INGENIC

NEWSLETTER

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IN THIS ISSUE

Editorial

At a meeting of twenty cocoa geneticists, breeders and other scientists held during the *11th International Cocoa Research Conference* in Côte d'Ivoire, in 1993, it was proposed that an international group be formed to address the needs and interests of cocoa breeders and geneticists. It was recognized that with limited resources for cocoa breeding and with rising costs, international cooperation is important for increasing efficiency in cocoa breeding. This forum led to the genesis of the International Group for Genetic Improvement of Cocoa - *INGENIC*. The main objectives of the group are to exchange information to accelerate progress in breeding and so stimulate efforts to conserve, manage and utilize cacao genetic resources. From its inception to the present, *INGENIC* has been under the chairmanship of Albertus Eskes of CIRAD-CP, Montpellier, France.

During the months that followed the Foundation Meeting, efforts were concentrated on informing the scientific community about the existence and objectives of the group and in galvanizing support for the proposed activities. In response to a survey conducted in 1994, 63 scientists from 27 countries endorsed the formation of *INGENIC* and helped formulate a list of the immediate objectives. They agreed that the group should organise a workshop biennially, and produce a newsletter. As evidence of *INGENIC*'s intention to endure, expand and accomplish the stated goals, the Acting Committee of *INGENIC* is pleased to release the first issue of what it hopes will be a very informative and productive Newsletter.

The *INGENIC* Newsletter will feature short communications on:

- breeding strategies, methodologies and novel results on genetics and breeding studies;
- data on germplasm evaluation;
- ideas for and progress in collaborative research;
- news from supportive institutions;
- upcoming events of interest to its readership;
- *INGENIC* activities.

The Acting Committee of *INGENIC* hopes that this medium will serve to foster links among cocoa breeders, geneticists and institutes. The Newsletter will be sent to scientists and research managers involved or interested in cocoa breeding at the same time as the Cocoa Research Unit (CRU) Newsletter. The objective of the *INGENIC* newsletter is to be complementary to that of the CRU newsletter, with more information on utilization of germplasm. To achieve success in meeting the goals of *INGENIC*, the Acting Committee looks forward to your support and I urge you to contribute pertinent short notes (not publications) on your research activities on a regular basis. Presently, it is intended that two issues of the *INGENIC* Newsletter should be released annually. Contributions for each should be sent to the Editor before October 15th and April 15th each year.

xxxxxxxxxxxxxxxxxxxxxx *Frances Bekele*

INGENIC News

General Foundation Meeting

At the General Foundation Meeting of *INGENIC*, which was held on the 18th October, 1994 in Kuala Lumpur, Malaysia, it was agreed that the main objectives of *INGENIC* should be to advance and exchange knowledge on cocoa genetics and breeding, and to stimulate international cooperation. The main activities will be to organize international workshops and to publish the proceedings of these meetings, and to edit a cocoa genetics newsletter. Although the possibility of establishing a formal constitution for the group was discussed at the meeting, it was decided that *INGENIC* should remain informal, at least until the next meeting to be held in 1996. Representatives of the various organizations invited to the meeting, such as BCCCA, CAOBISCO, ACRI, CPA, ICCO, IPGRI, and CIRAD, as well as research institutions in cocoa producing countries expressed their support for the creation of *INGENIC*.

The acting committee consists of:

Chairman	Dr. A.B. Eskes, CIRAD-CP, France
Vice-Chairman	Dr. G. Lockwood, CDC, U.K.
Treasurer	Dr. M.T. Lee, MCB, Malaysia
Secretary	Dr. M.J. End, University of Reading, U.K.
Editor	Mrs. F. Bekele, CRU, Trinidad

They were given a mandate to continue to explore possibilities for facilitating the smooth operation of *INGENIC*, and to organise further support for the group.

International Workshop on Cocoa Breeding Strategies (IWCBS)

The first workshop organized by *INGENIC* was held at the Hilton Hotel, Kuala Lumpur on the 18th and 19th October, 1994. The Workshop provided the opportunity for forty participants to learn of the breeding work and other related activities in progress internationally. The twenty-two papers presented covered a range of topics including results obtained in different breeding programmes, present and future breeding strategies, advances in biotechnologies, physiological and quality aspects of cocoa breeding and on evaluation of cocoa germplasm. Following useful discussion, the participants formulated a list of conclusions and recommendations (see later in this newsletter).

As part of the Workshop, a post-workshop tour was organized to visit on-going breeding activities in Sabah. The twelve participants were received by staff at BAL Plantations Sdn. Bhd. at Tawau and at the Quoin Hill Research Station of the Sabah Department of Agriculture.

The acting committee of *INGENIC* would like to take this opportunity to thank all of those who contributed to the Workshop and made this meeting such a success. In particular, we would like to express our gratitude to The Malaysian Cocoa Board (MCB) for providing the secretariat, Mr. Tony Lass (BCCCA) for acting as Workshop chairman and MCB, CIRAD-CP, CDC, BAL Plantations Sdn. Bhd., Sabah Dept. of Agriculture, ACRI, BCCCA, and CAOBISCO for providing institutional support. Proceedings of the Workshop are being prepared and should be published in the next few months.

Two of the numerous IWCBS Delegates at the International Cocoa Dinner

Cultural display at the International Cocoa Dinner, October 22nd, 1994, Kuala Lumpur, Malaysia

Current Activities

We are continuing our efforts to encourage widespread support for the group and to secure long-term funding for *INGENIC*. A second workshop meeting is planned to coincide with the *12th International Cocoa Research Conference* to be held in Brazil in 1996. This workshop will be entitled "*Breeding of Cocoa for Disease Resistance*" and we are investigating the possibility of commissioning an independent review on this subject, which would form the lead paper at the workshop. We have recently contacted cocoa breeders and pathologists to canvass their opinions on this suggestion.

We are also discussing initiatives for a number of separate projects, which were recommended during the IWCBS Workshop in Malaysia. One such proposal is for an international clone trial to evaluate a wide range of genotypes under different environmental conditions. Such a project would involve the selection of between 30-40 clones which are widely distributed, and of considerable genetic and breeding interest (see article by G. Lockwood in this newsletter), and the development of a standard methodology for their evaluation. Another initiative, which we are considering, is the production of an album of colour photographs of widely distributed clones which would help genebank managers to identify mislabelled germplasm.

We would welcome your suggestions for these and any other initiatives that might benefit the cocoa genetic resources and breeding effort. Please send correspondence to:

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Conclusions and Recommendations from the International Workshop on Cocoa Breeding Strategies (IWCBS), 18th-19th, October, 1994 Kuala Lumpur, Malaysia

Discussion by the participants of the IWCBS resulted in the following conclusions and recommendations. We would welcome your reactions to these recommendations, especially if you were unable to attend the meeting and we hope to publish these reactions in the next edition of this Newsletter.

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 fat content. Although improvement is possible, the weighting for cocoa butter fat 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 pests 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 provides a set of tools, which is complementary to competent conventional breeding programmes, and is best applied to problems not easily solved by conventional means. It is important that these technologies should not detract from practical breeding.

9. The analysis of genetic diversity of DNA markers demonstrates the large genetic distance between Criollo and Forastero genotypes. There is also significant differentiation among Forastero genotypes. This methodology seems now to 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 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 the 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 the 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 multi-locational 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 the 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 returns from the 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.

International Cooperation in Cocoa Breeding

One of *INGENIC*'s proposed activities is to stimulate international cooperation in cocoa breeding. While final selection of new varieties can only be done in local breeding programmes, the continuously decreasing financial inputs in such programmes urges breeders to find more efficient ways to obtain selection progress in cocoa breeding.

Major constraints in obtaining continuous and consistent breeding progress were identified during the *INGENIC* workshop in Kuala Lumpur, and can be summarized as follows:

- the lack of parental clones with known valuable agronomical features (like high disease resistance, quality);
- the lack of knowledge on the genetic relationships between and within populations in working collections, as well as in international collections;
- the lack of genetic knowledge on the cocoa crop; (relative importance of heterosis in relation to general combining ability, parent-offspring relationships, the value of clones in relation to hybrid varieties, and stability of characteristics such as disease resistance, quality, etc. in different environments);
- the lack of continuous progress by using the traditional hybrid selection method;
- the lack of knowledge on the importance of physiological parameters in selection of cocoa (yield efficiency, photosynthesis).

Some major areas in which increased international cooperation can be expected to be useful are:

1. increased contact between germplasm collection centres and user countries;
2. increased efforts on characterization and evaluation of germplasm, in order to identify new agronomically useful genotypes;
3. establishment, distribution and evaluation of a "users'" core collection representing original genotypes and/or genotypes presenting useful agronomic characteristics (disease or pest resistance, quality, special physiological features);
4. initiation of pre-breeding activities aimed at the accumulation of favourable alleles which should be available to all user countries;
5. initiation and evaluation of breeding strategies which may give more substantial and more continuous progress than the traditional hybrid selection method;
6. establishment of an international multilocational clone trial using original germplasm in different ecological conditions together with selected local genotypes as control varieties;
7. establishment of a hybrid trial, using the same genotypes from the clone trial as parents.

Points 6 and 7 should give answers to questions like the importance of genotype and environment interactions, parent-offspring relationships, expression of combining ability and heterosis in different conditions and may, at the same time, yield new candidate clones or hybrid varieties.

Recently, the International Plant Genetic Resources Institute (IPGRI), after consultation with numerous institutions such as the Alliance of Cocoa Producing Countries (CPA), CATIE, CRU, CIRAD, BCCCA, CAOBISCO and *INGENIC*, proposed a project to accomplish the above-mentioned activities with financing from the Common Fund for Commodities (CFC). This project has to be officially proposed to CFC by the International Cocoa Organization (ICCO), which is in the process of analyzing the project proposal.

The Executive Committee of *INGENIC* strongly supports the initiative of IPGRI, considering that the proposed project activities are fundamental for stimulation of cocoa breeding activities, for increased availability of improved germplasm, as well as knowledge on breeding strategies. We invite all interested persons to react to this proposal. Comments should be sent to the address given below.

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Core Collection of Cocoa Germplasm

The idea of a "core collection" and its application to cocoa is discussed by Albertus Eskes in the article above. The idea is a timely one and is linked to the proposal for realizing a multi-locational trial. I have given some thought as to entries for the trial, very much in the spirit of starting a discussion, so please send me your comments.

I have limited the selection mainly to clones which are already available in intermediate quarantine and so could be introduced in 1995. It seems to me that if we have to take clones into intermediate quarantine, we risk too great a delay in starting the trial. As it is, some countries require two years post-entry quarantine, for example Malaysia, so the earliest the trial can be planted is 1998, and even that assumes pre-multiplication in quarantine. A brief survey of what I might have added without this constraint does not make a lot of difference. I think that the risk of mixed accessions *i.e.* a Ghana clone differing from a Malaysian one, can be minimised by trying to use clones which all sites got from the same quarantine station. I have not tried to do this.

The exercise would have been (almost) impossible without the International Cocoa Germplasm Database and indeed Michelle End's skill in using it. We all have much to gain by pooling our knowledge and data by putting them into the database.

The exercise has also shown how patchily clones are distributed, which highlights the question of breeders' sampling strategy. Given the high overhead costs of maintaining germplasm in working collections, should we give priority to improving knowledge of the genetic structure of populations and if so how do we do this?

I have identified an inner core of 25 clones for the proposed trial, which is probably the minimum useful number, and a further 25 to give 50 (refer to the Table below), which is the maximum

Consulting the International Cocoa Germplasm Database

which might be considered practicable, given that local controls will be planted at each location. The final core collection of cocoa germplasm will be several times larger, and of course is not restricted to those which are in quarantine.

I have prepared notes on the current distribution of these clones and their origins.

Entries for Proposed Multi-Location Trial

All of the clones in the following table are available from Intermediate quarantine at Reading (^{R}) or from the Mayaguez (^{M}) Station.

		Inner 25		
AMAZ 15-15^{R}	GU 144^{R}	LCT-EEN 241^{R}	MXC 67$_{R}$	RB 29^{R}
Be 3^{R}	ICS 1^{M}	MA 12^{R}	NA 33^{R}	SCA 12^{M}
CAS 1^{M}	ICS 39^{M}	MO 20^{MR}	PA 13^{M}	SIAL 339^{R}
Coca 3348/44^{R}	ICS 95^{M}	Mocorongo^{R}	PA 300^{R}	TJ 1^{MR}
EET 58^{R}	IMC 67^{MR}	MOQ 417^{M}	P 7B^{R}	UF 29^{M}
		Outer 25		
APA 5^{M}	GU 247^{R}	IMC 14^{R}	P 4A^{MR}	SCA 6^{MR}
CC 10^{M}	GU 341^{R}	LCT-EEN 31^{R}	P 19^{M}	SCR 4^{M}
CC 38(or 41)^{MR}	ICS 45^{M}	LCT-EEN 46^{R}	P 25A^{M}	SGU 3^{R}
CCN 10^{M}	ICS 100^{R}	LF 3^{M}	PA 7^{R}	SPEC 41/11^{M}
GS 29^{M}	ICS 6^{M}	10P^{R}	Red Amel 1/27^{R}	UF667^{M}

Please send your comments to:

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Estimation of the level of heterozygosity and genetic diversity with RFLP markers

Valérie Laurent*, Jeanne N'Goran Andi Komi**, Albertus B. Eskes* and Claire Lanaud*1

More than 200 cocoa genotypes present in collections in Costa Rica, Venezuela, Brazil and Côte d'Ivoire were studied by RFLP and RAPD markers at CIRAD, France, between 1989 and 1993. Results on genetic diversity were reported in articles and in the Ph.D theses of Valerie Laurent and Jeanne N'Goran. This note reports on the level of heterozygosity observed by RFLP markers for the clones which, according to the available information, are identified here as Upper Amazon Forastero (UA), Lower Amazon Forastero (LA), Trinitario (T) or Criollo (C). The table below gives the number of heterozygous RFLP loci in relation to the total number of markers for which a single locus interpretation is possible. Some interesting features are presented below.

Clones with very low levels of heterozygosity were identified mainly among LA types, and less frequently so within the other populations. UA genotypes seem to have moderate levels of heterozygosity, however a few clones appeared to be nearly homozygous (as P2 and some LCTEEN). Clones which are descendants of crosses among F_0 clones, such as those with T and UPA codes, did not show higher average heterozygosity than the F_0 clones themselves.

Within LA Forastero clones, the C code identifies clones from Côte d'Ivoire, ERJOH are genotypes collected by CEPLAC in different regions of the Amazon basin, and GU are spontaneous genotypes collected by CIRAD in French Guiana. The West African Amelonado types (C1, C15, C2, C5), Catongo (SIC864), Comun, SIAL, Para and Matina (Mat6) clones generally appeared as nearly homozygous, which is in agreement with their self-compatibility and supposedly related genetic origin. The ERJOH clones were very variable, some genotypes being highly heterozygous. In the genetic diversity study, these clones appeared to be intermediate between traditionally used UA and LA genotypes. It was surprising to note that the four wild French Guiana clones were highly homozygous, although this germplasm seems to be largely self-incompatible and not related to LA Amelonado genotypes. The semi-wild Venezuelan genotypes, collected by Claire Lanaud in 1986, appeared very homozygous, with some heterozygosity being present in genotypes collected in the center of that country (Ven 1 and Ven 15). Two genotypes identified as Nacional (ECNR and Nacional) appeared to be very heterozygous and should not be considered as LA Forastero, as indicated also from the diversity study.

The separation between Trinitario and Criollo genotypes is difficult as this germplasm is genetically related. The diversity study suggested that most Trinitario genotypes are intermediate between LA Amelonado and some typical Criollo genotypes from Venezuela. The Trinitario clones showed generally average to high levels of heterozygosity, which is in agreement with their hybrid origin. Some exceptions were apparent, as with Wa40,

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which was homozygous and also shown to be very close to LA Amelonado in the diversity study. This clone, which came from the Côte d'Ivoire collection, should therefore not be considered as Trinitario. Another exception is the SC6 clone of Colombian origin and present in the CATIE collection. Its homozygosity may be explained by its genetic relationship to LA Amelonado, as identified in the diversity study.

The clones identified as Criollo were highly variable in heterozygosity level. High levels of homozygosity were present in some Venezuelan genotypes, such as some Andino Criollo clones (BOC 210, Hernandez 212, ZEA 206) and some Porcelana genotypes (PV6 Porcelana Rojo). Other Venezuelan genotypes classified also as Criollo were, however, moderately or highly heterozygous, as the Ocumare (Oc), Chuao and JS clones. The ICS 39, 40, 60 and 100, as well as the LF clones from Samoa appeared also to be highly heterozygous. The Pa 35 clone, from the Côte d'Ivoire collection, is clearly a misidentification, as noted also in the diversity study. This clone is apparently a Criollo type and shows an average level of heterozygosity.

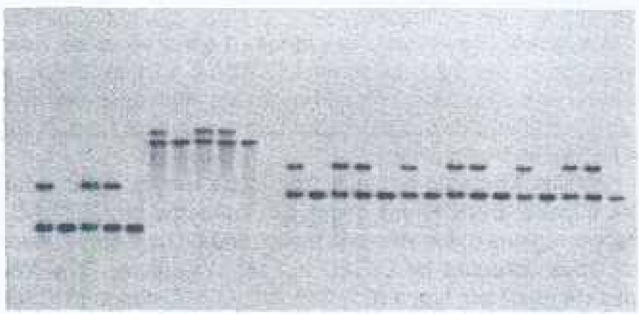

Plate 1 Restriction profile observed after hybridisation of a cDNA probe (cTcCIR47) on DNA of five clones (POR, UPA 409, SNK 12, UF676 and UPA 402) digested by several restriction enzymes.

In conclusion, the genetic relationship between cocoa genotypes, as identified by RFLP profiles shown in Plate 1, can be usefully complemented by an indication on the level of heterozygosity. Based on both types of information, wrongly classified genotypes could be identified in several cases (Wa 40, SC6, Pa35). The results also show that wild self-incompatible clones may sometimes be very homozygous. The behaviour of these clones in breeding should be studied as they may give heterotic and yet quite uniform progenies.

The above mentioned results show that the co-dominant RFLP markers should be considered of superior value to the dominant RAPD markers for breeding purposes, although the latter can be as good as RFLP markers for genetic diversity studies.

The authors thank Dr. B.G.D. Bartley, Dr. J. Morera and Dr. H. Reyes for sending leaves and information of the genotypes for which results are presented here. For more information, you may contact:

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Number of heterozygous RFLP loci observed for genotypes classified as Upper Amazon (UA) or Lower Amazon(LA) Forastero, Trinitario or Criollo

	UA			LA	
	HETERO	TOTAL		HETERO	TOTAL
EBC10	4	27	C1	1	26
EBC5	2	27	C15	3	21
EBC6	3	26	C2	0	22
IMC31	6	21	C303	3	24
IMC5	9	26	C307	1	22
IMC67	8	20	C361	0	26
IMC78	6	25	C4	7	23
LCT127	1	26	C414	7	24
LCT202	1	15	C5	3	27
LCT295	3	17	Comun	1	27
LCT325	6	21	ECNR	6	19
LCT326	6	24	EET59	5	21
LCT355	1	25	ERJOH10	1	18
LCT37	7	26	ERJOH11	4	24
LCT84	3	17	ERJOH12	7	27
MO9	6	27	ERJOH13	10	26
MO98	5	20	ERJOH14	3	27
NA32	6	25	ERJOH15	3	27
P1	2	27	ERJOH2	5	27
P16	8	27	ERJOH3	6	26
P2	0	27	ERJOH5	5	23
P32A	3	27	ERJOH7	2	18
PA13	11	25	ERJOH8	7	24
PA20	5	13	GU144	0	26
SCA12	9	25	GU154	0	27
SCA6	4	27	GU346	0	26
SCA9	7	25	GU349	0	26
SPA11	5	20	MAT6	0	27
SPA17	7	20	NACIONAL	10	27
SPA5	5	20	PARA	0	19
T60/887	3	22	SIAL325	0	27
T63/967	7	21	SIAL42	8	24
T79/501	6	18	SIAL70	0	27
T85/799	6	21	SC864	1	25
UPA401	5	19	VEN1	1	27
UPA413	7	21	VEN11	1	26
UPA603	6	22	VEN20	0	27
			VEN5	1	17
			VEN4	3	21

Invitation

An open invitation is hereby issued for short articles on research or other issues of particular interest to cacao breeders/geneticists. News on upcoming conferences and meetings would also be appreciated.

TRINITARIO	HETERO	TOTAL
ACT2-11	4	27
ACU85	11	26
C11	8	26
C304	13	24
C413	8	27
C420	7	26
C422	1	27
C7	3	27
CC10	5	19
CC39	8	27
CHUAO120	8	27
CHUAO24	9	27
CNS22	3	16
DR1	7	26
EQX107	8	22
EQX27	9	23
EQX94	9	26
G23	5	22
GS29	8	19
GS36	9	26
ICS16	8	26
ICS46	8	27
ICS48	9	27
ICS53	9	27
ICS6	7	27
ICS75	5	24
ICS84	10	26
ICS89	12	27
ICS98	9	23
K5	4	27
LAFI	4	23
MOQ122	3	18
MOQ216	7	26
MOQ647	7	22
MT1	10	27
RIM105	9	23
RIM113	10	23
RIM15	9	24
RIM19	8	24
RIM76	8	20
RIM8	10	27

TRINITARIO	HETERO	TOTAL
C19	4	26
C6	5	27
GS36	8	26
N38	1	23
RIM8	10	27
SC5	9	23
SC6	0	23
SNK109	4	23
SNK12	3	23
SPEC160	6	27
SPEC54	0	23
TJ1	5	27
UF10	9	24
UF168	9	27
UF221	10	27
UF296	12	26
UF667	10	27
UF676	11	27
WA40	0	27

CRIOLLO	HETERO	TOTAL
BOC210	0	26
CD8/6	3	22
CHO31	4	25
CUM214	3	24
LA ESMIDA	5	22
CHUAO211	5	25
CHUAO49	4	25
HERNANDEZ212	1	25
ICS100	6	26
ICS40	10	18
ICS60	12	17
IS201	6	27
JS202	12	25
JS206	7	26
JS210	11	15
LF1	9	25
LF2	8	27
LF3	2	20
OC61	3	23
OC73	7	23
OC77	10	27
PA35	3	26
SPEC38	8	16
SPEC185	6	23
POR210	3	27
POR211	4	27
POB	8	26
POC	6	27
POR	7	27
PORCELANA3	8	25
PROVIDENCIA201	5	27
PV2	4	27
PV6	0	25
Q7	3	26
POR ROJO	1	27
CATA211	13	19
ZEA1	12	27
ZEA206	1	27
PV4	4	13
ICS39	9	26
CUM209	6	12

Cross-compatibility of self-incompatible Trinitarios

Frank Cope[1] reported that 14 randomly selected self-incompatible ICS Trinitario clones were mutually cross-incompatible. It is usually assumed that these and all other Trinitarios carry incompatibility allele S1 (Dalton Glendinning's[2] nomenclature). This allele occurs in the Ghana clone W41, which has been distributed through intermediate quarantine.

BAL's collection includes ICS16 and ICS60, both of which are thought to be correctly identified. As expected, both are self-incompatible, the results of test selfings (sets/pollinations) were:

ICS16 0/90
ICS60 0/66

At BAL Plantations Sdn Bhd, the clone introduced as GS57 appears to be a typical Trinitario and there is no cause to question its identification. GS57 was selected by Frank Cope in Grenada in 1940 so it is unlikely that it is derived from Upper Amazon material, which would have introduced additional compatibility alleles. It is self-incompatible, the results of repeated tests being:

3/45; 1/43; 0/40; 3/119; 0/37

Unexpectedly, GS57 proved to be cross-compatible with both ICS clones:

ICS16 x GS57 11/24
ICS60 x GS57 11/32

and it is cross-compatible with the self-incompatible Papua New Guinea clone KA2-106.

Unfortunately, BAL does not have W41, so we are unable to test GS57 for S_1, but the above results leave little doubt that it is not expressing it. Has anyone else got unexpected results from compatibility tests among Trinitarios?

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[1] Cope, F.W.(1962) *Heredity* **17** 157-182.
[2] Glendinning, D.R. (1966) *Annual Report of the Cocoa Research Institute of Ghana* 1963-65, p. 75-86.

Environmental and parental effects on weight, shell and butter fat content of cocoa beans, and interrelationships between these values

Important economic values of the cocoa bean are bean weight, including cotyledons, embryo, seed coat; shell and butter fat content expressed as a percentage of the weight of the whole bean; and the cotyledon colour and bean flavour. The study of environmental and genetic effects on the first three bean values became the subject of my special attention since becoming involved in cocoa breeding and genetics in 1961, at the Cocoa Research Institute of Nigeria (CRIN). Recently, I retired from active service. In the light of a renewed interest in the subject of cocoa bean values, the following overview of relevant research, in which I participated, was made. The papers and reports mentioned below are available on request.

In 1964, the plant breeding laboratory at CRIN's Gambari Experimental Station, including balances and drying ovens, became operational. It enabled us to quickly record pod values, bean weights and shell contents. By the end of 1965, the soil chemistry laboratory had been equipped with a Soxhlet line, allowing for butter fat analyses to be made. The analyses were carried out according to the procedures recommended by the International Office for Cocoa and Chocolate (ICCO) in Brussels. First of all, methods had to be developed and standardised. Whereas recording bean weight and fat content was straightforward, "shell" required special attention. The shell of the cured (fermented and sun dried) bean consists of remnants of mucilage remaining after fermentation and drying and the seed coat. In order to study the effects of parents, data were taken of a series of usually 4-6 (in special cases more) hand-pollinated pods harvested at the same time during the main crop season. After opening the pods, a random sample of 10-20 beans were taken from a pod, each pod being considered a replicate. The beans to be analysed were too few in number to be cured. Instead, they were cleaned of mucilage by rubbing with saw dust, after which the seed coat could be peeled off prior to or after oven-drying and subsequent recording, resulting in the values of percentage seed coat.

The research began with a study of environmental effects on beans of the West African Amelonado (WAA), the variety of the Nigerian cocoa belt. WAA is morphologically very uniform and genetically homogeneous, which makes it eminently suitable for studies of environmental effects. A plentiful supply of pods and beans was available at all time from the Institute's "Agodi" farmers' cocoa plot in Ibadan. Moreover, an unpublished report (1952) by the former Economic Botanist at Moor Plantation Agricultural Research Institute contained three years of data of cured bean weight collected at three weekly harvest dates on that farm.

A first paper was presented by Toxopeus and Wessel during the second International Cocoa Research Conference in Bahia in 1967 (*Proceedings*: p. 351-355), whereas the results of a more elaborate study were published in the *Netherlands Journal of Agricultural Science*, volume **18** (1970): 132-139. The results showed the single main environmental factor to affect pod and bean values to be rainfall. Average cured bean weight is highly related to accumulated rainfall in the first four months of pod development (r=0.8). Two crop production seasons are distinguished in Nigeria: the mid crop from April to June after the dry season with practically no rain from December to March; and the main crop from September to January, following the rainy mid crop season, yielding about 90% of the annual production. Beans produced in the mid crop season are small, shell percentage is high and butter fat content is low. In August, bean weight increases, shell percentage decreases, and butter fat content increases to reach maximum values as from the beginning of the main crop season. As to inter-relations, the larger the bean, the smaller the percentage shell and the higher is the fat. However, beans of the same weight class from a main crop sample are lower in percentage shell and higher in fat compared with mid crop beans. Genetic effects were surveyed by comparing the bean values of hand-pollinated pods of selected crosses. Summaries of data are shown in the *CRIN Annual Reports* of 1966/7, p. 35-36; 1967/8 p. 49-51; 1968/9 p. 105 and 108; 1969/70 p. 71-73. Substantial and significant effects are shown of both female (the more prominent) and male parents on bean weight and fat content, and reciprocal differences are recorded. There is also the case of a substantial effect of the male parent on percentage seed coat, seed coat being a maternal tissue. The effect of bean weight on fat content could not be substantiated. It does not appear to be a general feature. Part of the data was presented by Jacob and Toxopeus in the *Proceedings of the Third Int. Cocoa Research Conference*, Tafo, Ghana, 1969, p. 556-559.

In 1977, a paper was published by Beek, Eskes and Toxopeus on pollinator parent effects on bean characters (*Turrialba* 27:327-332). This summarized results of research carried out at CEPEC, Bahia, Brazil in 1970/71 and at the Agricultural University of Wageningen, the Netherlands, by the first two authors. Two sets of four parents were crossed following a NC2 model, including reciprocals, but due to cherelle wilt this scheme was incomplete. Fat content was determined by NMR. The results showed:

a) a small but significant effect of pollinator parent on fat content, but not on bean weight;
b) a significant positive phenotypic correlation between bean weight classes and fat content within crosses;
c) a non-significant "genetic" correlation between bean weight and fat content calculated from the average figures of crosses.

A similar study was conducted a few years later by Ehrencron and Heemskork by employing more contrasting parents and obtaining a more complete crossing scheme. Field studies were again conducted at CEPEC and analyses were done in the Netherlands. The authors found highly significant male and female effects on fat content, interaction being non-significant. There was also a large effect of pods and less so of trees on fat content, showing the high environmental influence on this trait. Bean weight appeared to be slightly affected by pollinator parent. Environmental correlations between fat content and bean weight were often highly significant. The genetic correlations appeared less significant. The results of this study have so far only been published as an internal paper of the Agricultural University of Wageningen. Presently, I am in the process of preparing publications in English so as to make these results available to a wider readership.

Hille Toxopeus
Cocoa Production Specialist
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THE NETHERLANDS

News From MARDI, Malaysia

Ex situ conservation of cacao germplasm

A small, working collection of 304 F_0 clones, which was acquired from the Intermediate Quarantine Centers at Miami, Florida, Kew Gardens and the University of Reading, is being maintained on 40 ha of land in Hilir Perak. It is intercropped with coconuts in plots comprising 14 plants per clone. The cocoa trees are planted 3.0 x 3.0m apart in a triangular pattern with coconut avenues consisting of two rows of seven plants.

Germplasm Evaluation

The germplasm is being evaluated for several traits, including resistance to cocoa pod borer and Vascular Streak Dieback, bean quality and butter fat content, yield for bulk cocoa, and dwarfism. Hybrid evaluation (progeny evaluation and ortet selection) and ortet to clonal development and evaluation are also in progress.

Clonal Development and Evaluation

Clonal planting is recommended to farmers. Clonal material is generated by budding on seedlings, as well as matured seedling plants. Before any clone is recommended for commercial planting, clonal evaluation is carried out in adaptability trials in the major cocoa growing areas in Peninsular Malaysia. To date, MARDI has recommended 14 clones for commercial planting. These are KKM 1, KKM 2, KKM 3, KKM 4, KKM 5, KKM 6, KKM 15, KKM 17, KKM 19, KKM 22, KKM 25, KKM 26, KKM 27, and KKM 28.

Documentation

Presently, the observations made are being documented using the Germplasm Management System (GMS), which was introduced by IPGRI.

Sapiyah Subali
Breeder, the Cocoa & Coconut Division
MARDI Hilir Perak, MALAYSIA

Germplasm Labelling A Cautionary Tale

For several years, the germplasm collection at Solomon Island Plantations Ltd. included 60W. I thought I was knowledgeable about cocoa codes, but what could this be and where was it from? There was no ICGD to consult, so I was left to puzzle.

Eventually realisation came. We acquired 60W when a label was turned upside down - and lost MO9!

G. Lockwood
CDC, One Bessborough Gardens,
London SW1V 2JQ, UNITED KINGDOM

NEWS FROM A SUPPORTIVE INSTITUTION

The activities of the Technical Centre for Agricultural and Rural Cooperation (CTA)

Alan C. Jackson
Head, Programme Planning Division, CTA

The ACP-EU Technical Centre for Agricultural and Rural Cooperation (CTA) operates under the Lomé Convention between Member States of the European Union and the African, Caribbean and Pacific States.

All CTA's pursuits are carried out in the context of the Lomé Convention, which is a cooperation agreement between the 15 Member States of the European Union and the 70 African, Caribbean and Pacific States (the ACP Group) who are co-signatories to the Convention. CTA is an institute of the Convention and is entirely funded by the European Commission. The Centre's Headquarters are at Ede, in the Netherlands; in mid 1955, the Centre will move to the nearby university town of Wageningen. CTA's working languages are English and French.

The Centre has two broad objectives:

1) To improve the availability of scientific and technical information (STI) on methods and means of promoting agricultural and rural development;

2) To promote the development by ACP States of their own capacities for the production, purchase and exchange of STI on agriculture and rural development.

In order to fulfil its objectives, CTA provides a range of services to meet the needs of individuals and institutions in ACP countries. For example, CTA convenes technical meetings, or seminars, on a wide variety of technical subjects. The Centre supports the attendance of ACP nationals at conferences organized by other institutions and has established a small programme of study visits.

CTA's information bulletin "*Spore*", which appears in English and French, is published four times a year. The Centre publishes the proceedings of its seminars and commissions and publishes various studies, reports, bibliographies and directories. CTA's publications and co-publications services are very substantial: the publications list now includes more than 600 titles. Through the Centre's co-publications service, CTA jointly funds the production costs, which may include paying for translations of co-publications; and the Centre purchases technical books at preferential rates for free distribution to ACP countries. In various ways, CTA supports periodicals and network newsletters. The Centre also pays the not inconsiderable costs of distributing these free publications to the ACP countries.

One of the backbones of CTA's work has been the establishment of a Question-and-Answer Service. In addition to responding to specific technical enquiries, this service distributes CTA publications on request and delivers primary documents. Support services are provided to rural broadcasters and CTA offers short training courses for documentalists and for those writers, editors and publishers who are involved in communicating agricultural information. All these services are available free-of-charge to institutions and individuals in the ACP countries.

In addition, CTA has specific projects in the fields of information and documentation. These include a project to establish and support CD-ROM workstations; a scheme to donate reference books to agricultural libraries; and a selective dissemination of information programme which provides requested documents to designated research institutes.

In order to provide these services, CTA maintains an Administrative Division, a Programme Planning Division and an Operations and regional Activities Division, which includes a Documentation Unit. There are at present, thirty-eight staff members, including some fourteen professional agriculturalists and documentalists, at CTA's Headquarters in the Netherlands. The Centre supports a small Branch Office in Brussels as well as Regional Branch Offices in the Caribbean and the Pacific.

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UPCOMING EVENTS

26TH INTERNATIONAL COURSE ON APPLIED PLANT BREEDING

INTERNATIONAL AGRICULTURAL CENTRE (IAC)

Wageningen, the Netherlands
March 10th to June 22nd, 1996

Plant breeders have an important role to play in the development of varieties that can contribute to both increased food production and the protection of the environment. Varieties can be developed for higher yields, for yield stability, for production under marginal conditions, for resistance to diseases and pests, for a shorter growth cycle and/or for a better quality of the product.

A successful plant breeder must not only know his crop botanically, genetically, physiologically, agronomically, and economically, a breeder must also have a thorough knowledge of the conditions for which the crop is bred. This includes adaptation of the crop to cropping systems and the preferences of the users of the crop, as well as to ecological and economic environments in which the crop will be produced.

Using conventional and modern breeding techniques in a strategic way, the scope for crop improvement can be enlarged, and the number of years needed to reach a breeding goal can be reduced. This course aims at refreshing and up-dating participants' knowledge on the theoretical background of plant breeding, breeding techniques, breeding strategies and breeding goals.

OBJECTIVES/TARGET GROUP

The course is an in-service training course intended for university trained specialists in plant breeding, mainly from developing countries, who have not recently had the opportunity to acquaint themselves with modern plant breeding techniques. Its aim is to upgrade the participants' knowledge of and to give information on new developments in applied plant breeding through lectures and practical training.

Although the seed industry is an important aspect of the crop improvement process, the course is considered less suitable for persons whose work is limited to this subject. IAC offers a specialized course on Seed Production and Seed Technology.

In view of IAC's policy to promote participation of women in IAC training courses, women are especially invited to apply.

PROGRAMME

Various training methods will be applied to provide an effective and varied learning experience in the short time available. These include lectures, practicals, workshops, individual presentations and discussions. Laboratory work, excursions and visits to plant breeding companies and research organizations will illustrate subjects taught. Emphasis will be put on a participatory educational approach, making optimal use of participants' own experience and expertise.

The programme of lectures and exercises can be summarized as follows:

1. Basic disciplines and introduction to plant breeding: genetics, cytological techniques, flowering biology and hybrid varieties, theoretical aspects of plant breeding, selection methods, practical training in breeding techniques.
2. Design and statistical analysis of experiments: the use of the calculator and computer will be practised (CADEMO for planning, and analysis of field experiments).
3. Breeding for disease and pest resistance: general introduction, techniques used in disease research, disease resistance in practical breeding programmes.
4. Genetic variation and modification: ploidy, interspecific hybridization, mutation breeding, genetic resources.
5. Breeding strategies: breeding strategies are a central issue in this training; a number of breeding programmes, as carried out by institutes and Dutch breeding firms, will be presented.
6. Breeding for sustainable development: deals with the contribution of plant breeders to improvement of agricultural production as a component of sustainable development.
7. Use of the computer: the computer will be used for exercises in statistics, genetics and theoretical aspects of plant breeding.
8. Excursions to various parts of the Netherlands, breeding stations, research stations, research institutes and private firms.
9. Library/optional programme: time is reserved for visits to libraries of the Agricultural University and institutes of research in plant breeding, and for optional programmes.

Note: The course does not focus on biotechnology.

ORGANIZATION

The course is organized by the International Agricultural Centre in collaboration with the department of Plant Breeding of the Wageningen Agricultural University (WAU), the Centre for Plant Breeding and Reproduction Research (CPRO-DLO), the General Netherlands Inspection Service for Field Seeds and Seed Potatoes (NAK), other research and training institutes and organizations in the private sector.

Supervision of the overall training activity is with a Supervisory Board representing the major institutions contributing to the course.

DATES

The course will be held from March 10th to June 22nd, 1996.
March 11th: Registration and Opening Session
June 21st: Closing Session

CERTIFICATE

On completion of the full programme of the course, participants will be granted a Certificate of Attendance.

FEES/ACCOMMODATION

Total tuition fees amount to 5,000 Dutch guilders. This amount includes administration fees, lecture materials, excursions etc., so far as they are included in the programme.

This course is residential. Participants will be accommodated in the hostel of the International Agricultural Centre, WICC-IAC, on the basis of full board and lodging. Costs of full board and lodging are 78.50 Dutch guilders per day.

REQUIREMENTS FOR ADMISSION

Applicants should meet the following requirements:

- an agricultural education at least at B.Sc. level (degree);
- basic knowledge of genetics and statistics;
- at least three years of experience in plant breeding or closely related subjects;
- competence in the English language.

The International Agricultural Centre is responsible for the selection of the participants in consultation with the Selection Committee.

APPLICATION

Application should be made to the Director of the International Agricultural Centre, P.O. Box 88, 6700 AB Wageningen, the Netherlands.

Applicants should submit:

- the relevant form, duly completed;
- a certificate of proficiency in the English language issued by a recognized organization e.g. British Council (for applicants from non-English speaking countries only).

The Selection Committee will only consider fully documented applications, which have been received **BEFORE** December 1st, 1995, and will inform applicants about its decision shortly after that date. The number of participants will be limited to 25. Admission to the course is on a competitive basis. Places will be offered to suitably qualified candidates subject to financial support being obtained.

INSURANCE

The Organizers do not accept any responsibility for risks such as loss of life, accidents, illness, loss of property, theft et cetera.

FELLOWSHIPS

Participants are usually financially supported by their governments, their employers or by non-governmental organizations, from externally financed projects or by international fellowship granting organizations such as:

- the Netherlands government;
- UN agencies (e.g. FAO, UNDP);
- the European Union (European Development Fund);
- the World Bank; or
- other multilateral and bilateral donors.

For this course, fellowships are available from the Netherlands Government in the framework of the Netherlands programme of development cooperation with developing countries.

Applicants for a Netherlands Government fellowship should submit their applications to the Netherlands Diplomatic Representative (Embassy/Consulate) in their home country. Details about the procedure to be followed may be obtained from the Netherlands Diplomatic Representative.

Applicants for a fellowship from organizations other than the Netherlands Government should approach the local representative or delegate of the organization concerned, usually through their national government.

Candidates applying for a fellowship should bear in mind that official procedures require several months. It is therefore advisable to make a request for a fellowship as early as possible.

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Announcement

Workshop on:

Breeding of Cocoa for Disease Resistance organised by INGENIC and to be held simultaneously with the 12th International Cocoa Research Conference. This will likely be in November, 1996.

Request to be put on Mailing List

If you are not on the mailing list for the INGENIC Newsletter, please fill in the form below and return to:

Frances Bekele
The Cocoa Research Unit,
The University of the West Indies
St. Augustine, Trinidad

OR

Michelle End
Dept. of Horticulture, School of Plant Sciences
University of Reading
Whiteknights, P.O. Box 221
Reading RG6 2AS
UNITED KINGDOM

Yes, I would like to receive the INGENIC Newsletter

Name ______________________________

Address ______________________________

Explanation of acronyms

ACRI	-	American Cocoa Research Institute
BCCCA	-	Biscuit, Cake, Chocolate and Confectionery Alliance (United Kingdom)
CAOBISCO	-	The European Employer's Federation for the Chocolate and Biscuit Industry
CATIE	-	Centro Agronómico Tropical de Investigaciones & Enseñanza
CIRAD	-	Centre de Coopération Internationale en Recherche Agronomique pour le Dévelopment

STAMP

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