UTILISATION OF INTRODUCED GENETIC RESOURCES IN COCOA

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Cocoa *(Theobroma cacao.L.)* belonging to the family Sterculiaceae; (now classified under Malvaceae), is an important beverage crop, seeds being the source of cocoa and chocolate. Cocoa is consumed the world over for the flavour and textural properties of chocolate. Collection, conservation and international exchange of genetic resources constitute the basis of crop improvement programme. Breeders need germplasm containing sufficient diversity to allow them to produce varieties with good economic characteristics. Collection, Conservation, Characterisation, Cataloguing and Distribution are all important in germplasm.

Collection

Collection of wild germplasm from the centre of diversity is essential to broaden the genetic base of the material. The centre of origin of cocoa is the lower eastern equatorial slopes of the Andes where the greatest range of variation exists. The major diversity is seen in the upper Amazonian region of South America especially Ecuador, Peru and Colombia. Major efforts have been placed on germplasm collection and important clonal repositories have been established in Brazil, Costa Rica, Ecuador and Trinidad. It was only during 17^{th} & 18^{th} centuries that cocoa crop was introduced to many other countries. The breeder's collection in Africa & Asia all had their origin in one or more of these primary collections. The deliberate collection of exotic germplasm started in 1930's by F.J.Pound. The expeditions held since 1949 to collect cocoa germplasm in primary and secondary centers of genetic diversity indicate serious concern in preserving as much genetic diversity as possible before it is lost due to deforestation and other socio-economic causes. Because of the prevalence of serious diseases of cocoa in different geographical zones, such as 'witches broom' in the American continent, 'swollen shoot' in Africa and "vascular streak die back" in South East Asia, precautions must be taken during any transfer of plant material from one country to another. The FAO/IBPGR Technical Guidelines for the Safe Movement of Cocoa Germplasm were developed and published in 1989 to provide scientifically sound methods for the exchange of cocoa germplasm.

Conservation

The material must be conserved internationally recognised field gene banks or field collections such as international Cocoa Gene Elank, Trinidad (ICGT - CRU or at CATIE or Costa Rica. The need to exchange material with other collections is of great importance. *Ex situ* field germplasm collections have been assembled, mostly in Trinidad (over 2400 accessions), CATIE (nearly 700 accessions), Ecuador (over 250 accessions) and in Brazil (over 1700 accessions). In due time other conservation methods eg. tissue culture or low temp storage may be possible. Cocoa seeds being recalcitrant cryopreservation may not be feasible in this species. The collection of cocoa trees in germplasm centers represent an important resource for the world cocoa community.

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Characterisation

The purpose of characterisation is to establish the provenance of each clone and its biological & commercial characteristics using a variety of proven techniques as available, e.g. morphological descriptors, isozyme analysis, and RAPD markers. The cocoa collections in the world over have been characterized and useful data obtained for practical plant breeding. The CATIE descriptor list has 63 characters. The use of biotechnological tools aid in clone identification and paternity analysis, the assessment of genetic effects of clones and ultimately will allow gene based evaluation of the agronomic value of clones.

The use of molecular markers in germplasm management and identification of genetically divergent populations has been widely used by many workers in cocoa. Also various markers have been used for identification and characterization of cocoa genotypes like isozyme, RFLP, RAPD, AFLP & SSR. The use of microsatellites (SSR) provides anchor points for mapping populations. The small genome size of cocoa with very little repetitive DNA and presence of considerable polymorphism in cocoa have facilitated the construction of genetic linkage maps at CATIE and C1RAD. QTL studies have provided useful genetic information on correlation of molecular markers with economically important traits.

Cataloguing

The data obtained as a result of characterisation has to be assembled in a computer data base, which is readily usable in wide variety of different locations and providing facilities for updating and the incorporation of new data as these become available. Today internet has a vital role in dissemination of information. The proper conservation and most productive utilisation of all forms of genetic resources are usually based on prior knowledge of germplasm. The International Cocoa Germplasm Database (ICGT) has been compiled to give information on the origin, present location and characteristics of most widely grown cocoa clones and is available online (www.icgd.rdg.ac.uk.) As service to the breeders, the central crop data base can provides current information on the specific collections and assist in the selection of germplasm that possesses specific attributes.

Distribution

Distribution of germplasm is carried out by authorised organizations like IPGRI (India-NBPGR). Import of cocoa materials is tightly controlled for fear of introducing destructive cocoa diseases. Distribution of cocoa germplasm must be through internationally recognised intermediate quarantine so as to ensure that only healthy material is circulated. Cocoa germplasm has been distributed from Trinidad and Costa Rica. Large quantities of seed has been distributed mainly from Trinidad to Ghana in 1944 and to Nigeria and Papua New Guinea in the sixties. Long distance distribution is done using intermediate quarantine facilities like University of Reading, UK.

Cocoa was introduced to India for trial cultivation during the late 19th & early 20th centuries. Commercial cultivation started only in the 1970s. Central Plantation Crop Research Institute (CPCRI) Regional Station, Vittal was the pioneer Institute to start cocoa research in India with its mandate of introduction, selection, hybridisation and evaluation. Cocoa Research at Kerala Agricultural University was initiated in 1979 which was strengthened substantially in 1987 with sanctioning of a collaborative Research Project with funding from Cadbury India Ltd.

Cocoa germplasm and its utilisation at Kerala Agricultural University

Breeding programme at Kerala Agricultural University is one of the strongest in the world with the biggest assembly of germplasm collection in India. The collection located at the main campus of the Kerala Agricultural University at Vellanikkara has six sets of plants. Four were from seeds and last two, cloned material. Germplasm I consists of plants from open pollinated pods of 15 plants introduced from the Cocoa Research Institute of Ghana. Germplasm II to IV were from pods of promising plants from the bulk populations from all over the country and Germplasm V and VI, clonal material from the different types available in the various research stations and those directly introduced from the University of Reading, UK. Systematic introduction of clonal material starting from 1990 was made and total number of such clones introduced through 34 consignments comes to 790 so far.

The procedure for import is as follows. Each budwood consignment from UK consists of 20-50 clones. Three to four twigs of each clone is wrapped with wet cotton, covered with paper and properly labelled. The consignment is sent through NBPGR, New Delhi after observing the quarantine procedures to Kerala Agricultural University through courier service. The budwoods from these twigs are budded immediately on to seedling root stocks and maintained in an insect proof quarantine house. Under present procedures cocoa seedlings need to be kept in intermediate quarantine for two years during which period the plants are observed for susceptibility to diseases. Healthy plants are selected for field planting in the month of June-July. The newly added clones are being regularly evaluated for yield, pod and bean characters and self incompatibility. The collections maintained at Kerala Agricultural University are being evaluated for the following characters.

1. Height	2. Collar girth	3. Flush colour
4. Flowering intensity	5. Flower diameter	6. Pedicel length
7. Sepal length	8. Sepal width	9. Sepal colour
10. Petal length	11. Petal width	12. Ligule width
13. Staminode length	14. Ovary length	15. Ovary width
16. Number of ovules/ ovary	17. Fruit colour before ripening	18. Fruit colour at ripening
19. Fruit surface rugosity	20. Fruit apex form	21. Fruit base form
22. Total number of pods/ tree	23. Number of mature pods/ tree	24. Pod length
25. Pod width	26. Pod weight	27. Pod wall thickness
28. Number of beans/pod	29. Weight of beans/ pod	30. Dry weight of single bean
31. Seed length	32. Seed width	33. Seed thickness
34. Seed colour	35. Shell content	36. Incompatibility
37. Fat content of dry beans	38. Protein content of dry beans	

The superior types are utilized either in the breeding programme for direct distribution as an improved clone or as parent in the hybridization programme. Selection of superior plants from germplasm collection was continued from 1987 and hybrids were produced from time to time and as a, result four comparative yield trials were established. Based on performance and tolerance to VSD, seven clones (CCRP 1 to 7) and three hybrids (CCRP 8 to 10)were released for cultivation in India.