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Cadbury Limited

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Editorial

The publication of this issue has been delayed as we felt it was important to include a report on the Seventh International Cocoa Research Conference which was held in Douala last November. This conference was larger and more widely attended than any of its predecessors. This indicates an increasing recognition of the value of these conferences as opportunities for exchange of information and opinions. Language poses a problem to such exchange, and this is emphasised in one part of the report. Not only do the barriers of language tend to slow down the exchange of information on research, they deter collaboration between workers studying the same or similar problems.

The need for greater collaboration and indeed co-ordination of research work was emphasised by the Cocoa, Chocolate and Confectionery Alliance at this Conference. The Alliance considers that the scientific and financial resources available for cocoa research should be increased to meet the problems facing the industry and therefore a greater degree of co-ordination would help to use those resources more effectively. If this could be done by means of an international body, the resources of men and money might well be increased. It is hoped that this proposal will be pursued.

G. A. R. WOOD

Review of Production and Consumption

May 1980

A. B. Cook, Cadbury Schweppes Limited

Production

Gill and Duffus's latest forecast of 1979/80 production is 1,586,000 tonnes which would make it marginally more than the 1971/72 season which was the highest year's production on record.

The basic reason for the improvement over last year is that, while both Brazil and the Ivory Coast are expected to be close to repeating their record outturns of last season, Ghana and Nigeria are both expected to make significant recoveries from last year's poor crops. Even after these recoveries both Ghana and Nigeria will still be well below the tonnages that they were producing in the early 1970's.

The rapid expansion of production in Malaysia is expected to continue.

Consumption

1980 estimated world consumption is estimated at 1,442,000 tonnes and this continues the trend of the last three years with a fairly small increase each year from the low 1977 level of 1,361,000 tonnes. However this means that 1980 consumption will still be some 80,000 tonnes lower than the 1976 figure of 1,525,000 tonnes.

Consumption seems to have recovered remarkably little since 1977 in view of the amount bean prices have fallen since the peak prices of 1977. There are two major reasons for this. Firstly, although bean prices reached over £3,000/tonne (approx. 235 c/lb) in 1977, very little cocoa was actually bought and sold at these levels as instanced by the average annual U.S. import figures which have never exceeded 150 c/lb.

Secondly, there has been the effect of cocoa butter prices, which have moved quite differently from bean prices over the last few years. Bearing in mind that a typical milk chocolate recipe requires 1.2 lb of cocoa butter to 1.0 lb of cocoa bean, this makes a significant impact on the cocoa cost of a bar of chocolate.

The following table, based on U.S. import data, helps to illustrate both the above points:—

Average U.S. Import Prices (cents/lb f.o.b.)

	Cocoa Beans	Cocoa Butter	Cocoa Cost in milk chocolate (cents/lb)	World Consumption ('000 tonnes)
1972	23.8	56.0	91.0	1,565
1973	38.2	95.6	152.9	1,556
1974	63.9	148.1	241.6	1,478
1975	62.0	128.3	216.0	1,462
1976	68.0	153.1	251.7	1,525
1977	126.1	235.5	408.7	1,361
1978	145.5	197.4	382.4	1,389
1979	145 Est	230	421	1,422 Est
1980	135 Est	270	459	1,452 Est

Stocks

Gill and Duffus are forecasting that world stocks at the end of the 1979/80 will be 635,000 tonnes compared with 501,000 tonnes at the end of 1978/79. This would be virtually back to the stock level at the end of the 1971/72 season and well above anything that we have seen since then.

Prices

Month end prices for nearby Ghana shipment cocoa have been:

1979	March	£1692/tonne		October	£1472/tonne
	April	£1724/tonne		November	£1580/tonne
	May	£1773/tonne		December	£1535/tonne
	June	£1748/tonne	1980	January	£1556/tonne
	July	£1480/tonne		February	£1460/tonne
	August	£1415/tonne		March	£1437/tonne
	September	£1600/tonne		April	£1330/tonne

Prices eased further during the summer of 1979 as it became clear to the market that there was going to be a third successive year of surplus of production over consumption, although at that stage the size of the surplus was in considerable doubt. Since the early autumn the major producing countries have been taking special measures to try to prevent a further decline in prices. The most significant of these measures has been the stockpiling of over 100,000 tonnes of cocoa in the Ivory Coast which has, so far, effectively prevented any of this season's forecast surplus from reaching the market. Their action was successful to the extent that prices remained stable at around £1500/tonne from October to March. However, since then prices have fallen substantially as there have been increasing signs that the origins are not going to be able to withhold cocoa from the market indefinitely. As at May 21st nearby shipment Ghana is £1190/tonne.

International Cocoa Agreement

The International Cocoa Agreement expired on March 31st after producers and consumers had failed to agree on any basis for continuing its existence. Under the rules of the agreement the buffer stock funds are returned to the producers on a pro-rata basis. At present the indications are that the producers are going to try to use these funds to operate their own version of a buffer stock mechanism, under the auspices of the Cocoa Producers Alliance.

WORLD COCOA PRODUCTION AND GRINDING DATA
Reproduced from Gill and Duffus Market Report
Dated 22nd April 1980
(Thousand Metric Tons)

Production

	1977/78	1978/79 (Estimate)	1979/80 (Forecast)
Africa	939	856	997
America	458	509	476
West Indies	42	47	37
Asia and Oceania	64	69	76
WORLD TOTAL	1503	1481	1586
Principal Countries			
Ghana	268	250	295
Nigeria	205	137	175
Ivory Coast	304	312	350
Cameroon	108	106	120
Equatorial Guinea	7	8	8
Brazil	283	314	273
Ecuador	75	90	95
Dominican Republic	30	33	27
Venezuela	18	17	17
Colombia	29	31	33
Mexico	33	37	38
New Guinea	30	28	30
Malaysia	23	26	31

Grindings

	1978	1979 (Estimate)	1980 (Forecast)
Western Europe	509	499	499
Eastern Europe and USSR	192	202	212
North America	174	170	170
Central and South America	287	334	327
Australia and New Zealand	16	15	15
Asia	56	57	64
Africa	155	145	155
WORLD TOTAL	1389	1422	1442
Principal Countries			
United States	163	160	160
Germany (Federal Republic)	144	142	142
Netherlands	126	127	125
United Kingdom	72	61	62
USSR	90	120	130
France	40	43	40

Projections for Cocoa Production by ICCO

(This summary was prepared by the Editor)

Amongst its many activities the Secretariat of the International Cocoa Organisation has made several special studies for meetings of the International Cocoa Council. Amongst these studies have been occasional surveys of the world cocoa economy with projections of future consumption and production, the most recent of which was issued in September 1978. The survey reviews recent developments in cocoa production, grindings and other aspects of the world cocoa economy, and goes on to make projections of production, consumption and prices up to 1985.

This summary deals with the projections on production. Eight countries are dealt with in detail. The figures for them and for the whole world are given in table 1. The projections indicate a considerable increase in production of nearly 400,000 tonnes during the five years to 1984/85, the bulk of which is expected to come from Brazil and Ivory Coast.

The projections are based on information on the following points:

1. The existing area planted with cocoa.
2. The rate at which old farms are going out of production.
3. The current rate of planting, derived from the distribution of seed of new varieties and estimates of plantings with traditional varieties.
4. Yields expected from new and traditional varieties.

It will be appreciated that, while the area planted with cocoa may be known with a fair degree of accuracy, several assumptions have to be made in arriving at trends in yields and effective rates of planting.

In the case of Brazil the area under cocoa in 1974/75 is taken to be 457,000 hectares of which 393,000 has. were ordinary varieties over 10 years old and 60,000 has. were planted with hybrid varieties. The area over 10 years old is expected to decrease at about 4.5% p.a. However, a high rate of planting of up to 54,000 has. p.a. is estimated to be taking place, based on an annual gross distribution of 100·m hybrid seeds. This material is expected to yield 1300 kg/ha by the eighth year. Therefore the projected increase in production will depend fairly heavily on the success of these new plantings.

The planting of hybrid varieties features in the calculations for nearly all the countries listed in table 1 and the contribution of mature hybrids to production in 1984/85 is shown in table 2. The production from the large areas of immature hybrids is excluded from this table in which the data have been rounded to the nearest whole number. It will be seen that the yields expected from hybrids at maturity vary considerably. They are not identical genetically, though in most cases they are crosses between selected Amazons and local varieties.

It will be seen from the data in the two tables that production in Ghana is expected to decline, while production in Ivory Coast is expected to increase considerably. This is due to different trends in the older areas. In Ghana production from areas planted before 1968 is expected to decline from 374,000 tonnes in 1974/75 to 149,000 tonnes in 1984/85, a fall of 225,000 tonnes or 60%. By contrast, in the Ivory Coast production from the areas planted before 1969/70 is expected to fall by only 17.5%, from 217,000 tonnes to 179,000 tonnes. Two factors may account for the more gradual decline in Ivory Coast. First cocoa production developed more recently than in Ghana so the bulk of the cocoa area is younger. Second, the campaign to rehabilitate older farms is expected to maintain yields at a higher level.

In Nigeria it is expected that the decline in production from old farms will be less severe and will be offset by production from new plantings.

Production in Malaysia is not dealt with in detail but it is estimated that production there will reach 38,000 tons by 1984/5.

These projections show trends calculated on the data mentioned earlier and on the assumptions that current programmes will be continued and that no major new pest and disease problems arise. The projections do not represent forecasts for the individual years as production fluctuates widely from year to year. The average annual changes in the 1970s were 7½% for total world production and much higher proportions for individual countries. These changes, which cannot be forecast, will have as great a bearing on prices as the general trend projected by this survey.

Table 1 – Projections of cocoa production

	1974/75	1979/80 (Thousand tonnes)	1984/85
Brazil	231	267	449
Cameroon	107	116	129
Dominican Republic	37	37	43
Ecuador	65	65	69
Ghana	382	281	257
Ivory Coast	222	300	406
Nigeria	210	191	237
Papua New Guinea	33	33	40
Others		194	244
World Total		1484	1872

Table 2 – Contribution of mature plantings of hybrid varieties to estimated production in 1984/85.

Country	Area 000 has.	Yield kg/ha	Production 000 tonnes	Proportion of est. prodn.
(Data on mature plantings of hybrid varieties only)				
Brazil	111	1300	145	32%
Cameroon	17	600	10	8%
Dominican Republic	6	1000	6	14%
Ecuador	4	800	3	4%
Ghana	66	700–800*	52	20%
Ivory Coast	102	1000	102	25%
Nigeria	57	900	51	22%

* The oldest plantings of hybrids are expected to have passed their peak.

The Seventh International Cocoa Research Conference

Douala, Cameroon, 5 to 12 November 1979

Part 1 Summary of proceedings

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Introduction

The first of the present series of International Cocoa Research Conferences took place in Abidjan, Ivory Coast, in November 1965. Since then a number of such Conferences have taken place (Table 1). This development is indicative of the importance attached to the 1965 Conference and the need for continued exchange of technical information on cocoa research. The Conferences took a new dimension in September 1975 after the Fifth Conference when the Cocoa Producers' Alliance assumed responsibility for the overall organisation of these Conferences. One of the objectives of this new arrangement was to provide continuity between conferences through its permanent Secretariat while the venue retains its rotational nature. The Seventh International Cocoa Research Conference is the second to be organised by the Alliance in collaboration with the Host Country, which this time was the United Republic of Cameroon.

This report presents a summary of what took place during the 7th Conference.

The usual Proceedings will be published later.

Table 1 – Information on previous International Cocoa Research Conferences

		Registered Participants			
Date	Venue	Total	Host	Foreign	No. of Countries
1. 15–20 Nov. 1965	Ivory Coast	55	13	32	13
2. 19–26 Nov. 1967	Brazil	145	97	46	20
3. 23–29 Nov. 1969	Ghana	191	112	79	23
4. 8–18 Jan. 1972	Trinidad & Tobago	96	18	78	24
5. 1– 9 Sept. 1975	Nigeria	171	96	75	26
6. 6–12 Nov. 1977*	Venezuela	167	83	84	24

* Figures given are estimates only.

Registration of participants

Registration started on Saturday, 3rd November and 186 participants registered for the Conference, 60 were from the Host Country and 126 from outside, an increase of 50 per cent over the figure for the Sixth International Cocoa Research Conference.

Opening ceremony

The Opening Ceremony took place on Monday, 5th November in the Conference Hall of the 'Office National de Commercialisation des Produits des Base (ONCPB)'. The three main speakers were the Minister of Economy and Planning of the United Republic of Cameroon, His Excellency, Youssoufa Daouda; the Executive Director of the International Cocoa Organisation, Mr. U.K. Hackman, and the Deputy Secretary-General of the Cocoa Producers' Alliance, Mr. D.S. Kamga. Other personalities and individuals from consumer and producer countries were also present.

Sessional activities

The Theme for the Conference was 'The influence of environment on the growth and production of the cacao tree', although other aspects of research were dealt with including Socio-economics. One day was devoted to Cocoa Extension. The choice of the Conference Theme was based on the current global trends in cocoa production, with a view to focussing attention on the need to know more about the various environmental factors affecting the cocoa tree and how to manipulate these factors to obtain better results.

The Conference Theme was divided into various aspects and each aspect had an Invited Speaker to present an introductory paper, which was followed by other contributions. As in previous conferences more attention was devoted to diseases than to any other subject. 90 papers were presented on the whole, 22 (24.4%) on diseases, followed by 21 (23.3%) on agronomy, which included rehabilitation and physiology. 11 of the papers were presented by the Invited Speakers.

Poster Sessions

The organisers decided to have simultaneous poster sessions at the 7th and future Conferences. This itself was not an innovation but an attempt to adopt an existing practice so that the Conferences can absorb as many papers as are available within the normal duration of one week and still have adequate time for presentations and discussions. These poster facilities were provided outside the Conference Hall. A few authors had indicated their preference for the poster sessions which were also used as a forum to continue discussion of some papers not satisfactorily covered during the normal sessions. All the same, the poster sessions offer good potentials for future conferences.

Special extension sessions

Unlike previous International Cocoa Research Conferences, special sessions were set aside for cocoa extension methods and techniques. Apart from the general invitations sent out to both research and extension workers, special invitations were sent out to governments to prepare reports as a follow-up of the Technical Consultation on Extension held in Brazil in May 1977. As a result, 10 papers were presented on extension alone; 8 on behalf of governments, and 2 by organisations. The poster facilities were extensively used to back up the presentations.

In the discussion the following points were emphasised.

– the need to re-appraise the present incentives given to encourage farmers' participation in extension programmes, with the objective of stimulating more effective participation,

- the importance of good planning in any extension programme, especially to ensure that all the necessary inputs are available beforehand,
- the need for liaison between research and extension,
- the need to build a smooth feedback mechanism into any extension system.

Working Groups
The practice has been for experts in any discipline to constitute themselves into Working Groups on a voluntary basis and to meet during International Cocoa Research Conferences when they consider it necessary. Consequently no Working Groups in the different disciplines have been institutionalized as in some other organisations. However two Working Groups have functioned in the last few Conferences. These are the Phytophthora Workers and the Cacao Geneticists. In addition to meetings the Phytophthora Group has organised workshops on the subject. At the Seventh Conference the two Groups each came up with resolutions which were embodied in the final resolutions.

Discussions
The final discussions took place in two parts: (a) the plenary session on world-wide cocoa research and extension needs took place at the end of the research sessions and (b) the concluding discussions took place on Monday 12th November after the extension sessions.

(a) Plenary session on World-wide cocoa research and extension needs

In addition to the normal plenary session which comes up at the Conference, a special plenary session to discuss the long terms needs of cocoa research and extension was held on Saturday afternoon at the end of the research sessions. During this session, the proposal on long term needs of cocoa research and extension, tabled by the United Kingdom Cocoa, Chocolate and Confectionery Alliance was discussed.

The Conference consequently recognized:

- the need to augment the present scarce resources available for international projects in cocoa, particularly of long term nature,
- the need for more effective coordination of cocoa research and extension work throughout the World,
- the need for early international action in the interest of both producers and consumers.

In cognisance of the above the Conference therefore recommended that the Cocoa Producers' Alliance:

- examine the possibility of supporting the establishment of a small group of cocoa scientists by the International Cocoa Organisation, with the mandate:

  (i) to review the works that are currently in progress or envisaged,

  (ii) to identify the global needs of cocoa research and extension and subsequently,

- to establish a priority list of the global needs of cocoa research and extension to fill any gaps thus revealed,
- to identify the sources of finance for any projects envisaged,
- to coordinate the timely and effective resolution of any problems thus identified.

(b) Concluding discussions

Three resolutions resulted from the concluding discussion. The first concerned the recommendations made to the Cocoa Producers' Alliance on the World-wide needs of cocoa research and extension. The recommendations on the subject were unanimously adopted.

On the losses caused by Phytophthora pod rot the conference emphasized the need to continue research on various pod rots and to encourage contacts between research workers by means of African and American sub-Group meetings alternating with the International Cocoa Research Conferences.

Concerning the cocoa clones and the intermediate quarantine facilities at the Royal Botanic Gardens, Kew, United Kingdom, the Conference recommended that the Cocoa Producers' Alliance should take steps to assure the appropriate authorities in the United Kingdom, of the continued interest by cocoa plant breeders in the facilities and the collection, so that both facilities should continue to be maintained and developed.

A number of other points of interest were discussed in one form or another. Two countries from Latin America have applied to host the 8th Conference. Whichever is chosen the traditional pattern of alternating between Africa and America will remain unchanged. A lot of enthusiasm in hosting future conferences was shown by participants during the discussions. While one or two countries from South East Asia were also thinking of approaching their governments, other participants were also considering the possibility of a future conference being hosted by a consumer country.

Closing ceremony

The Closing Ceremony took place on Monday 12th November, after the extension sessions and the final discussions. The ceremony was again presided over by the Minister of Economy and Planning, His Excellency Youssoufa Daouda. The Chairman of the International Organising Committee for the 1977/79 Seventh Conference period, Mr. Jean Braudeau, the Director-General of the IFCC, also delivered an address.

The International Organising Committee

This report will not be complete without a word about the International Organising Committee. This Committee was set up by the Cocoa Producers' Alliance as a sub-Committee of its Scientific Research Committee in 1977. A note on the Scientific Research Committee's activities has been published earlier (1). The International Organising Committee is responsible specifically for the technical aspects of the International Cocoa Research Conferences. Its membership includes members of the Cocoa Producers' Alliance itself, other cocoa producing countries, consumer organisations and specialised research organisations. The Committee therefore provides a forum for all cocoa scientists and administrators to exchange ideas about these conferences. Its president is appointed on personal merit on two-year basis. In executing its job the Committee works in close collaboration with the Host Country for each conference.

(1) Adenikinju, Sam. A. (1978). The Scientific Research Committee (SRC) of the Cocoa Producers' Alliance (CPA): A potential instrument for tackling production problems on international basis. International Sugar Confectionery Manufacturers Association — International Office of Cocoa and Chocolate Periodic Bulletin Nr. 16 April 1978, 23–24.

Part 2 Review of papers

J.B. O'Donohue and C. Prior
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Agronomy — general

Eight papers were presented on general agronomy including an invited paper which reviewed the problems and the approaches available for solving them. The papers dealt with the ecological factors affecting production, agronomic practices and recommendations, and diagnostic criteria for assessing the suitability of land for cocoa growing. An interesting situation occurs in Ecuador where an unusual distribution of rainfall and radiation results in unusually low moisture stress in the dry season. Shade trees provide valuable mulch but also compete for water. A paper on pest problems in Papua New Guinea considered that shade type influenced pest levels, with coconut shade being the most suitable, in contrast to the widely planted *Leucaena* which has several associated pest problems.

Two points which recurred in a number of papers were firstly the influence of management on production, regardless of the constraints of soil and climate, and secondly the huge gap which exists in all cocoa-growing countries between research attainments and application by growers. All countries report yield figures on research stations of between 1.2 and 2.5 tonnes/ha and occasionally higher, but the usual national average production is of the order of 0.25 tonnes/ha.

Agronomy — regeneration

Only one, invited, paper on regeneration was presented. The speaker outlined the economic, sociological and technical considerations involved in the rehabilitation of run-down plantings. The paper touched on urban drift and this point was echoed by a number of delegates. The need was recognised to attract young people to cocoa farming by providing in the rural areas some of the attractions which lure them to the cities (e.g. sporting facilities, electricity, water). In discussion the problem of supplying seed for replanting was mentioned and the method used by Brazil to distribute large quantities of seed was described.

Agronomy — physiology

An invited paper dealt with recent studies on the environmental physiology of cocoa. The main points of this paper were:

1. The distribution of rainfall is a very significant factor in determining production patterns.

2. There is no evidence that sunlight directly retards juvenile plants. More important than reducing insolation are the effects of shade in reducing the breakage of pulvini by wind, in reducing weed growth and in ameliorating pest problems.

3. Flowering depends directly on the cambial activity. Low temperatures lead to reduced cambial activity and reduced flowering, while prolonged flooding has the same effect.

4. Leaf flushing is controlled by hormones but environmental factors also influence this activity.

5. Where there is a very definite dry season production can be correlated with rainfall seven months previously.

Four papers dealt with field investigations of cocoa ecophysiology. Studies in Ecuador on incident radiation, leaf area and self shading revealed large differences between Trinitario and Nacional cocoa. Other papers discussed the effects of drought on various aspects of cocoa growth including flowering and production. Wind was shown to cause serious damage to the pulvinus when this was flaccid due to water stress. In Togo, where drought is a severe problem, a method has been developed for screening for drought resistance in young seedlings. A correlation was established between transpiration rate in seedlings and their drought susceptibility.

Comments during discussion included the importance of windbreaks in some cocoa-growing areas, and the marked difference between cocoa types in susceptibility to wind damage. Leaf moisture content varies markedly between seasons and depends on the plant's moisture status and solar radiation.

A final sub-session on physiology comprised three papers on more basic physiology than the above, together with a poster display in the same vein. One paper dealt with chloroplast formation, one with shoot apex activity and the third with the effects of morphactin on the growth of seedlings. The poster display was entitled "A study of growth periodicity in cocoa seedlings, with particular reference to the root system". It demonstrated that root and shoot growth is alternate in cocoa seedlings.

Soils and Nutrition

An invited paper reviewed the properties of soils which affect plant growth, and commented that a method must be found for quantifying shade before comparisons can be made of shade/nutrition interactions. Points that arose in discussion of this and other papers included:

1. The physical properties of soils in relation to the amount and distribution of rainfall.

2. The use of the ratio of total nitrogen to total phosphorus as the index of phosphorus status.

3. The rate of soil moisture release and the status and availability of phosphorus as major factors in the selection of cocoa soils.

4. The importance of overall crop management in rendering the oxisols of S. Bahia as productive as the better alfisols.

5. Foliar analysis. In Brazil, this is posing problems because of the many variables involved in determining leaf composition. In the Ivory Coast, after fifteen years of work, it was decided that foliar diagnosis was not an appropriate tool for determining cocoa fertiliser requirements.

Genetics and Improvement

Three papers reviewed breeding programmes in Cameroon, Venezuela and Brazil. The breeding programme in Cameroon uses local Trinitario material crossed with Amazonian clones from Nigeria. Black pod and mirid resistance are included in the programme. The Venezuelan programme has progressed from clonal propagation to hybrids and one cross, Santa Cruz 10 x Sca 6, was reported to have produced well over 4000 kg/ha. They are now entering the third phase of their cocoa programme involving the up-grading of existing cocoa, and maintenance of quality. Brazil is also looking to hybrids to improve production and has some under test that have produced over 3000 kg/ha.

These general papers were followed by four others on more specialised breeding and selection topics. A vigour and productivity trial in Costa Rica showed that within each cross selection should be made on the basis of vigour at the seedling stage. Two papers dealt with the importance of pollination in determining production; work in the Ivory Coast showed that the pod wilts if insufficient ovules are pollinated. Where pollination is adequate, the number of ovules per ovary is the important criterion in determining production. Ovules/ovary, wilt resistance of the cherelles and ovule fertility were rated as important selection criteria.

The use of calibrator trees and the adjustment of plot yields by the yields of neighbouring trees were described as means of improving the precision of breeding trials.

One paper discussed global concepts in cocoa breeding. Research stations have been unable to handle new material from the wild, and are using material collected twenty years ago. A plea was made for new collections from the wild, because of the exploitation of the Amazon region and the consequent loss of primitive gene pools. New centres are needed for the evaluation of such material and for quarantine before distribution to other countries.

A meeting was convened of all delegates in any way connected with cocoa breeding. Vacant positions in the Working Group of Cocoa Geneticists were filled and a paper was distributed on "Cocoa descriptors, their states and modus operandi". A decision was made to publish the descriptions of cultivars already compiled, even though the list of descriptors used differs from that given in the paper.

During the meeting it was revealed that the Royal Botanic Gardens at Kew will be disposing of their cocoa material to make way for other accessions. Kew does not maintain a large permanent cocoa collection but merely passes material through quarantine. Countries requiring material from Kew should therefore act now.

The cocoa collection at Mayaguez occupies only 3 ha, but this collection is to be expanded. Brazil has recently acquired a station of about 200 ha to house a collection.

Pathology

Twenty papers were presented on cocoa pathology of which thirteen were on various aspects of the biology and control of *Phytophthora* diseases, four were on cocoa swollen shoot virus and only three on other diseases. This indicates the dominance of *Phytophthora* as the chief cocoa disease problem, at least in the minds of researchers.

Taxonomic work on the vary variable fungus "*P. palmivora*" has now led to the opinion that three separate species cause black pod disease. These are *P. palmivora* (formerly morphological form 1), *P. megacarya* sp. nov. (formerly morphological form 3) and *P. capsici* (formerly morphological form 4). Whether world wide differences in black pod severity are due to the distribution of these fungi is not clear; *P. palmivora* for example is world wide in distribution and yet black pod severity varies widely in countries where it occurs. *P. megacarya* occurs mainly in Cameroon and Nigeria which have serious black pod, and yet it has been found in Malaysia and Papua New Guinea but not on cocoa. Much remains to be discovered about the adaptation of *Phytophthora* spp. to cocoa and the factors which result in serious black pod outbreaks.

Work on the epidemiology of black pod in Nigeria has shown that re-infection from sources in the canopy is the most serious problem preventing effective control. Sanitation is unlikely to be effective unless applied over a very large area, but insecticide treatments to reduce the amount of inoculum carried up from the soil by ants did reduce the amount of disease from 12% to 7%. It was speculated that *P. palmivora* grows on the feeder roots of mature trees, thereby providing a constant reserve of inoculum in the soil. This debilitation could account for the low yields of some trees.

There were several reports of improved methods of chemical control. In Bahia, aerial spraying of low volume copper by helicopter gave as effective control as low volume application by mist blower. Redistribution of copper from the canopy after aerial spraying allowed effective coverage. The new systemic fungicide CG A5505 (Ridomil) is under trial in several countries including Brazil, Cameroon, Ghana, Ivory Coast and Papua New Guinea. Brazil reported that control was superior to copper treatments when Ridomil was sprayed at 200–400 g a.i./100l every month. Some control was obtained when the interval was increased to seven weeks. In Cameroon, effective control is claimed for a spot application of 30–50 g a.i./100l every 15–21 days during crop maturation only. This leads to very economical use of fungicide. The manufacturers have recommended 30–50 g a.i./100l where disease is light and 100–200 g a.i./100l where disease is severe. However, much depends on the crop density and means of application. (Work in Papua New Guinea has shown that although Ridomil is very effective for controlling black pod, its cost may make it uneconomic on low yielding cocoa).

A new screening technique for systemic fungicides using cocoa seedlings was described, and the differences in behaviour of three currently available anti-*Phytophthora* systemics were described. This technique will facilitate testing further new systemics which are bound to be developed from the existing first generation.

Only one paper was presented on witches broom disease, despite its presence in the major new Brazilian plantings in Amazonia, its serious effects in other S. American countries and its threat to the currently disease-free cocoa in Bahia. The paper described some most interesting observations on the penetration of cocoa callus tissue by basidiospores of *Crinipellis perniciosa*. Scavina callus was more resistant to infection, which correlates with observations on this variety's resistance in the field. The growth of the fungus was also affected differently by alcohol extracts of resistant and susceptible material. These observations could lead to the development of an in vitro screening technique for disease resistance. The paper also reported on differences in the karyotic states of the biotrophic and nectotrophic forms of the fungus, which could explain the sudden changes from one form to the other which are observed in culture.

Entomology

Eleven papers were presented on aspects of cocoa entomology, of which two dealt with pollinators, five dealt with mirids in Africa and S. America and the remaining four with other insect problems, particularly *Selenothrips, Bathycoelia* and *Earias*. The absence of insect problems from Central and S. America was most notable: a review of pest problems in Central America stated that these were few, not serious and mainly confined to nurseries. There is currently no entomologist working on cocoa in Central America. Mirids are the main pest in S. America and these are controlled effectively by B.H.C.

The increase in pest problems following shade removal was widely recognised and it was stressed that shade removal in W. Africa must be accompanied by chemical control of mirids. There are in fact two distinct economic situations: low input low yield with shade, and high input (pesticides and fertilisers) high yield without shade.

In view of the absence of pest problems in the Americas, and the lack of fresh information on African mirid problems, most interest was centred on the work on insect pollinators. In particular, two aspects were discussed: does the absence of pollinators limit production, and does mist blowing (in itself and because of the anti-mirid pesticides) affect pollination levels? Some countries, e.g. Nigeria, have heavy losses from cherelle wilt, indicating that pollination exceeds the trees' bearing capacity and therefore cannot be limiting. Other countries (Brazil) have only 5% pollination, and this could be a factor limiting yield. It was concluded that the effect on pollinators of thermofogging insecticides was transient; insect numbers recovered in 24 hours. However, numbers only recovered after 7 days when mist-blown insecticides were used. It was not felt that the mechanical effect of blowing pollen around would do much to improve fruit set, but this work was done in the Cameroon where pollination levels are high anyway. Another paper claimed that in Bahia the air blast alone would triple yield and was an economic treatment. If this is so, it raises questions about figures for increased yields resulting from pest and disease spray programmes. The issue was further complicated by the observation that in C. America mist blowing increased pollination, i.e. increased the number of pods set, but these fruits had low bean contents implying that pollination had not been adequate for complete fertilisation. It is clear that comments on pollinating insects are only valid for specific countries and when there is a thorough background knowledge of pollination levels.

It was pointed out that in areas where pollination was limiting, e.g. Bahia, attempts should be made to encourage the pollinators by providing breeding sites. These are principally epiphytic bromeliads and rotting banana stems. There is also a good prospect of breeding the midges and releasing them.

Production and economics

Eight papers were delivered on these subjects. One concerned the excess acidity in Malaysian and Papua New Guinea cocoa. It was felt that this was due to the high pulp content of these cocoas, which resulted in excess production of acids during fermentation. Mechanical removal of the pulp was seen as a promising way of overcoming the problem. Two papers dealt with relative humidity and storage problems, and concluded that if stores were kept pest free and the RH kept below 70% by mechanical dryers, cocoa could be stored in the tropics for up to 15 months with negligible deterioration.

A demonstration was given of a simple wooden pod-breaking machine which it was claimed gave an eight fold increase in pod-breaking speed. The author also described a simple three stage fermentation box which was available to Cameroon growers in kit form and gave better fermentation than traditional methods.

A film was shown illustrating a pod-breaking machine. The machine breaks the pods, separates the beans from the placenta, ejects the placenta and then separates the beans from the husk. Separation is not complete as there is about 5% of husk among the beans. The machine is powered by a 4 hp engine and requires four men to operate it. It can break up to 12,000 pods/hr, equivalent to 1000 kg wet beans, although four men could probably only feed it at the rate of 10,000 pods/hr over long periods. The unit can be towed from point to point. Like other such machines, the operation of this one presupposes the collection of pods into large heaps, but this expense could be avoided by breaking as near as possible to where the pods are hooked. Obviously the decision to buy such a machine would be made on purely economic grounds.

The language problem

One problem that is always apparent at the International Conferences is the isolation of knowledge by language. There is English research, French research, Spanish research and Portuguese research, and few workers are aware of what is going on in depth in more than one of these. Any measures that could increase communication across the language barriers would be most valuable, and there is a definite need for a centralised service to evaluate, translate and circulate cocoa research literature in all the major languages. The establishment of such a service would be a very valuable contribution to world cocoa research.

Conclusions

There is an enormous disparity between cocoa yields recorded on research stations and national average figures. Research stations often record 2000–5000 kg/ha, whereas national averages are in the 200–500 kg/ha range. Thus research has shown how to produce up to ten times the national average in some countries, and one must conclude that research stations know how to produce enough cocoa to oversupply world needs. These high yields are obtained particularly from the Upper Amazon hybrid material which most countries are using for their replanting programmes but even existing non-hybrid plantings are amenable to great improvement.

This disparity exists partly because the effort needed by the growers to improve yields is too great and partly because knowledge is insufficient. It is probably an illusion to think that hybrid material will give much improved yields under the poor management conditions which must be very widespread, because the extra yield is only likely to be obtained when pests, diseases and the environment are not limiting. For instance, more pods usually means more black pod, because the disease spreads more easily from pod to pod where pods are numerous. Thus when the disease is not controlled the yield from a high yielding tree may actually be less than when pods are sparse. Another well-proven example concerns shade removal. Yields can be increased if shade is removed, but will be maintained only if fertilisers and pesticides are used; if they are not then this approach usually results in a rapid yield decline.

One result of cocoa research has been to increase the amount of management effort required to reap benefits from this research. Often research results are not implemented because growers are not prepared to make the effort and one must conclude that, for whatever reason, the motivation is insufficient. We were told at Caracas that the net profit gained from an additional input such as spraying must be more than 50% if growers are to be motivated, but it may be too simplistic to think that a simple figure for expected capital return will provide sufficient motivation.

It appears to us that the most urgent need right now is for improved extension. Only certain specific problems require further research, allowing that resources are limited. If the international body proposed by the Cocoa Chocolate and Confectionery Alliance is formed it should consider ways of extending existing information as a high priority. This is not a job for scientific research workers who rarely have the economic and sociological skills required. Sociological answers should be sought within the countries now most needing to improve production. This will mean recruiting workers in the socio-economic field to solve the problems of increasing production. Finding the right people is as important, and at least as difficult, as finding the funds.

The Quarantine Facilities for Cocoa at the Royal Botanic Gardens, Kew

Over the past 100 years, the Royal Botanic Gardens, Kew, has played an important part in the distribution of cacao germplasm throughout cocoa growing areas of the Old World. This was fully described in an article published in the "Cocoa Growers' Bulletin" issue No. 24.

For some years it has been the policy to retain a stock of cocoa clones after material received for intermediate quarantine has been despatched to its final destination and a collection of some 200 clones is presently being held. Material from these clones has always been distributed on demand to interested parties according to availability.

The need to increase the genetic variation available to cocoa breeders in West Africa and elsewhere, has led to plans for further collections of germplasm. These plans have also been stimulated by the wholesale felling of the forests in the Amazon basin and systematic collecting has been initiated in more than one area. The material collected will have to pass through quarantine and Kew will have a major part to play. In view of the large numbers of new selections which are expected to arise, the facilities for intermediate quarantine and distribution will have to be increased but even with increased facilities it will not be possible to maintain a large collection of cocoa clones. A revision of policy concerning the stock of clones is therefore necessary.

In order to maintain a steady flow of material through the greenhouse selections will be kept for about one year after they have passed through quarantine. During that time the selections will be available for distribution. A list of selections available will be issued at regular intervals probably every 6 months. This list will be sent to the major cocoa research institutes and will be published in the "Cocoa Growers' Bulletin".

It follows from this change of policy that the collection at present held at Kew will have to be reduced. A list of this material is appended and requests should be sent to the Quarantine Station, Royal Botanic Gardens, Kew, Richmond, Surrey, UK.

The material will be kept until the end of December 1980, after which it will not be available.

Most of this material has been sent to germplasm collections and will be added to the collection maintained by the USDA at Miami, Florida. It is, however, hoped to maintain a small collection, about 20 clones, of parents suitable for seed gardens, but not all are available at the present time.

The maintenance of cocoa clones at Kew receives no consistent support from any official body, and it is therefore necessary to levy a charge to cover running expenses. A sum of £25.00 sterling plus freight costs and incidentals will thus be made for each clone (approximately 10 buds) supplied ex stock.

Selections available at Kew 1980

180M
10P
41R
AMAZON 2-1
AMAZON 15-15
AMELONADO — W. African (Open-pollinated)
BE 3
CAS 1
CC 10
CC 11
EEG 65
EET 272
EET 308
EQX 94
EQX 97
EQX 100
EQX 105
ICS 95
ICS 116
ICS 122
IMC 3
IMC 9
IMC 10
IMC 11
IMC 13
IMC 14
IMC 16
IMC 20
IMC 22
IMC 23
IMC 30
IMC 33
IMC 41
IMC 44
IMC 45
IMC 47
IMC 51
IMC 53
IMC 54
IMC 61
IMC 63
IMC 68
IMC 77
IMC 78
IMC 83
IMC 85
IMC 94
IMC 96
IMC 97
IMC 103
IMC 105
LAF 1
LAF 3
LARANGE
MATINA 1-9
MO 9
MO 81
MOCORONGO
MOQ 413
MOQ 417
MOQ 528
NA 58
NA 242
NA 691
POUND 2B
POUND 4A
POUND 4B
POUND 4C
POUND 5C
POUND 9C
POUND 11A
POUND 14B
POUND 16A
POUND 19A
POUND 19B
POUND 31B
POUND 32A
PA 4
PA 13
PA 18
PA 20
PA 29
PA 30
PA 51
PA 52
PA 56
PA 71
PA 88
PA 107
PA 120
PA 121
PA 127
PA 137
PA 159
PA 175
PA 184
PA 188
PA 191
PA 195
PA 200
PA 276
PA 292
PA 300
PA 303
PA 310
P 30
PLAYA ALTA
PUCALA 1
REDAMEL 1-31
SCA 5
SCA 8
SCA 11
SCA 19
SCR 5
SIAL 93
SIAL 339
SIC 5
SIC 813
SPA 12
SPEC 54-1
SPEC 160-9
SPEC 189-8
TAP 1-2
TJ 1
UCA 3-5
UF 11
UF 168
UF 221
UF 667
UF 676
UF 713

Vascular Streak Dieback

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Distribution

Papua New Guinea, Malaysia and the Pacific Islands are mercifully free of many serious cocoa diseases. Apart from the ubiquitous Black Pod and stem canker, the only serious disease problem in the region is vascular-streak dieback. The present known distribution of this disease is from peninsular Malaysia in the west to New Britain island in the east. Reliable reports state that it also occurs in Sabah and the Philippines. Within Papua New Guinea, the disease does not occur in the outlying islands of Manus, New Ireland and Bougainville. Even within New Britian island the distribution is patchy; the heavily planted areas on the Gazelle peninsula and in the Hoskins-Kimbe area of West New Britain are infested, but isolated plantations on the island's south coast are disease-free. Similar isolated disease-free areas occur on the mainland.

History

A pre-war report (2) on cocoa disease lists "dieback" as the most serious above-ground disease problem in Papua New Guinea but it is not clear whether this was vascular-streak dieback or some form of physiological debility. Cocoa plantings were devastated by the war and replanting began in the early nineteen fifties. In the early nineteen sixties severe outbreaks of vascular-streak dieback occurred in East New Britain and in several areas on the mainland. The disease was readily recognised as distinct from physiological dieback (1) but the cause was obscure. Many positive isolations of the fungus *Botryodiplodia theobromae* were made from infected stems but this fungus could not be made to reinfect healthy plants.

In 1968 a collaborative research project was set up between the Department of Agriculture, Stock and Fisheries and the University of Papua New Guinea to investigate "*Botryodiplodia* dieback". In 1971 the previously unknown fungus *Oncobasidium theobromae* Talbot & Keane (Basidiomycotina: Tulasnellales) was discovered to be consistently associated with diseased stems and it is now clear (3, 6) that this is the causal pathogen. Meanwhile, the epidemic has declined and vascular-streak dieback no longer kills large trees as it did at the height of the outbreak although it can still be a problem in young trees, especially when these are planted near or among older infected trees.

Symptoms

Several of the symptoms are peculiar to the disease and when taken together they are very distinctive. In approximately chronological sequence they are:

1. A single leaf in the second or third flush back from the tip turns yellow with a pattern of characteristic green spots and then falls (Figure 1).

2. Further leaves progressively develop a similar pattern up and down the stem from the first one and are lost, leading to a distinctive situation where the youngest and oldest leaves are still present but all the middle ones have fallen. This distinguishes the disease from physiological dieback caused by environmental stress or insect attack (Figure 2).
3. The bark in the leaf fall region becomes rough due to the swelling of the lenticels. This is actually the earliest symptom to appear, but is not usually noticed until the leaves start to fall.
4. The axillary buds of the fallen leaves sprout and then rapidly die.
5. The wood is discoloured by brown streaks which can be seen when the branch is split. In the early stages these originate from the traces of fallen leaves but later this pattern becomes obscured (Figure 3).
6. When the infected stem is cut transversely or when the bark is stripped off, the cambial zone very rapidly turns a rusty brown colour.
7. At a later stage the terminal leaves may show interveinal necrosis reminiscent of calcium deficiency. This is particularly noticeable on shoots that have arisen from infected stems (Figure 4).
8. In wet weather the fruiting bodies of *Oncobasidium theobromae* appear as a white crust on the infected stems, arising from the scars of freshly fallen leaves (Figure 5).
9. Infected branches die slowly, often taking several months.

Figure 1.
First leaf symptoms in the second leaf flush back from the tip: in this case the tree has formed the jorquette after infection occurred.

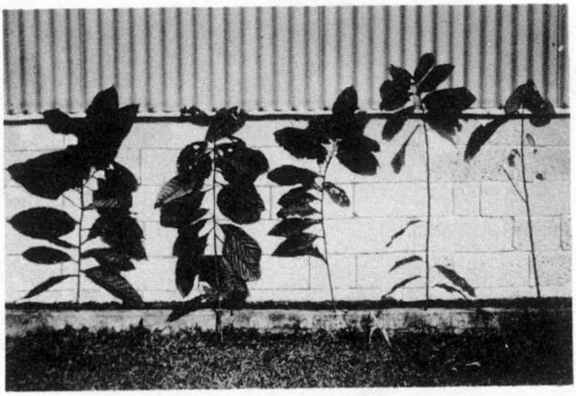

Figure 2.
Progressive pattern of leaf fall in fan branches, healthy branch on the left.

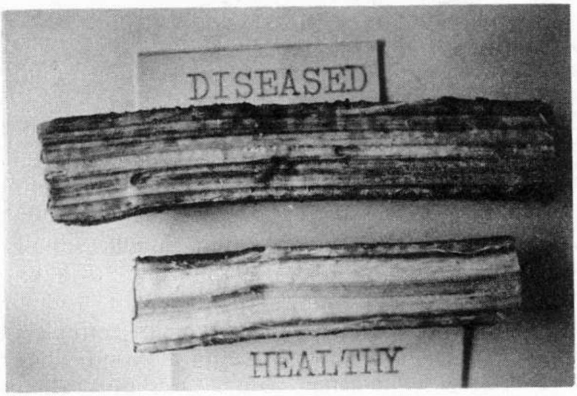

Figure 3.
Brown streaks in the wood of an infected stem.

Figure 4.
Interveinal necrosis (cf. calcium deficiency) in terminal leaves of an infected stem.

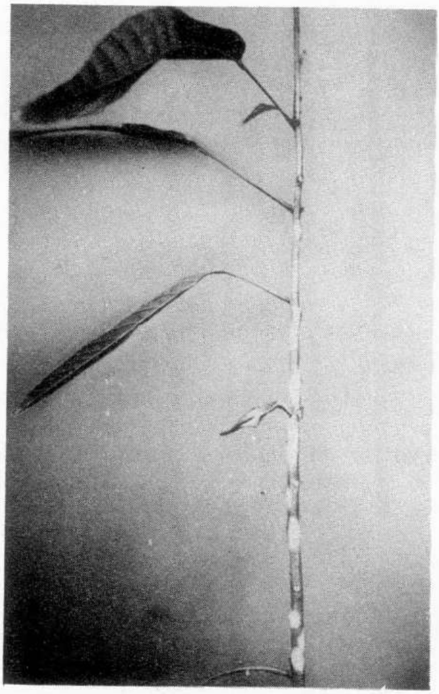

Figure 5.
White fruiting bodies of *O. theobromae* arising from the scars of fallen leaves.

Disease spread

The fruiting bodies of the causal fungus produce colourless basidiospores that are shed only at night and are carried by the wind. Those that land on the surface of young, unhardened cocoa leaves germinate and penetrate through the epidermis and mesophyll into the veins. From there the fungus grows down into the stem, but an incubation period of three to five months occurs before the first symptoms are visible. Dew provides adequate moisture for spore germination but not for fruiting body formation, for which the bark surface must be wetted by rain. For this reason spores are produced and infections occur only in wet weather. Because night winds are usually light within cocoa blocks the disease spreads slowly. However, sudden upsurges in disease incidence are common within infected cocoa, and these are the results of heavy spore production three to five months previously.

Control of vascular-steak dieback

1. *Chemical control.* Protectant fungicides are practically worthless because of the need to protect a rapidly growing and expanding tissue during the wettest weather. Systemic fungicides are theoretically more promising and would be useful in protecting young cocoa in the first two years of its life, which is when the most serious effects of the disease are felt. Unfortunately none of the currently available systemics have been effective in trials at Keravat.

2. *Cultural control – pruning.* Regular monthly pruning-out of infected branches is recommended for controlling the disease in infected trees. The branches are first split to reveal the extent of brown streaking in the wood and then cut off 30 cm below the last detectable streak. This is necessary because the fungus may be present beyond the visible limit of discolouration. Pruning both removes infections from the tree, allowing it to recover, and also prevents the spread of the disease by removing the infected branches on which the fungal fruiting bodies form. Neither removal nor burning of the infected prunings is necessary, because the fungus cannot sporulate or live in dead or dying wood.

3. *Cultural control – resistance.* Resistance appeared very early during the epidemic among the clonal trees at the Lowlands Agricultural Experiment Station, Keravat. The disease was so severe that some clonal trials had to be abandoned, but even while this was occurring selections of resistant material were made. In the first resistance trial the most susceptible clone sustained fifteen times as many infections as the most resistant and was entirely destroyed by the disease. The most resistant clones in this trial and a number of others whose resistance is equally good can grow and produce well even under severe infection pressure once they are more than two or three years old and full resistance has developed. This resistance has not yet been broken and clones selected as resistant fifteen years ago are still propagated for distribution to growers.

   Resistance is the most desirable method of disease control from the grower's point of view because the cost of control has been borne by somebody else and his only expense is the increased cost of planting material (4). In Papua New Guinea, vegetatively propagated material has been available from Keravat for many years, at a small charge or free depending on current government policy, and the distributed clones all show at least some resistance to vascular-streak dieback.

4. *Quarantine.* A total ban on the movement of cocoa planting material from disease-infected areas to the disease-free islands of Manus, New Ireland and the North Solomons (Bougainville) has been in force since the epidemic started. This has meant that these areas have not been able to benefit from the selection work carried out at Keravat because none of the clones developed there (which are superior agronomically as well as disease resistant) have been allowed entry. This situation has become critical now that production of hybrid Trinitario x Amazonian material is about to begin at Keravat at the same time that most cocoa growing areas in the country are beginning to replant.

   An elaborate quarantine procedure has been devised to allow the import of the improved material. Budwood is cut from selected clones after preliminary isolation for six months in a shade house at Keravat, and transverse sections from each end of each budstick are microscopically examined for the presence of hyphae in the vessels. After checking, the budwood is taken to a quarantine station on a disease-free island between New Ireland and the North Solomons and budded onto rootstocks raised from seed originating in the North Solomons. After a further six months, budwood is taken from the island to the North Solomons and other disease-free areas to provide budded clonal trees for multiplication and subsequent planting in seed gardens. An additional advantage of this scheme is that, should vascular-streak dieback ever appear in these areas, the planted cocoa will already have some resistance to the disease and the ensuing epidemic will not be so severe.

Unsolved problems concerning vascular-streak dieback

1. *What is the alternative host?* Vascular-streak dieback is known only from cocoa in S.E. Asia and Melanesia, where cocoa has been grown for less than a hundred years. It is reasonable to assume that an alternative host exists in the native flora, but this has not yet been identified. It would appear that New Britain is the most easterly limit of this host or hosts' distribution. There are no clues to the host's identity, but native relatives of *Theobroma* in the Sterculiaceae are obviously suspect.
2. *A growth medium for O. theobromae.* There have been reports (3) that *O. theobromae* can be grown in culture to a limited extent, but in my experience such growth is slow and erratic and inadequate for any cultural studies. The fungus is effectively an obligate parasite in that it will only grow successfully in association with living tissues of its host. Some preliminary success in growing the fungus in dual culture with living cocoa callus tissue (5) has prompted further work on the use of callus in shaken liquid culture as a growth medium for the fungus. The aim of this work is the production of spores of *O. theobromae* in culture, because only when spores are readily available for inoculating young plants can effective work on resistance screening be carried out (6).
3. *Is there more than one race of O. theobromae?* This question can only be answered fully when the problem of culturing the fungus is solved. Perhaps the greatest threat from the disease is the possibility that a new and more virulent race will appear. At present, the risk of this occurring cannot be assessed because nothing is known of the potential for variation and recombination in the fungus.

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Plant Parasitic Nematodes associated with Cocoa

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Cocoa (*Theobroma cacao L.*) a native of the Amazon region in South America, is one of the major cash crops in the tropics, about 60 per cent being grown in West Africa. In India, cocoa has been grown for 200 years, but until recently, was confined to a very small area. There has been in recent years, an increasing interest in the cultivation of cocoa in this country, particularly as a mixed crop in coconut and arecanut gardens. Today the area under cocoa is about 10,000 ha of which Kerala State grows 5,500 ha.

Ritzema Bos (11) was the first to record the root-knot nematode on cocoa. This paper presents the results of a preliminary survey on plant parasitic nematodes associated with cocoa in Kerala and Karnataka and supplements the review of nematological investigations by Whitehead (17) and Thorold (15).

Evidence of nematode attack

Though many species of plant parasitic nematodes have been recorded from the rhizosphere of cocoa, precise information on the pathogenicity of any one of them except *Meloidogyne incognita*, is lacking. Ghesquiere (6) showed that *Meloidogyne* sp. caused rapid drying of the aerial parts and quick death of the tree as a consequence of intensive attack on rootlets. Similar symptoms on the aerial parts of the tree are typical of the disease *"morte subite"* or *"sudden death"*, a puzzling disease noted occasionally in most of the cocoa growing areas in Brazil.

Jimenez (7) suggested that destruction of feeding roots by both root-knot and root lesion eelworms might be the cause of *"morte subite"*. Sharma *et al.* (12) studied the pathogenicity of *M. incognita* on cocoa var. 'Catongo' in Brazil using three inoculum levels under glasshouse conditions. Significant differences in plant growth appeared 17 weeks after inoculation. The inoculated plants were stunted and unthrifty, with galled root systems. Comparing the plants inoculated at three levels with controls 37 weeks after inoculation it was found that dry plant weight, stem diameter and plant height had decreased by 31.2% to 47.9%, 10.6% to 17.4% and 20.6% to 28.4% respectively. Histopathological observations of inoculated plants revealed giant cell formation and hyperplasia of the vascular parenchymatous cells. The stelar region was completely disorganised with partial to total destruction of xylem, phloem, pericycle and endodermis. Adult females were found embedded in the cortex with giant cells around their heads and egg masses deposited on the root surface through ruptures in the cortex. Thus the pathogenicity of *M. incognita* was established on cocoa and also suggested its probable primary role in the etiology of "sudden death" disease under field conditions in Brazil.

Preliminary observations in Ghana and Nigeria revealed the decreasing incidence of eelworms with increasing distance from bananas and plantains planted amongst cocoa. Concern was expressed that these hosts might maintain a large population of parasitic nematodes injurious to cocoa trees (4, 5).

In Ghana *Terminalia ivorensis* was found free of nematodes (5) and was considered as a suitable tree for shading cocoa (2).

In Papua New Guinea *M. javanica* was found to infest roots of the shade tree *Leucaena glauca* but appeared not to affect cocoa (16). Corbett (3) put forth the need for an alternative nurse crop to cocoa in place of banana to reduce the nematode infestation in Malawi.

Nematodes in India

Kumar *et al.* (9) reported multiplication of *M. incognita, Pratylenchus coffeae* and *Rotylenchulus reniformis* on cocoa in the coffee tracts of South India.

Results of the preliminary survey (Table 1) comprising 88 samples of both soil and roots collected in Kerala and Karnataka showed that the most common root parasite is *Meloidogyne incognita* and the dominant nematodes in the rhizosphere are *Hoplolaimus* sp and *Helicotylenchus* sp. Inoculation studies showed that cocoa seedlings developed severe root galling with females of *M. incognita* with egg masses exposed on the root surface. On the other hand the 'banana race' of *Radopholus similis* collected from coconut was found to penetrate cocoa roots in small numbers but failed to multiply.

Control

Entwistle and Caveness (4) reported in Ghana that nematodes were controlled by Nemagon @ 4 gal. per acre. Increase in number of pods through application of different nematicides such as Dasanit, Nemacur and Nemagon were reported by Martin (10). Nemagon @ 70 lb/acre was reported to be phytotoxic because of decreased yields. Jimenez *et al.* (8) studied the effect of Nemagon on germination and growth of seedlings and mature plants of cocoa. Seedlings were damaged by high concentrations but young plants and trees withstood soil applications of 40 or 60 ml of 75% Nemagon emulsion applied at a depth of 15 cm. Tarjan *et al.* (13, 14) reported increased yields subsequent to application of nematicides such as Nemacur, Terracur and Mocap which also indicated that cocoa trees infested with nematodes are benefitted by application of nematicides.

Nematodes in the nursery can retard the growth of seedlings or kill them. The transplantation of nematode infested seedlings carries nematodes to the plantations, where the transplants may die. In the nursery protection may be easily obtained by raising the seedlings in pots/polythene bags using soil fumigated with methyl bromide @ 500 g/100 cu. ft. under polythene cover for 24–48 hrs. This is a standard practice in all government pepper nurseries in Kerala (1).

Table 1 — Occurrence and population density of nematodes in association with cocoa in India.

Genera	Number of occurrence in 88 samples	Population range in 250 g soil
Aphelenchus sp.	2	3–5
Criconemoides sp.	4	3–114
Diphtherophora sp.	1	14
Helicotylenchus sp.	22	2–321
Hemicriconemoides sp.	2	5–15
Hoplolaimus sp.	22	2–166
Longidorus sp.	7	1–3
Meloidogyne sp.	27	7–2341
Mononchus sp.	9	1–41
Pratylenchus sp.	1	3
Radopholus similis	9	1–8
Rotylenchulus sp.	11	32–1213
Trichodorus sp.	3	1–3
Tylenchorhynchus sp.	17	7–440
Xiphinema sp.	11	1–76

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Cocoa Abstracts

COCOA ABSTRACTS: These abstracts are reprinted from "Abstracts on Tropical Agriculture" published by the Royal Tropical Institute, Amsterdam.

January 1979

(Insects associated with cacao trees in the coastal zone of Sao Paulo State) Insetos associados ao cacaueiro no litoral do Estado de Sao Paulo BOVI, O.A.; CORAL, F.J.; PARRA, J.R.P. Seçao de Plantas Tropicais, Instituto Agronomico, Campinas, Sao Paulo, Brazil — *Bragantia (Brazil)* v. 36 p. XV-XVIII; Jun 1977

Thirty-nine pests of cocoa trees belonging to 16 families are listed.

February 1979

(The swollen shoot disease of the cocoa tree in Togo. Preliminary inventory and first estimate of the losses caused by this disease) Le "swollen shoot" du cacaoyer au Togo. Inventaire préliminaire et première estimation des pertes causées par la maladie PARTIOT, M.; DJIEKPOR, E.K.; AMEFIA, Y.K.; BAKAR, K.A. Centre de Recherches, Institut Français du Cafe et du Cacao (IFCC), Kpalime, Togo — *Café, Cacao, Thé (France)* v. 22(3) p. 217-228; Jul 1978.

In this study, the presence of several types of virus diseases of different aspects and aggressiveness, has been revealed. The most serious form is seen by the swelling of the twigs and the appearance of characteristic mosaic patterns on the leaves of the cacao tree (Theobroma cacao). It affects 21% of the plantations in the country. The question of the origin of the Togo virus is raised in connection with the study of the ecological factors. Further study and the examination of atypical forms of the disease, in order to make it possible to achieve a more effective control of it, are needed.

(Agriculture for export and the struggle for development in tropical Africa. The economy of cacao) L'économie du cacao. Agriculture d'exportation et bataille du développement en Afrique tropicale ASSOUMOU, J. — Editions Universitaires. Jean-Pierre Delarge Paris (France) 351 p. 1977.

With the help of a detailed analysis of the economy of cacao (Theobroma cacao), and taking that as a model, thoughts are developed on the deficiency of dynamics of tropical economies, especially in Africa, resulting from lack of organisation aiming at growth. This situation is then enhanced from the outside by industrial countries and their dominating marketing economies, and from the inside by the difficulties of taking measures necessary for development. It is concluded that underdevelopment is not a fatality, but that the will to develop must be there.

The breeding of cacao (Theobroma cacao L.) SORIA, V.J. Department of Tropical Crops and Soils, Tropical Agricultural Research and Training Center (CATIE), Turrialba, Costa Rica – *Symposium on methods of crop breeding (Tropical Agriculture Research Series (Japan))* Ministry of Agriculture and Forestry Yatabe, Ibaraki (Japan) no. 11, p. 161-168; Mar 1978.

Cacao is native to extensive areas of the humid lowlands of Tropical America. Breeding for higher production, disease and pest resistance, and better quality is discussed in this paper from Costa Rica. Included are variability and genetics of the most important characteristics, yield and yield components, incompatabilities, heterosis, individual tree selection for clones, and sexual progeny selection, among other things.

Some factors affecting fat content in cacao beans (Theobroma cacao L.), with emphasis on the effect of the pollinator parent BEEK, M.A.; ESKES, A.B.; TOXOPEUS, H. Centro Melhoramento de Trigo, Empresa Basileira de Pesquisa Agropecuaria (EMBRAPA), Passo Fundo, Rio Grande do Sul, Brazil – *Turrialba (IICA)* v. 27(4) p. 327-332; Oct 1977.

The beans resulting from 2 pollination experiments were used for the study of some sources of variation on the fat content of cacao beans. No significant differences between trees of the same clone were found. A positive and significant correlation ($r = 0.56$ to 0.66) between bean weight and fat content existed within the bean populations as a total for female clones. For individual bean measurements, however, this correlation was low and often insignificant. Absolute differences in fat content of individual beans within a cross or even within one fruit could be as high as 8 per cent. Female and male parents both affected significantly the fat content of the beans. Also the fat determinations on individual beans showed considerable differences in variation of fat content between crosses, the reciprocals of which always showed the same magnitude of variation. So it would seem, that the genotype of the zygote may be a main factor in determining its fat content. Authors' summary.

Megaceresium horni (Heller), a new longicorn stem borer of cocoa in the British Solomon Islands FRIEND, D; MACFARLANE, R. Agricultural Department, Honiara, British Solomon Islands – *PANS. Pest Articles and News Summaries (UK)* v. 20(2) p. 203-207; Jun 1974.

The longicorn stem borer, a new pest of cacao (Theobroma cacao), has been described. The larvae of the beetle cause severe damage to branches by tunneling through the pith and sapwood; one larva may kill up to 3 m of branch in 4-6 weeks. In the outbreak reported, up to 5 branches per tree were infested on 58 per cent of the trees. An intensive campaign of pruning and burning infested branches at 3-4 day intervals for 1 month, followed by pruning at 2 weekly intervals for 3 months, reduced the level of infestation from over 100 larvae per 100 trees to 2 per 100.

A virus of the cocoa swollen shoot group infecting cocoa in North Sumatra KENTEN, R.H.; WOODS, R.D. Rothamsted Experimental Station, Harpenden, Hertfordshire, UK – *PANS, Pest Articles and News Summaries (UK)* v. 22(4) p. 488-490; Dec 1976.

The disease of cacao (Theobroma cacao) examined causes leaf symptoms ranging from a clearing of the major veins to a more complex mosaic pattern. It is transmitted by grafting and by the mealy bug (Planococcus citri). Bacilliform particles similar in size and shape to those of cacao swollen shoot virus were found in preparations from diseased leaves. This suggests that the disease is induced by infection with a virus of the cacao swollen shoot group.

Research on cocoa diseases in Ecuador: Past and present EVANS, H.C.; EDWARDS, D.F.; RODRIGUEZ, M. Pichilingue Research Station, Instituto Nacional de Investigaciones Agropecuarias, Quevedo, Ecuador – *PANS. Pest Articles and News Summaries (UK)* v. 23(1) p. 68-80; Mar 1977.

The history and importance of cacao (Theobroma cacao) diseases in Ecuador are discussed and the biology of the two more important pathogens is described. Chemical methods offer few prospects for economic control. Cultural control appears ineffective in reducing infection by Crinipellis perniciosa (witches' broom) but there are possibilities of a partial control of Monilia roreri (Monilia pod rot) by cultural methods. Manipulation of the crop to escape infection has shown promise in reducing pod losses from both diseases. Authors' summary.

Cocoa, tea and coffee ASHBY, H.K. – *World Resources Series (UK)* Priory Press Ltd. Hove, Sussex (UK) 88 p. 1977.

This book provides information on the growth requirements of cacao, tea and coffee, where the crops are grown in the world, production and the history of its cultivation. It also shows how each crop is grown, cared for and harvested, including how the plants are protected from pests, diseases and bad weather. It describes how each crop is processed and prepared for sale on the world-wide commodity markets and in shops.

(Determination of the genotypes of incompatibility or compatibility in various clones of cacao (Theobroma cacao L.)) Determinación de los genotipos de incompatibilidad o compatibilidad en varios clones de cacao (Theobroma L.) TERREROS S.J.R.; CHAVARRO B, G.T.; OCAMPO R.F. – *Acta Agronomica (Colombia)* v. 26(3-4) p. 70-75; Aug 1976.

This article describes a study on incompatibility in 15 clones of cacao.

(The world cacao market) Le marché mondial du cacao HAEGEN, P. VAN DER – *3. Congrès des économistes belges de langue française. (Etudes & Expansion (Belgium))* v. 77(277) p. 519-535; Jul 1978.

After having briefly reviewed the growing of cacao, the author discusses production and export by country. The importing countries, the consumption of cacao products, methods of buying, activities of some principal cacao processing industries, evolution of prices and international agreements are reviewed.

April 1979

Cocoa flower Diptera; their identity, pollinating activity and breeding sites WINDER, J.A. Division of Entomology, CSIRO, Curitiba, Parana, Brazil – *PANS. Pest Articles and News Summaries (UK)* v. 24(1) p. 5-18; Mar 1978.

The Diptera associated with cocoa flowers throughout the world, their pollinating activity and known breeding sites are reviewed, and the disadvantages of using cages for assessing pollinating potential are discussed. Author's summary.

Tapinanthus bangwensis in a cola plantation in Ghana CLERK, G.C. Department of Botany, University of Ghana, Legon, Ghana – *PANS. Pest Articles and News Summaries (UK)* v. 24(1) p. 57-62; Mar 1978.

An investigation has been made into the infestation of a 16-year old kola (Cola nitida) plantation by the mistletoe, Tapinanthus bangwensis (Fam. Loranthaceae) at the Agricultural Research Station at Kade in Ghana. Eighty-four per cent of the kola trees were attacked by the mistletoe, the dispersion of which appeared to be contagious rather than random. The parasite commonly developed on the thinner portions of the host branches and the presence of more than 25 shrubs caused death of the host plant. Control of T. bangwensis by removal of the parasitised portions of branches of the kola trees is recommended. Author's summary.

Black pod and canker of cocoa FIRMAN, J.D. South Pacific Commission (SPC), Noumea, New Caledonia – *Advisory Leaflet (SPC)* SPC Noumea (New Caledonia) no. 7, 3 p. 1978.

Black pod and canker of cacao are caused by Phytophthora palmivora, occurring wherever the crop is grown in the South Pacific region. Symptoms of the diseases, pathological aspects and control measures by removal of diseased pods and chemical control are discussed. Copper fungicides are commonly used for black pod control, applying 1120 g Cu in 560 l of spray liquid/ha. If a motorised knapsack blower is used, a concentration of 25 g Cu/l at the rate of 67 l/ha (1675 g Cu/ha) is applied. In addition the planting of resistant varieties, such as Amelonado, is recommended.

(The present state of Brazilian cacao growing) Situaçao actual da cacauicultura no Brasil – Departamento de Extensao, Plano de Recuperaçao Economico – Rural da Lavoura Cacaueira (CEPLAC), Itabuna, Bahia, Brazil – *Cacau Atualidades (Brazil)* v. 14(3) p. 10-21; Jul 1977.

The history of cacao growing since 1770 is traced. The State of Bahia is by far the largest producer, attaining 94.5 per cent of the total Brazilian production.

May 1979

(Methoxy-triazine as pre-emergent herbicide in young cacao) Methoxy-triazine sebagai herbisida pra-tumbuh pada tanaman cokelat muda NASUTI, U.; BASUKI Rubber Research Center, Tanjung Morawa, Indonesia – *Menara Perkebunan (Indonesia)* v. 45(1) p. 31-34; Feb 1977.

A field trial to test the efficacy of methoxy-triazine (terbumeton) herbicide for controlling general weeds in young cacao stands was carried out on the Silau Dunia estate (P.T. Perkebunan IV), in North Sumatra. The results prove that methoxy-triazine at the dosage of 2-2.5 kg in 500 litres of water per hectare, sprayed as a pre-emergent herbicide along the planting rows, suppresses regrowth of weeds effectively for 5-6 months without having any deleterious effect on young cacao trees. The cost of chemical weeding with methoxy-triazine is lower than that of manual weeding. Authors' summary.

June 1979

Stability, export taxation, and economic development: The role of cocoa marketing boards and cocoa stabilisation funds in Nigeria, Ghana, Ivory Coast and Cameroon. Thesis Ph.D. Univ. of Wisconsin NZEKIO, E.P. — University Microfilms Ann Arbor, Michigan (USA) 319 p. 1973.

This study is a theoretical and empirical investigation of the effect of commodity price stabilisation policies on relevant economic variables, with special attention given to the consequences of cocoa price stabilisation efforts in Nigeria, Ghana, Ivory Coast and Cameroon. Welfare implications, cocoa producer response under uncertainty, export tax and economic development, with possible alternatives, are discussed.

July 1979

International Cocoa Agreement 1975 KHAN, K.R. Department of Public International Law, University of Edinburgh, Edinburgh, Scotland, UK — *Food Policy (UK)* v. 4(1) p. 15-25 1979.

An analysis is made of the regulation of the world cocoa market by the International Cocoa Agreement of 1975. The agreement is considered from a legal perspective. It is examined as an instrument of economic regulation, as a tool for achieving the goals of the new international economic order and as an example of reciprocity between exporting and importing countries.

Yield of cocoa farms with and without fungicide spray to control black pod disease VERNON, A.J. Research Div., Department of Agriculture, Suva, Fiji — *Fiji Agricultural Journal (Fiji)* v. 39(2) p. 111; Jul 1977.

Results of a simple 4-site trial confirmed that copper fungicide (Perenox — cuprous oxide) spraying gives a useful degree of control of black pod disease in terms of percentage loss to black pod disease or increase in yield per hectare. The yield levels of pure West African Amelonado cacao on sandy-clay loam alluvial soil at two of the three smallholder farms were very high (over 2000 kg/ha), when the black pod disease was properly controlled.

(Effect of farm yard and phosphate manures on bulk cocoa (Upper Amazon hybrids)) Pengaruh pupuk kandang dan fosfat pada tanaman coklat bulk (Upper Amazon hybrids) POELOENGAN, Z. — *Bulletin Balai Penelitian, Perkebunan Medan (Indonesia)* v. 9(1) p. 4 (summary), 21-28; Mar 1978.

An experiment to study the effect of farmyard and phosphate manures on young cacao growing on yellowish red podzolic soil was conducted at

Adolina. The results on the weight per pod, the total pod production and the weight of dry beans per tree are reported here. It seemed that the total pod production and the weight of beans per tree were affected by the farmyard manuring, but not so with the weight per pod. The interaction effect between the farmyard and phosphate manures was not seen and this awaits further observation. Author's summary.

August 1979

Cacao canker caused by Phytophthora palmivora MOHANAN, R.C. Regional Station, Central Plantation Crops Research Inst., Vittal, Karnataka, India – *Plant Disease Reporter (USA)* v. 62(12) p. 1080-1082; Dec 1978.

A severe canker on the trunk and branches of Criollo and Forestero cacao (Theobroma cacao) varieties, and subsequent die-back of affected plants or branches, were observed in India. Phytophthora palmivora was consistently isolated from the cankered portion. Pathogenicity experiments proved that this fungus is the causal organism of the disease. Symptoms of the disease are described. This is the first report of canker of cacao in India. Author's summary.

Cocoa bean processing – a review ONG KHENG HOI Divison of Agriculture, Ministry of Agriculture and Rural Development, Selangor, Malaysia – *Malaysian Agricultural Journal (Malaysia)* v. 50(2) p. 229-247; Dec 1975.

This paper reviews some aspects of work carried on cocoa bean processing. Information on the subject is scant and often contradictory. The best possible operating conditions, involving the controlling factors temperature, airflow, bean depth and agitation, should form a compromise between the minimum capital cost, reduced drying cost and time, and quality.

(Cacao. in Africa and in Bahia) Cacau: na Africa como na Bahia OLIVEIRA, E. Plano de Recuperaçao Economico-Rural da Lavoura Cacaueira (CEPLAC), Ilheus, Bahia, Brazil – *Cacau Atualidades (Brazil)* v. 14(2) p. 2-7; Apr 1977.

With the emphasis on farm size, credit, research, extension and marketing, this article compares cacao production in Bahia with that in Francophone Africa.

(The most important pests of cacao in the state of Pará) Principais pragas do cacaueiro no Eestado do Ppará COSTA, A. DA S. CEPLAC/SEBE, Belem, Brazil – *Cacau Atualidades (Brazil)* v. 14(4) p. 13-24; Dec 1977.

In 1972 an inventory was made of the occurrence of the major cacao pests in the State of Pará, Brazil (6000 ha in 1971). These are: Peosina mexicana, Sylepta prorrogata, Selenothrips rubrocinctus, Maecolaspis ornata, Taimbezinha theobromae, Colaspis aeruginosa, Costalimaite ferrunea, Plectrophorus incertus, Euchroma gigantea, Azteca chartifex, A. peraensis bondari, Solenopsisi sp., Atta sexdens, A. cephalotes, Acromyrmax sp. Trigona Monalonion sp., Homoptera, Arp. Tetranychus mexicanus and Ephestia cautella. Recommendations for their control are also given.

(The occurrence of abnormal trees in a budded cacao orchard. 2) Sebab-sebab terjadinya tanaman abnormal pada kebun cokelat berasal dari okulasi. 2 SOENARYO Balai Penelitian Perkebunan Bogor, Bogor, Indonesia — *Menara Perkebunan (Indonesia)* v. 45(4) p. 175-182; Aug 1977.

This paper gives an explanation why different results were obtained in an experiment on the influence of budwood length on the main stem of the budding which was repeated at different times of the year. The weather conditions, including duration of sunshine seemed to have an influence too on the length of the stem of the buddings.

September 1979

The North American species of Forcipomyia, subgenus Euprojoannisia (Diptera: Ceratopogonidae) BYSTRAK, P.G.; WIRTH, W.W. Plant Protection Section, Maryland Dept. of Agriculture, Annapolis, Maryland, USA — *Technical Bulletin — USDA (USA)* USDA, Science and Education Administration Washington, D.C. (USA) no. 1591, 55 p; Dec 1978.

Six species are described as new — canadensis, dowi, fuscicalcarata, navaiae, pechumani and unica. Forcipomyia turfacea Kieffer 1925 is synonymized with F. hirtipennis (Malloch, 1915) (New synonymy). Larvae of Euprojoannisia species are usually found in semiaquatic habitats, such as algae-covered rocks or mud, wet moss or leaves, mats of decaying aquatic vegetation, and leaf axils of water-holding plants.

(Influence of pollination hazards on the yields of the cocoa tree. Mathematical model and simulation) Influence des aléas de la pollinisation sur les rendements de cacaoyer. Modèle mathématique et simulation REFFYE, P. DE; PARVAIS, J.P.; MOSSU, G.; LUCAS, P. Centre de Recherches, Institut Français du Café et du cacao (IFCC), Bingerville, Ivory Coast — *Café, Cacao, Thé (France)* v. 22(4) p. 251-274; Oct 1978.

Mathematical modelling techniques enable the reconstitution of the statistical repartition of the number of beans per pod in the cacao crop. This study led to the identification of three important breeding criteria, viz. fertility, number of ovules per ovary, and wilting point. Once these characteristics have been fixed yield depends only on pollination quality.

(The possibilities of improving techniques of pod breaking and fermentation in the traditional process for the preparation of cocoa.) Les possibilités d'amélioration des techniques d'écabossage et de fermentation dans le processus artisanal de la préparation du cacao GRIMALDI, J. Société de Développement du Cacao (SODECAO), Yaoundé, Cameroon — *Café, Cacao, Thé (France)* v. 22(4) p. 303-316; Oct 1978.

The author gives a detailed description of the construction and mode of operation of a cocoa pod breaker, a mucilage remover, and a fermentation box for the small-scale preparation of cocoa.

Insecticide residues and tainting in cocoa OWUSU MANU, E. Cocoa Research Inst., New Tafo, Ghana — *Pesticide management and insecticide resistance* Academic Press New York (USA) p. 555-564 1977.

This paper reviews the study of residues and tainting in cacao that may result from the use of insecticides to control cacao pests. The standard method for testing residues is to spray plots of Amelonado and hybrid cacao twice or 4 times at 28-day intervals with double the recommended effective dosage of the insecticide. Pods (including beans) are harvested 1, 7, 14, 21, 28 and 56 days after the last treatment for residue analysis. Since 1962 about 10 insecticides have been tested for residues, and the results are listed. Residues in whole beans, nibs and shells, contamination of cacao beans, tainting and alternative methods of pest control are discussed.

Insecticides against larvae of the cacao webworm Pansepta teleturga Meyrick (Lepidoptera : Xyloryctidae) BAILEY, P.T.; O'SULLIVAN, D.F. Lowlands Agricultural Experiment Station, Keravat, New Britain, Papua New Guinea — *Papua New Guinea Agricultural Journal (Papua New Guinea)* v. 29(4) p. 27-31; Dec 1978.

Thirty-five insecticides were screened for effectiveness against larvae of Pansepta teleturga, a wood borer in cacao trees. Several of the more promising insecticides were selected for field trials, using 1 or 2 of 3 methods of application : (1) spraying onto the web. (2) application of systemic insecticides to the bark, and (3) swabbing a dilute solution onto the feeding area. Swabbing was the only effective method. Endrin, azinphos-ethyl and dimethoate were the most effective insecticides when swabbed. Dimethoate is recommended because of its comparatively low mammalian toxicity. Authors' summary.

(Preliminary study on cocoa jelly standardisation) Estudo preliminar sobre a padroniza cao da geléia de cacau BORGES, J.M.; GOMES, F.R.; PEREIRA, V. DE P. Divisao de Bioengenharia (DIBIO), Centro de Pesquisas do Cacau (CEPEC), Itabuna, Bahia, Brazil — *Revista Theobroma (Brazil)* v. 8(1) p. 3-20 Jan 1978.

Cocoa jelly, a traditional product of the cocoa region of the State of Bahia, Brazil, is prepared from the sweatings of cocoa by a process which is not yet standardized. Standardizing will be essential for commercialization purposes. The results are discussed of a study to prepare cocoa jelly with characteristics that would meet acceptable production requirements, and would serve as a standard for future reference.

Technical consultation on agricultural extension methods and techniques for cocoa. Itabuna/Ilheus, Bahia, Brazil. 2-7 May 1977 ANON. Cadbury Schweppes Limited Bournville, Birmingham (UK) 51 p. 197?

This report presents summaries of the case studies presented at the Technical Consultation on Agricultural Extension Methods and Techniques for Cocoa held in 1977, and of the discussions and recommendations. The latter include training programmes for farmers and extension workers, links between research and extension, transfer of knowledge and managerial capability of farmers.

Fungicide application together with cultural practices to control cocoa diseases in Ecuador CRONSHAW, D.K. Instituto Nacional de Investigaciones Agropecuarias, Pichilingue, Ecuador — *Tropical Agriculture (Trinidad and Tobago)* v. 56(2) p. 165-170; Apr 1979.

Three fungal pathogens: Crinipellis perniciosa, Monilia roreri and Phytophthora palmivora inflict severe losses on cocoa production in Ecuador. In the present study it was shown that five protectant fungicides applied weekly to trees previously hand pollinated on the lower part of the trunk gave good control of all three pathogens. This combination of chemical control and cultural practice is simple and can provide an economic means of reducing losses until plants more resistant to the principal disease (witches' broom) can be made available. Author's summary.

Mutation breeding against black pod (Phytophthora pod rot) disease of cacao (Theobroma cacao) OPEKE, L.K. Department of Plant Science, University of Ife, Ife, Nigeria — *Induced mutations against plant diseases. Proceedings of a symposium, Vienna. 31 Jan. - 4 Feb. 1977* International Atomic Energy Agency (IAEA) Vienna (Austria) p. 241-246; Jul 1977.

In Nigeria, seeds and vegetative buds of 2 cacao cultivars — F3 Amazon and N38 — were irradiated at various gamma ray dose rates from a ^{60}Co source. After the seedlings had recovered from the radiation shock (about 6 weeks), the leaves of all surviving irradiated materials and control were sprayed in the nursery with a sporangial suspension of Phytophthora palmivora. Transplanting into the field occurred 4 months after sowing/planting, and after about 1 year all plants were sprayed again with a sporangial suspension of P. palmivora. The results showed that some young irradiated plants became resistant to this disease, but not the mature irradiated plants.

Breeding places and sites of collection of adults of Forcipomyia spp. midges (Diptera, Ceratopogonidae) in cacao plantations in Bahia, Brazil: a progress report SORIA, S. DE J.; WIRTH, W.W.; BESEMER, H.A. Divisao de Zoologia Agricola, Centro de Pesquisas do Cacao (CEPEC), Itabuna, Bahia. Brazil — *Revista Theobroma (Brazil)* v. 8(1) p. 21-29; Jan 1978.

There is evidence that midges in the subgenus Forcipomyia (Euprojoannisia) are the main pollinators of cacao in the State of Bahia, Brazil. Results of a study show that rotten cacao fruits are a breeding place for F. genualis, other species of the same subgenus and species of the F. (Microhelea) fuliginosa group. Rotten banana stems are a special breeding place for F. poulaineae, Dasyhelea borgmeieri and F. (E.) spatulifera. Sugar-cane leaf axils are a breeding place for F. (Warmkea) spinosa and for F. (F.) argenteola. Other breeding places are used by F. (Euprojoannisia). The number of adults on the cacao tree can be determined only by the examination of flowers.

(Responses of cacao to nitrogen, phosphorus and potassium fertilizers in Bahia, Brazil) Respostas do cacaueiro ao nitrogeênio, fósforo e potassio em solos da regiao cacaueira da Bahia, Brasil MORAIS, F.I.; SANTANA, C.J.L. DE; CHEPOTE, R.E. Divisao de Geociências, Centro de Pesquisas do Cacau (CEPEC), Itabuna, Bahia, Brazil — *Revista Theobroma (Brazil)* v. 8(1) p. 31-41; Jan 1978.

Fertilizer trials with cacao of the Catongo variety in the State of Bahia, Brazil, showed that cacao responded mainly to P. There was also a positive interaction of NxP. K was not effective, probably due to rapid leaching. Liming of the soils was effective for three years. P. fertilizer was most effective at a rate of 90 kg/ha. Production increases intensified after three years of fertilizing.

(The effect of mulching and NPMg fertilizers on cocoa (Theobroma cacao L.)) Pengaruh serasah dan pemupukan N P Mg pada tanaman coklat (Theobroma cacao L.) POELOENGAN, Z. – *Bulletin Balai Penelitian Perkebunan Medan (Indonesia)* v. 9(3) p. 96, 109-114; Sep 1978.

Results for the first two years are given for a 4 year term experiment concerning the effects of mulching (with Guatemala grass) and various levels of N, P and Mg fertilizers on initially 4 year old trees growing on a reddish brown podzolic soil in Balimbingan Estate, North Sumatra. Mulching significantly increased the total number of pods and the weight of dry beans/tree/year, but not the weight of beans/pod. Nitrogen and Mg did not have any significant effect on these production parameters. Phosphorus, however, at 60 g P_2O_5/tree/year compared with no phosphorus application, increased the weight of dry beans/tree/year by about 7 per cent, but did not change the weight of beans/pod and the total pods/tree/year. Author's summary.

October 1979

Coconut intercropping systems in Peninsular Malaysia DENAMANY, G.; MD SHARIF BIN AHMAD; NASRUN BIN BAGINDA HAMID Malaysian Agriculture Research and Development Inst., Serdang, Selangor, Malaysia – *Oléagineux (France)* v. 34(1) p. 7-15; Jan 1979.

Intercropping trials in coconut plantations in Malaysia showed that the combination with cacao gives the highest income, followed by pineapple, coffee and banana. Vegetables such as cauliflower, cabbage, tomato and shallots gave a higher gross income but are also more labour-intensive. Possibilities of intercropping on various soils and under various climatic conditions in Malaysia are discussed.

(Diploidized haploids and production of fertile homozygous genotypes in cultivated cacao trees (Theobroma cacao)) Haploïdes diploïdisés et obtention de génotypes homozygotes fertiles chez les cacaoyers cultivés (Theobroma cacao) DUBLIN, P. – *Café, Cacao, Thé (France)* v. 22(4) p. 275-284; Oct 1978.

The improvement of cacao trees in Africa is based on the exploitations of the heterosis appearing when Amelonado or Trinitario are crossed with Upper Amazonian cacao. Amazonian hybrids commonly used are, however, very heterogeneous. This problem can be overcome by the identification of haploid seedlings and their subsequent diploidization. The author reviews the work done on this subject in the Ivory Coast since 1972.

(Infestation control trials and anti-mirid treatments) Tests de contrôle d'infestation et traitements anti-mirides DECAZY, B.; ESSONO, B. Station agronomique Nkolbisson, Institut de Recherches Agricoles et Forestères (IRAF), Yaoundé, Cameroon – *Café, Cacao, Thé (France)* v. 23(1) p. 35-42; Jan 1979.

The Cameroon Cacao Development Organization has developed a highly satisfactory method for the control of capsids (Sahlbergella singularis and Distantiella theobromae) which consists of chemical treatment after insect counts have shown the need for it. Experiments described in the present paper show that the method can be improved by spraying all fields in July-August possibly followed by a second spray if capsid populations have increased above a newly defined level.

(Fertilizer experimental work in Cameroon. The fertilizing of stimulant plants) Expérimentation d'engrais au Cameroun. Fertilisation des plantes stimulantes MBONDJI, M. Stimulant Plants Division, Institute of Perennial Crops, Ekona, Cameroon – *Rap. Sém. FAO/NORAD ... Dév... Emploi... Engrais... Cameroun... Déc... 1975* FAO Rome (Italy) p. 54-62; Dec 1976.

Field trials with coffee, tea and cacao showed good responses to fertilizer dressings. For robusta coffee, applications range from 300-400 kg $N:P_2O_5:K_2O$ fertilizer (20-10-15 or 20-10-10) per ha. For arabica coffee, 300-500 kg sulphate of ammonia (21 per cent N) per ha is adequate. For cacao, dressings of 50 kg K_2O, 125 kg MgO and 665 kg CaO/ha are proposed. Tea received 1200-1500 kg sulphate of ammonia per ha as an economic dose, before recent price increases.

Crop protection in cocoa in Malaysia MAINSTONE, B.J. Dunlop Research Centre, Batang Melaka, Negri Sembilan, Malaysia – *Planter (Malaysia)* v. 54(631) p. 643-658; Oct 1978.

Cacao is relatively new as a large-scale crop in Malaysia. It is affected by various diseases and pests which may flare up or cause steady loss. Agricultural factors markedly influence evidence, and the need for control techniques to be integrated with general cultivation practice is stressed. Appropriate agronomy is the main route to disease control; insecticides are sometimes essential, but there are serious dangers in their indiscriminate use; rodent pests can sometimes totally destroy the harvest. It is vital to avoid the import of further diseases and pests. Author's summary.

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