CONCLUSIONS AND RECOMMENDATIONS OF THE INTERNATIONAL WORKSHOP ON COCOA BREEDING STRATEGIES*

Discussion by the participants of the IWCBS resulted in the following conclusions and recommendations.

1. There is increasing evidence that many quantitative traits of economic interest are inherited additively. The implication is that there should be more emphasis on phenotypic rather than genotypic evaluation as the basis for selection of parents as positive correlation can be expected, especially when mating related genotypes.
2. There is general acceptance that cocoa can be improved in a properly managed recurrent selection programme, which would exploit GCA and SCA effects.
3. Although there is little direct evidence in the literature for heterosis over the best parent for yield in wide crosses, there is evidence for inbreeding depression which is an indirect demonstration of heterosis.
4. There is growing recognition that efficient breeding for yield would benefit from improved understanding of cocoa physiology. Emphasis should be placed on canopy architecture, assimilate accumulation and partitioning, and optimum planting density. Improved methods are required for measuring physiological traits at the single tree level.
5. Many more breeders are paying attention to flavour. Progress is dependent on direction and commitment from the manufacturers and processors of cocoa.
6. There is also increasing attention to cocoa butter content. Although improvement is possible, the weighting for cocoa butter content in an economic selection index remains to be established.
7. The historic emphasis in direct breeding for pest and disease resistance is coming into question with the realisation that rather limited progress has been made in many programmes. A new approach is needed in the light of recent work on the genetics of partial resistance to many diseases. The great importance of pest and diseases emphasises the need to improve methodologies for the rapid and reliable measurement of expression of resistance.
8. The new biotechnologies offer new insights to the genetic structure of cocoa and new more powerful methods of characterising, classifying and selecting material. Use of quantitative trait loci has been demonstrated for disease resistance and other traits and could be used to improve the efficiency of selection. In the future, insertion of genes will be possible. There is recognition that biotechnology is a set of tools which is complementary to competent conventional breeding programmes and is best applied to problems which are not easily solved be conventional means. It is important that the biotechnologies should not detract from practical breeding.
9. The analysis of genetic diversity by DNA markers demonstrates large genetic distance between Criollo and Forastero genotypes. There is also significant differentiation among Forastero genotypes. This methodology seems to now be sufficiently advanced to analyse genetic diversity within these groups in germplasm collections. Genetic knowledge generated by these markers could help the choice of base

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These were agreed during the course of this Workshop in Kuala Lupur held from the 18th to the 19th October, 1994.

populations for recurrent selection.

10. Effective cooperation in the utilisation of cocoa genetic resources depends on the correct identification of individual genotypes. High priority should be attached to development of simple, rapid methods for recognising mis-identifications. Positive identification of individual clones is a separate problem.

11. INGENIC's first Workshop and the 1992 Workshop in Trinidad have demonstrated the value of meetings among specialists in the genetic improvement of cocoa and the need for an Association. Such workshops encourage the sharing of information and development of new ideas on which future progress depends. With limited resources for cocoa breeding and rising costs, international cooperation is to be encouraged. Genetic resources and their utilisation are a common basis for this.

12. Evaluation of genetic resources is a major opportunity for international cooperation. Our conclusion that phenotypic evaluations of economically important traits are useful in parental selection prompts consideration of a multilocational clone trial with diverse germplasm. Such a trial would support development of the required standard methodologies for clone characterisation, including for physiological traits, resistance testing, quality evaluation, *etc.* Early steps in the establishment of such a trial are identification of a core sample of the many clones which are available and improvement and adoption of a rapid, reliable quarantine procedure which can handle large numbers of clones.

13. In the light of the present insecure funding for cocoa germplasm conservation and for practical cocoa breeding programmes, there is a pressing need for stable, secure long-term funding. The Workshop participants, therefore, strongly recommend that decision makers should transfer a significant proportion of the monies returned from liquidation of the ICCO Buffer Stock to a fund dedicated to assuring the long-term viability of the world cocoa industry, more specifically to co-ordinated international efforts on cocoa genetic resources.