitable cultivation. Value addition at farm level has also been made possible through research interventions. When the average yield in the major cocoa producing countries continues to be below 500g /plant per year, the average yield in India is above 1 kg/plant /year. The credit for securing this high average yield of cocoa in India solely goes to the pioneering efforts of the Kerala Agricultural University.

Many of the long term breeding experiments laid out every year from 1987, are to be continued to derive fruitful results. In many of the major cocoa producing countries of the world, the cultivation is facing severe threats from pest and diseases. Though Indian cocoa is at present free from major threats, the possibility of such incidences cannot be ruled out in future. Unless there is a strong research foundation, problems confronted from time to time cannot be effectively tackled.

Attempts are underway to bring more areas under cultivation under varying soil and climatic conditions in Kerala, Karnataka, Andhra Pradesh and North Eastern states which warrants strong research support. More clonal gardens using disease resistant and prepotent parents are to be laid out to meet the increasing demand of planting materials. Another major thrust area for research is value addition, so that a wide array of products are made, patented and finally delivered to the public at affordable prices.

ATTENTION AUTHORS

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