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Editorial

Once again we apologise to our readers for the fact that a year has passed since the last issue, number 21. We hope the next issue will appear in six months' time.

Aid to Cocoa Research

We are glad to publish an article from the U.K. Government's Ministry of Overseas Development on the aid it is providing for cocoa research. We believe that many, if not most, readers of the *Cocoa Growers' Bulletin* will be surprised to learn of the extent of this aid. No less than ten cocoa growing countries are being helped, some with a team of specialists others with a single expert.

Many of the aid projects are concerned with diseases which reflects the extent of losses they cause to the crop, losses once estimated at nearly 30 per cent. As usual research on black pod, which has been mentioned frequently in these editorials, forms part of the programme in several countries. This attack on disease is of great importance. While there is much knowledge on *Phytophthora palmivora*, which has been assembled in a book reviewed in this issue, control is costly and only partially effective and selections resistant to the disease have still to be found, but there are other diseases, Monilia in particular, on which there is little basic knowledge and hence no control at all.

It is hoped that the U.K. Government will continue its aid for cocoa research at least at the current level but as the article states "aid can only be provided where there is the necessary expertise". Research workers in specialist sciences will presumably be forthcoming for worthwhile projects but general expertise in cocoa cultivation may become harder to find. At present there are a few ex-members of Agricultural Departments and one or two others with wide experience, but they will disappear. Where will be found men with an understanding and experience of cocoa growing under a wide range of conditions?

G. A. R. WOOD

Review of Production and Consumption

February 1975

A. B. Cook, Cadbury Schweppes Limited

Production

The latest Gill & Duffus forecast of 1974/75 production predicts a world total of 1,433,000 long tons, an increase of 11,000 tons above the estimated final 1973/4 figure of 1,422,000 long tons and 60,000 tons above the 1972/3 total of 1,373,000 tons.

The principal changes from last season are in Brazil and Ghana. In Brazil the main crop is expected to reach 1·6 million bags, well down on last year's record of just under 2·4 million bags, but still a good out turn when compared with any year before the last two. Prospects for the coming temporao crop are encouraging and an out turn of 1·9 million bags is forecast, compared with the average of recent years of 1·45 million bags. This would give a total for the year of 3·5 million bags, 0·4 million bags or 24,000 tons down on last year's record level.

In Ghana prospects are better than last year, with purchase figures well above the figures at the corresponding dates last year. An increase of 30–40,000 tons is expected.

Production in Nigeria, Ivory Coast and Cameroon is expected to be very similar to last year.

Latest available purchase figures in the West African countries compared with figures at the corresponding dates last year were:

	1974/75	1973/74
Ghana 13th February	351,762 tons	328,740 tons
Nigeria 16th January	157,151 tons	145,726 tons
Ivory Coast 14th February	*192,000 tons	184,435 tons
Cameroon 15th February	76,026 tons	71,694 tons

*estimated

Consumption

World consumption in 1975 is forecast by Gill & Duffus at 1,380,000 tons, a decrease of 52,000 tons from the estimated final 1974 figure of 1,432,000 tons which was itself 111,000 tons below the final 1973 figure. It is clear that the high prices which have prevailed since early 1973 have had a severe effect on consumption.

Stocks

The net deficit in 1974 was finally only 24,000 tons. The improvement from the estimate of 43,000 tons made in February 1974 by Gill & Duffus was principally due to consumption falling off rather more rapidly than expected.

Gill & Duffus are predicting a net surplus in the 1974/75 season of 46,000 tons. This would leave the end of season stocks at 331,000 tons (2·9 months usage) compared with 285,000 tons (2·4 months usage) at the end of the 1973/74 season. In spite of the slight improvement this level is still exceptionally low.

WORLD COCOA PRODUCTION AND GRINDING DATA

Reproduced from Gill & Duffus Market Report
Dated 18th February 1975

(Thousand long tons)

Production

	1972/73	1973/74 (Estimate)	1974/75 (Forecast)
Africa	1,014	936	968
America	280	390	367
West Indies	41	43	41
Asia and Oceania	38	53	57
World Total	1,373	1,422	1,433
Principal Countries			
Ghana	411	343	380
Nigeria	237	212	200
Ivory Coast	178	206	212
Cameroon	105	107	108
Equatorial Guinea	10	12	12
Brazil	159	242	225
Ecudor	42	70	60
Dominican Republic	28	30	28
Venezuela	16	15	15
Colombia	23	23	25
Mexico	30	28	30
New Guinea	22	31	34

Grindings

	1973	1974 (Estimate)	1975 (Forecast)
Western Europe	584	535	488
Eastern Europe and U.S.S.R. ..	245	245	245
North America	292	241	214
Central and South America ..	196	204	203
Australia and New Zealand ..	19	18	19
Asia	68	53	47
Africa	139	146	169
World Total	1,543	1,432	1,380
Principal Countries			
United States	274	226	200
Germany (Federal Republic) ..	150	136	125
Netherlands	121	113	110
United Kingdom	105	92	82
U.S.S.R.	132	138	138
France	47	37	34
NOMINAL BALANCE .. (after allowing for 1% loss in weight)	—184	—24	+42

Prices

Month end prices for nearby Ghana shipment cocoa have been:

1974	February	£ 687·0/metric ton
	March	£1,020·0/metric ton
	April	£1,195·0/metric ton
	May	£1,004·0/metric ton
	June	£1,018·0/metric ton
	July	£1,050·0/metric ton
	August	£1,050·0/metric ton
	September	£ 850·0/metric ton
	October	£ 940·0/metric ton
	November	£ 815·0/metric ton
	December	£ 740·0/metric ton
1975	January	£ 755·0/metric ton

It can be seen that with world stocks already at very low levels, the small 1974 deficit had a significant effect on prices, with nearby and afloat cocoa at substantial premiums. The prospect of a slight improvement in the supply situation in 1975 has already led to an easing in prices but levels remain historically very high.

British Government Aid to Cocoa Research

R. W. Smith, Assistant Agricultural Research Adviser, Ministry of Overseas Development

The U.K. Government provides aid for agricultural research to help developing countries through its Ministry of Overseas Development (ODM). Aid is provided in various ways of which the following are the most important:

1. Projects, aimed at solving specific problems and fulfilling certain criteria, financed from special central research funds. The main criterion for the use of these funds is that the objectives must be the discovery of new knowledge or new techniques which are directly related to developing country needs and capable of reasonably quick practical application and preferably of wide geographical relevance. Projects can be mounted overseas in developing countries only at the request of the Government concerned. Projects are also mounted in the United Kingdom in certain circumstances.
2. Aid for national research programmes in developing countries can be provided under the ODM's various schemes of geographical technical assistance. Recipient Governments can, for example, be provided with technical assistance personnel to undertake specific research duties, at the same time training local counterparts to continue the work after the departure of the British personnel.
3. British scientists can be provided to occupy 'cadre' staff positions in local governments or research institutions. The local salaries of such officers can be supplemented, and other allowances paid to them, as a form of aid.
4. By providing short-term consultancy and advisory visits by British scientists to overseas departments or institutions.
5. By providing training for scientists from overseas, in existing British institutions.

In addition Britain provides support for international research including International Institutes such as the International Rice Research Institute in the Phillipines and the International Institute of Tropical Agriculture in Nigeria. These come under the aegis of the Consultative Group for International Agricultural Research of which Britain is a member.

In recent years aid for cocoa research has been, or is being, provided to many countries in each of the above categories. Aid can only be provided if the necessary expertise is available and expertise in cocoa resulted from overseas service during the Colonial period, when Britain was largely responsible for establishing cocoa research and development organisations in countries where cocoa was a major crop. There is also much knowledge of cocoa among the British chocolate manufacturers, particularly with those companies which were involved in the buying of the cocoa crop in tropical countries.

1. Cocoa research in West Africa

(a) *Ghana*

One of the main cocoa research centres in West Africa is the Cocoa Research Institute of Ghana (CRIG), which evolved from the earlier West African Cocoa Research Institute (WACRI).

Cocoa swollen shoot virus (CSSV) continues to be the main biological problem facing cocoa in West Africa, and Britain is currently financing a research project at CRIG which is aimed at breeding varieties of cocoa resistant to this disease. The new varieties must be acceptable in other respects both to farmers and manufacturers. The research team therefore consists not only of plant breeders and virologists but of scientists working on the associated agronomic, mycological, entomological and physiological problems. Varietal tolerance to virus infection was shown by earlier work to be very sensitive to environmental conditions, but the early field trials on resistance were quite encouraging in that the natural spread of CSSV has been considerably slower than would normally be expected in Amelonado. The first phase of the project was used to locate suitable Upper Amazon male parents for substitution in the existing series 2 hybrid seed gardens. Substitution became a feasible objective once the plant breeders had demonstrated the practicality of hand pollination for pod production in seed gardens. Potential male parents are being screened for suitability and are being planted in proximity to their respective seed gardens, so that any hybrids chosen for use can be produced on a large scale without delay.

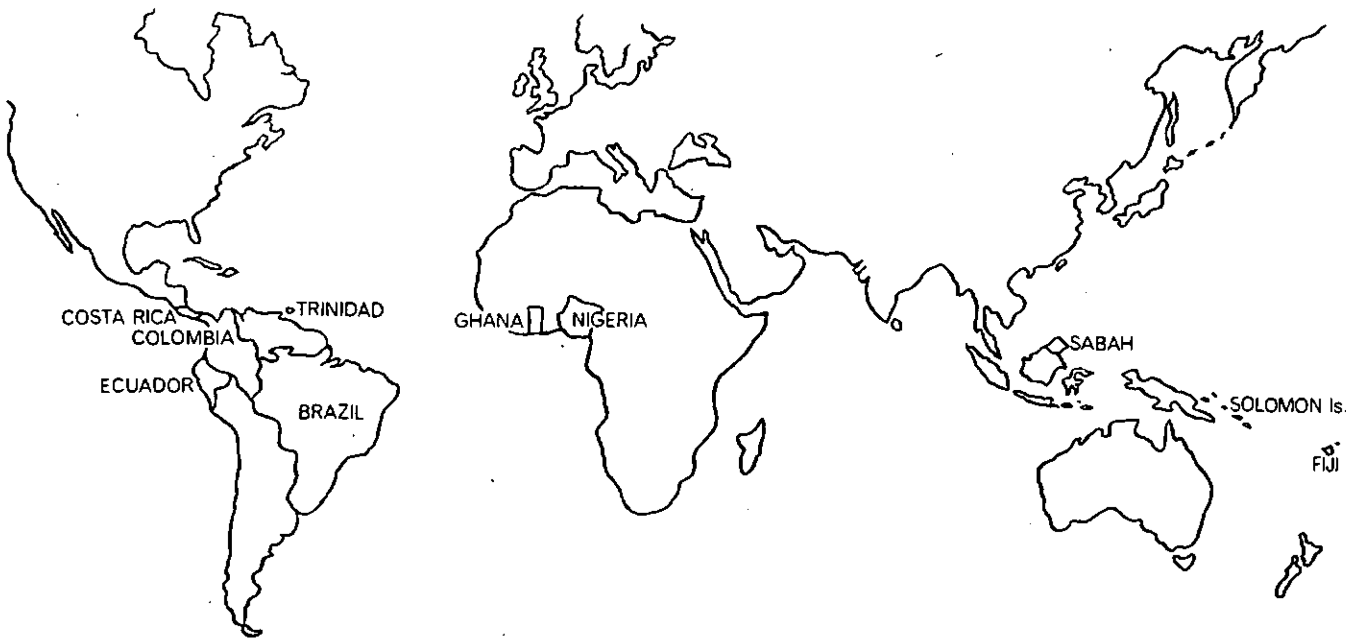
The laboratory screening techniques for the manual inoculation of beans with virus extracts and for transmission by vectors were improved and numerous inter-Amazon hybrids, involving the seed garden parents, were tested. The more resistant progenies have been planted in trials to check their field resistance, and a few have been planted by the Ghana Cocoa Production Unit in a routine way on farms treated for swollen shoot disease. Together, these trials will check the field resistance of the varieties and their suitability for farmers' use. They will also provide cocoa for quality assessment.

The second phase of the project is to develop hybrids with greater resistance and better characteristics than the phase one hybrids. This has led to the selection of the two clones, Nanay 34 and IMC 76; seed gardens of both clones, about 60 acres in total, are being established.

Screening of the germplasm collection has indicated that no Ghanaian clone gives greater virus resistance to its progeny than Nanay 34 and IMC 76. In an attempt to find more resistant types the plant breeder has visited cocoa centres in the U.S.A., the Caribbean and Latin America and is arranging for new germplasm to be imported into Ghana. These introductions have been quarantined at the Royal Botanic Gardens, Kew, or have come directly from plant quarantine in Miami, U.S.A.

Data from existing breeding trials has provided information on the performance of certain parent combinations and indicated that selection can be reliable when the trials are seven years old. The genetics of resistance is also being studied to indicate how resistance can be built up by hybridisation and selection. Vector studies are concerned with the basic biology of mealy-bugs, their spacial distribution, population dynamics and dispersal. The general reduction of shade over cocoa in Ghana has apparently led to an increase of *Planococcus citri* relative to the less mobile *P. njalensis*. Immature vectors have been found to be more mobile

COUNTRIES RECEIVING U.K. TECHNICAL AID FOR COCOA



than previously reported and particular attention is being given to canopy edges, where movement from tree to tree is precipitated. Cocoa progenies differ in their resistance to insects and breeding material is being surveyed to see if this character can be utilised.

Some Amazon material suffers heavy losses from black pod disease (*Phytophthora palmivora*). Studies of this disease suggest that losses are related to periodicity in cropping, which is partially determined by the compatability system. It has also been shown that vectors are important in the developing of the annual epiphytotics and that cankers induced by the fungus are more serious during periods of water stress, the latter being accentuated by CSSV.

Physiological factors that limit pod production are being studied to determine how to maximise the supply of seedpods from existing and future seed gardens. Irrigation trials are in progress and progenies are being assessed for their ability to withstand the exposure and drought that are encountered in many of the rehabilitation areas.

Although an original estimate of 10 to 15 years was put forward for the screening and release to farmers of seed of new progenies, it now seems likely that seed from phase one of this project will be available in 1977 or 1978, that is only 8 to 9 years after the start of the work. This new seed is likely to be far more resistant to CSSV than anything that was previously available in the country. However, the material is by no means completely resistant to CSSV and the research project has indicated that for more resistant types to be available, a further breeding programme will have to be undertaken and will have to be based on a much wider genetic basis.

The information and the varieties being produced under this research project will naturally be of benefit to the whole of the West African area where cocoa swollen shoot virus occurs.

(b) *Nigeria*

In Nigeria, ODM has helped the Cocoa Research Institute of Nigeria with biometrics problems, by providing advice and help with experimental design and statistical analyses of results. This was made possible through the ODM tree crops biometrician based at East Malling Research Station in Kent, who has undertaken advisory visits to Nigeria and corresponded with scientists.

2. Latin America

Brazil, Ecuador, Colombia and Costa Rica have cocoa industries backed by local research programmes which are being aided by Britain in several ways. The main biological problems are again caused by diseases, especially monilia pod rot (*Monilia roreri*), witches' broom disease (*Marasmius perniciosus*) and black pod disease. ODM scientists in Ecuador and Colombia are able to maintain close contact with each other to avoid duplication of work, and to ensure that the results in either country will be of mutual benefit.

(a) *Colombia*

In Colombia the organisation responsible for the cocoa research programme is the Instituto Colombiano Agropecuaria (ICA) and Colombia has sought British aid in the form of a two-man team of consultants to advise on its research priorities and research programme. In 1974 this team of consultants made its first visit, and made a comprehensive set of recommendations to ICA. The

"Moniliasis" programme is currently being supervised by a Colombian plant pathologist and Britain has provided a plant physiologist to work with him at Manizales on the relationship between the monilia fungus and the environment. The consultants have also recommended that Colombia should centralise cocoa research at a cocoa station, and have suggested that Manizales is the most appropriate location. The National Federation of Coffee Growers (Fedecafe) has a programme for the development and diversification of the coffee zones (PRODESARROLLO), and one of the crops being planted in these coffee areas is cocoa. Britain has provided PRODESARROLLO with a cocoa adviser who has given valuable assistance with the cocoa planting programme and has been able to maintain close links with the ICA cocoa programme.

(b) *Ecuador*

In Ecuador cocoa research is the responsibility of the Instituto Nacional de Investigationes Agropecuarias (INEAP), and is centred at the research station at Pichilingue. INEAP, like PRODESARROLLO, have also been provided with a cocoa adviser. In addition to his advisory role, the adviser has been able to carry forward the INEAP cocoa breeding programme at Pichilingue, particularly in relation to the two main diseases, monilia and witches' broom. In addition Britain has provided a cocoa pathologist, and is shortly to provide an assistant pathologist. They are undertaking specific work on the biology of the monilia fungus, its epidemiology, and its relationship with witches' broom disease. ODM will also be providing a plant physiologist to work at Pichilingue on the relationship between the growth and flowering cycles of cocoa and these diseases.

(c) *Brazil*

In Brazil, the cocoa research centre (CEPEC) is situated at Itabuna in Bahia. Cocoa production is being expanded in Brazil, both in Bahia and the neighbouring state of Espirito Santo and in the states of Amazonas and Para to the north. In Bahia black pod disease is seasonal, but of paramount importance and the present recommended control by spraying with copper-based fungicides is only economic in the higher yielding farms. In Espirito Santo, a drier area, black pod disease is absent. Recently ODM has been able to provide CEPEC with an agroclimatologist to carry out research on the relationship between phytophthora epidemiology and the micro and macro climatic factors with a view to predicting crop yields and disease incidence. Hopefully this will indicate to agronomists and breeders objectives for the programmes aimed at creating conditions less favourable to the spread of the disease. This appointment follows an advisory visit to Brazil in 1972 by Professor J. Monteith of Nottingham University, which was also funded by ODM.

Cocoa drying is a major problem in Brazil, and ODM has recently sent an expert on the subject from the Tropical Products Institute to CEPEC, to assist in identifying the problem which exists, with a view to ODM eventually providing an engineer to develop cocoa dryers suitable for the small farmer and thus help in improving the quality of Brazilian cocoa.

(d) *Costa Rica*

The black pod work in CEPEC resulted from a report produced in 1969* which recognised the seriousness of the black pod problem in nearly all cocoa-growing countries, and recommended several lines of work. One of these was to develop a

*Black Pod Disease Report, The Cocoa, Chocolate and Confectionery Alliance, 1969.

sound method of screening cocoa varieties for resistance to black pod disease. This work is currently being carried out at the Tropical Agricultural Research and Training Centre (CATIE), in Turrialba, Costa Rica, by a British scientist provided by ODM. Although no cocoa cultivar immune to black pod disease has been found, a number of types exist which show variable degrees of field resistance. There is an urgent need to search for resistant material for use in breeding programmes. Many test methods have been used by various workers, with variable results, but it is necessary to standardise methods to enable results in different countries to be compared.

At CATIE, six cultivars which vary in field resistance from high susceptibility (UF677) to low susceptibility (CC/42) in field trials are being used in the research programme. On each three screening methods have been compared using the same isolate of *Phytophthora palmivora*. These are (a) inoculation of detached pods; (b) inoculation of attached pods and (c) inoculation of seedling stems.

Early results indicate that inoculation of attached pods gives results which are best correlated with field resistance, but further refinements of the method, particularly concerning the age of the pod to be inoculated, the point of inoculation and the humidity, are to be resolved. The techniques will then be used to screen the cocoa variety collection at CATIE. Work is also in progress on control of black pod disease using fungicides, and on the release of sporangia and their dispersal.

3. The Caribbean—Trinidad

For many years a main centre of cocoa research has been the Cocoa Research Unit in Trinidad, a part of the Regional Research Centre (RRC) of the University of the West Indies. Britain has for many years been providing budgetary support for the RRC. Budgetary support has now been replaced by project aid, but so far no British-aided cocoa research projects have been started. The future role of this Unit, and indeed the future form of the Regional Research Centre as a whole, remains uncertain. Attempts to convert the Unit into an International Cocoa Research Centre have so far been unsuccessful, and recommendations that the Unit should be developed into a centre for research into cocoa genetics (and for the conservation of cocoa germplasm) have not been wholly accepted by the West Indian authorities. ODM currently has no direct involvement with the Centre, following the replacement of budgetary aid to the Regional Research Centre by project aid. The Director of the Cocoa Research Unit has, however, been used by ODM as a consultant to the Government of Bolivia to advise on its cocoa development programme.

4. The Pacific

In the Pacific, cocoa research in the British Solomon Islands Protectorate and in Fiji is in progress within the respective departments of agriculture. ODM supports the appointments in Fiji of a cocoa specialist and biometrician, on secondment from Rothamsted Experimental Station, and in the British Solomon Islands of a pathologist who is working on *Phytophthora palmivora* (and particularly on stem canker) at Dala Experimental Station. The British Solomon Islands are developing cocoa on Guadalcanal, and the agronomist in charge of the project is also supported by ODM.

5. Malaysia

In Malaysia Cocoa Research is centred at Quoin Hill in Sabah, where active breeding and nutrition programmes are in progress, and seed production is carried out for the whole of Malaysia. Aid is being given by the secondment of a staff member of the Land Resources Division, who is responsible for this work.

Summary

British support for cocoa research takes many forms, and is based at several centres in many parts of the world. It is expected that British expertise on the crop can continue to be made available to the developing countries in response to requests for aid and technical assistance.

Cocoa Production in Sierra Leone

L. A. Are, West African Rice Development Association, Monrovia

Introduction

Cocoa has been grown in Sierra Leone since the 18th Century. The first export of cocoa—6 cwt—was made in 1890, since then cocoa has become the third largest export crop after palm kernels and coffee. Production averaged 4,000 tons during the 1960's but has risen sharply to over 6,000 tons since 1971. The sharp increase in production was due to the good results obtained from the black pod and capsid spraying programme initiated in the 1971/72 season by the Sierra Leone Produce Marketing Board. The present production is still, however, far from the level of 10,000 tons which was expected by 1970 (8).

Most of the cocoa is grown in the Kenema and Kailahun districts of Eastern Province where soils and climate are suitable. Much of the rest of the country is open savannah unsuitable for cocoa.

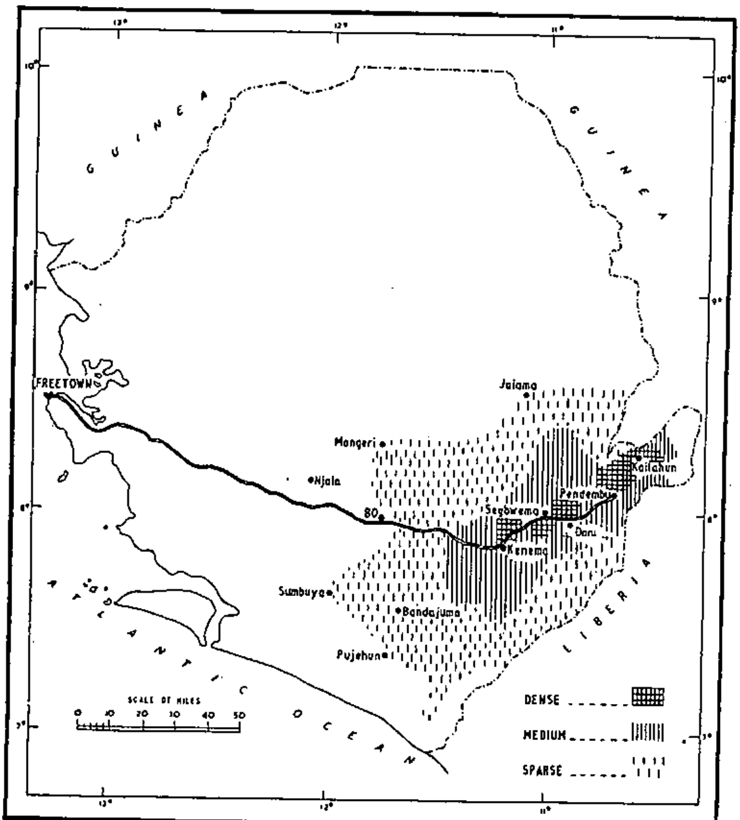


Fig I: COCOA PRODUCING AREAS OF SIERRA LEONE

Table 1

Mean monthly rainfall and temperature in some cocoa growing areas of Sierra Leone, Ghana, Nigeria and Cameroon

	MONTHS												Mean Annual	DRY SEASON*			Rainfall in Nov.–March
															Rainfall		
	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.		Period	Total	Per Month	
Daru, Sierra Leone																	
Rainfall (ins)	0·5	1·3	4·2	5·8	9·9	11·2	11·2	14·5	16·1	13·1	8·1	2·5	98·4	Dec–Feb.	4·26	1·42	16·65
Temp. Mean Max. °F	88·1	91·2	91·4	90·3	89·0	86·8	83·6	82·0	85·4	87·0	87·4	86·2	87·4				
Mean Min. °F	66·9	68·0	70·3	71·1	71·8	71·3	70·7	70·7	71·0	70·4	70·6	68·8	70·1				
Tafo, Ghana**																	
Rainfall (ins)	1·49	3·20	5·89	6·26	7·14	9·80	6·05	3·14	6·40	8·64	3·94	2·57	64·52	Dec.–Jan.	4·06	2·03	17·09
Temp. Mean Max. °F	91·9	94·1	93·6	93·7	92·4	89·3	86·8	86·7	87·9	89·6	90·7	90·6	90·6				
Mean Min. °F	59·5	62·0	66·4	67·1	67·4	66·6	66·2	65·9	67·1	67·2	66·1	62·4	65·3				
Ibadan, Nigeria††																	
Rainfall (ins)	0·38	0·96	3·54	5·31	5·81	7·39	6·08	3·26	6·97	6·18	1·74	0·37	47·99	Nov.–Feb.	3·45	0·86	6·99
Temp. Mean Max. °F	90	93	93	91	88	85	82	81	84	86	88	90	87				
Mean Min. °F	69	70	72	72	71	71	70	69	70	70	71	69	70				
Ondo, Nigeria††																	
Rainfall (ins)	0·41	1·38	4·26	6·14	6·70	8·33	9·15	5·13	9·14	7·58	2·87	0·67	61·76	Nov.–Feb.	5·33	1·33	9·59
Temp. Mean Max. °F	88	91	90	88	87	84	81	80	82	85	87	87	86				
Mean Min. °F	71	72	73	72	71	71	69	69	70	70	72	71	71				
Ikiliwindi, Cameroon†††																	
Rainfall (ins)	1·38	2·17	8·44	10·80	9·41	12·25	13·33	15·01	13·20	13·57	6·88	1·28	107·72	Dec.–Feb.	4·83	1·61	20·15
Temp. Mean Max. F°	87·4	89·1	88·7	87·7	85·9	84·4	81·2	81·1	83·3	84·5	85·8	86·5	85·6				
Mean Min. °F	69·2	69·9	70·5	70·6	70·6	70·1	69·7	69·8	69·5	69·9	69·9	69·5	69·9				

*Dry Season is defined as a period with less than 3 inches of rain per month.
**Source: Ann. Rep. Cocoa Res. Inst., Ghana 1968–69, opposite p. 15.
††Source: Temperature, Smyth A. J. and Montgomery, R. F. (1962) *Soils and Land use in Central Western Nigeria*, Ibadan
Rainfall, Wessel, M. (1969) Cacao soils of Nigeria *Second Internat. Cacao Res. Conf. Bahia* 1967 417–430
†††Source: Wood, G. A. R., personal communication.

Climate

The rainfall and temperature conditions at Daru, Sierra Leone are compared with those of Tafo, Ghana, Ondo and Ibadan, Nigeria and Ikiliwindi, Cameroon in Table 1.

The mean maximum and minimum temperatures of the cocoa growing areas of Daru, Ibadan and Ondo and Ikiliwindi are similar. The mean maximum temperature for Tafo is higher than those of the other places, while the mean minimum temperature is lower.

The cocoa growing areas of Sierra Leone enjoy an average annual rainfall of approximately 100 inches. The rainfall is well distributed over nine months and the area enjoys a very short, mild, dry season.

Soils

Cocoa is grown mainly on river terrace soils high in moisture content. Some cocoa is also grown on red clayey soils such as are found on convex slopes and which are generally deep and relatively free from gravel. Some of the soils are however known to dry out during the dry season causing water stress on the trees.

The Moa soil series is found on level and nearly level terraces but distinctly above streams. These soils have a strong brown (7.5YR hue) colour in the upper part of the subsoil and have deep, gravel-free silty or very fine sandy clay loam subsoil. They are well drained up to a depth of 24 inches and are fertile, rarely droughty and flooded only for very short periods of time. The parent material is a well sorted, thick layer of silty or clayey river alluvium. The pH ranges between 4·5 and 5·2 and most of its clay fraction is kaolin (7). The Moa soil series is thought to be best suited for coffee, oil palm or cocoa.

Cultivation

It is estimated that about 46,000 acres were planted to cocoa by 1965/66 (1). 40,000 acres were reported to be in pure stands, while the remaining 6,000 acres were mixed plantings of varying density with other crops. Cocoa is grown under selectively thinned forest shade.

Amelonado and F_3 Amazon varieties are grown by the farmers. Amelonado supplies the bulk of the crop, while F_3 Amazon was introduced only in the 1950's. In recent years, the Ministry of Agriculture and Natural Resources (MANR) has distributed limited quantities of F_2 Amazon pods and F_3 Amazon seedlings from nurseries scattered all over the Eastern Province. Initially two or three seeds were sown at stake at irregular spacings of about five feet, but in the last 20 years many farmers have adopted regular spacing on the advice and supervision of the MANR field officers.

Generally cocoa comes into bearing when four to six years old depending on the variety planted and the level of maintenance after planting.

The tree population per acre appears adequate, but cocoa farms in Sierra Leone are generally poorly maintained, being inadequately weeded and pruned. Clean weeding is possible on most of the irregularly-planted small farms of 1 to 5 acres, otherwise row weeding (1½ feet on each side of the cocoa trees) thrice a year, supplemented with 6 slashings of the remaining spaces between the trees is recommended annually. Apart from the competition for soil nutrients and water, tall weeds in an unpruned farm tend to keep the relative humidity very high most of the year thus increasing the spread of black pod. The seriousness of this situation lies in the fact that the wet season in the cocoa area of Sierra Leone covers 9 months of the year and nearly all farms are heavily shaded. The shade trees are not thinned, although this is necessary in order to stimulate higher yields. In a few instances, the shade trees were completely removed without attempting to control the capsids which attacked the suddenly exposed cocoa farm. Complete shade removal should therefore be accompanied by increased spraying to check capsids. It must be stressed that improved management of existing cocoa farms is the quickest method of increasing total cocoa production.

Average yield is about 290 lb dry beans per acre.

Disease

The most important disease of cocoa in Sierra Leone is black pod. Since all cocoa in Sierra Leone is produced between August and January, a period when conditions are highly humid except in December and January, the pods are liable to be attacked by the disease during most of their development period. In addition many cocoa farms are close to rivers and streams where the relative humidity is always high. It is therefore not surprising that black pod disease is a serious threat. The MANR (3, 4) reported that crop losses due to black pod in unsprayed cocoa farms around Kpuabu averaged 30 to 50 per cent annually. An extreme case of 95 per cent black pod attack was reported in 1969 at Kpuabu in a variety trial (8). Adequate and timely application of control measures can substantially increase cocoa production since 50 per cent control can be obtained with the copper fungicides now in use (Gorenz, personal communication, 1970), (Table 2).

To achieve control, recommended fungicides such as Lime-Bordeaux mixture, Carbide bordeaux mixture and Perenox are sprayed with pneumatic knapsack sprayers six or seven times a year at intervals of four weeks as from May. The dosage of the Bordeaux mixture is 1 lb. copper sulphate in 8 gallons of water and 0·41 lb. calcium carbide or hydrated lime in 2 gallons of water. The two solutions are mixed thoroughly and stirred well to give 10 gallons of spray material. The operators ensure that all pods are totally wetted.

Table 2

Percentage loss of cocoa and yields in sprayed and unsprayed plots

Year	Un-sprayed Plot	0·4% Perepod	1% Carbide Bordeaux	Cocoa Yield per Acre		
				Sprayed Plot	Un-sprayed Plot	Increase from Spraying
	(%)	(%)	(%)	(lb.)	(lb.)	(lb.)
1956	30·96	5·04	2·97	Not recorded	Not recorded	—
1957	41·17	1·52	0·93	670	289	381·
1958	23·56	0·00	0·00	589	413	176
Average	31·90	2·19	1·27	630	351	279

Source: Blackpod disease of cocoa. Ann. Rep. Dept. of Agric., Sierra Leone, 1957 and 1958.

Factors militating against the effective control of black pod disease in the Eastern Provinces of Sierra Leone include:

(i) Wrong timing and frequency of fungicide application. The interval between applications should be reduced from 4 weeks to 2 to 3 weeks because of the rather high number of rainy days and the fact that the fungicides in use lack effective stickers that could prolong their persistance. However, farmers may not adopt higher spraying frequency since fungicides are relatively expensive in Sierra Leone and the spraying has to be done in the "hungry season" when the farmer needs his money to provide food for his family rather than for the purchase of chemicals.

(ii) Some farmers are known to apply carbide bordeaux mixture when still hot. This causes some injury to the trees, especially to the flower cushions, and reduces future yields as a smaller number of flowers are subsequently produced.

(iii) Diseased pods are removed from cocoa trees are often buried in the farm or just outside it.

Burying of diseased pods increases the incidence of black pod disease in the farm in subsequent years. In addition, all diseased pods at the base of cocoa trees should be promptly removed at the beginning of the rains since they are responsible for infecting the pods in the upper canopy of the trees. Their removal should help to reduce the spread of the disease within a cocoa farm (6).

Pests

Monkeys constitute a very serious pest of cocoa in Sierra Leone because they feed on the sweet juicy pulp around the beans. The monkeys doing the most damage are the Putty Nosed Monkey, the Sooty Mangabey and Cambells Guenon (5). It is estimated that monkeys are responsible for 10 to 20 per cent crop loss annually. Monkeys unfortunately do not form a popular article of diet, so human biological control has not been effective. In a bold attempt to reduce substantially the loss caused by monkeys, "Monkey Drives" were organised by the MANR in all the cocoa growing districts of Sierra Leone. Although thousands of monkeys are still around, the results of the "Monkey Drives" have been encouraging.

Rodents, squirrels in particular, are also known to cause some damage though not of economic importance, while goats eat pods hanging up to a height of 3 feet 6 inches on cocoa trees growing near villages. This may damage the flower cushions and enhance the entry of pests and diseases.

Gorenz (2) has established squirrels as an important agent for spreading black pod disease on cocoa farms where they are numerous. No records are being kept of the indirect effect of monkeys and squirrels on the spread of black pod disease, but it is reasonable to suspect that they cause additional loss of cocoa in this manner.

Capsids cause "die-back" by attacking the leaves and young branches of cocoa trees. In effect, they cause a degeneration of a cocoa farm and hence much reduced yields. In some cases, the pods produced are also damaged if capsids feed on them. *Sahlbergella singularis* is the more commonly found capsid and is responsible for most of the damage. Aldrex 40 is more widely used than other chemicals, but wherever Aldrex 40 is used tip borers become a serious problem thus leading to breaks in the canopies. The use of Aldrex 40 is generally thought to be unwise and its use is no longer approved in Ghana and Nigeria. Since no resistance to the cyclodiene group of chemicals by capsids has been reported in Sierra Leone, BHC (Gammalin 20 or Kokotin) should be sprayed to control them.

Harvest, Preparation and Marketing

There is only one cropping season stretching from August to January. There is therefore no "light crop" in May/June as occurs in Ghana and Nigeria.

Fermentation is generally well done. Baskets lined with a layer of fern leaves are commonly used. The duration is 5 to 6 days.

It is estimated that between 15 to 20 per cent of the cocoa produced in the Eastern Provinces is smuggled into Liberia, where the price of cocoa is £56 to £101 per ton of dry beans above the price paid by the Sierra Leone Produce Marketing Board. The cocoa is not graded and cash is paid for it on the spot. Apart from encouraging farmers not to pay enough attention to processing, this situation depresses the true level of cocoa production in Sierra Leone.

It is felt that it is not enough for the Government to concentrate its efforts on reducing the smuggling activity; rather, it is suggested that the Sierra Leone Produce Marketing Board should consider raising its cocoa producer price and announce it much earlier than at the time of harvest. Moreover, Licensed Buying Agents should be made to pay cocoa farmers immediately the produce is delivered.*

Conclusion

Cocoa cultivation is not expanding at the same rate as in Ghana and Nigeria. The poor yield per acre and the low total cocoa output can be increased by improving farm maintenance, replacing some of the old derelict plantings and reducing the present high level of crop losses by effectively controlling black pod disease, monkeys and capsids. In addition, the amount of cocoa smuggled into Liberia could be considerably reduced if the S.L.P.M.B. raised the producer price.

*This paper was written in 1971. It is possible that the situation described in this paragraph has changed since then.—*Editor.*

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The Pattern of Leaf Production in Cocoa and its Influence on Insect Distribution and Abundance

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Introduction

Cocoa, like many other tropical tree crops, exhibits a pattern of periodic leaf production known as flushing (12). The new leaves are at first red, then they turn pink, white and finally green.

During the flush, cocoa is particularly susceptible to attack by a wide variety of leaf feeding lepidopterous larvae, Coleoptera, shoot-feeding psyllids and other insects (5, 6). The symptoms of swollen shoot virus disease first appear in the new leaves (10). Furthermore the sudden requirements for nutrients by the new growth may lead to wilting or death of young pods (6). In view of the importance of flushing, a number of studies have attempted to discover both the underlying mechanisms and the factors influencing the onset of the flush (1, 2, 3, 6, 7, 13, 14). There has been considerable controversy over the various findings.

The present study was designed to elucidate the pattern of flushing in time and space in order to understand how insect pests interact with it; the long-term aim was to predict the distribution and abundance of these pests in order to control their abundance more effectively. Some information on the factors influencing flushing was also obtained and is discussed here.

Method

The study was performed at Kade, Eastern Region, Ghana on Amelonado cocoa unless otherwise stated. Flush intensity on trees was scored by awarding one unit for each branch tip of approximately 4 mm diameter bearing at least one red leaf over 4 cm long. The total score was taken as an indication of the intensity of flushing.

1. Distribution in Time

Weekly flush-counts along a 50 m strip of cocoa facing open ground and on 20 cocoa trees in the centre of the cocoa farm are shown in Figure 1. In both cases it can be seen that there is a regular rhythm with a periodicity ranging from eight to eleven weeks and a mean of 9·4 weeks. The March and October flushes correspond to the two main peaks, or major flushes, noted by other workers (5, 6).

All the cocoa trees observed flushed in the March major flush, although there was a reduction in the number of trees flushing at successive minor flushes until August. This trend was more marked on shaded trees (Table 1), as noted by Sale (13), and may have resulted from a lower moisture stress and hence less stimulus for flushing on shaded trees (2). Alternatively sub-critical temperatures under shaded conditions may have prevented budburst (7).

Table 1

The number of cocoa trees, in the centre of the cocoa plot, flushing at successive flushes in shaded and insolated conditions

	1971					1972		
	Mar.	May	Aug.	Oct.	Dec.	Mar.	May	July
Unshaded trees (n=10)	10	10	9	10	9	10	10	9
Shaded trees (n=10) ..	10	8	5	7	8	10	10	9
Total	20	18	14	17	17	20	20	18

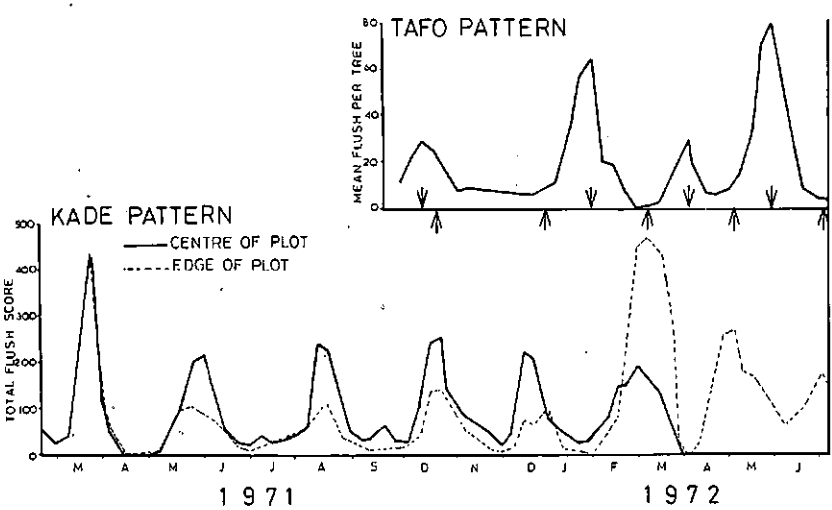

Fig. 1. Seasonal pattern of flushing on trees at the edge and centre of a cocoa farm at Kade. Part of the corresponding pattern at Tafo is also shown.

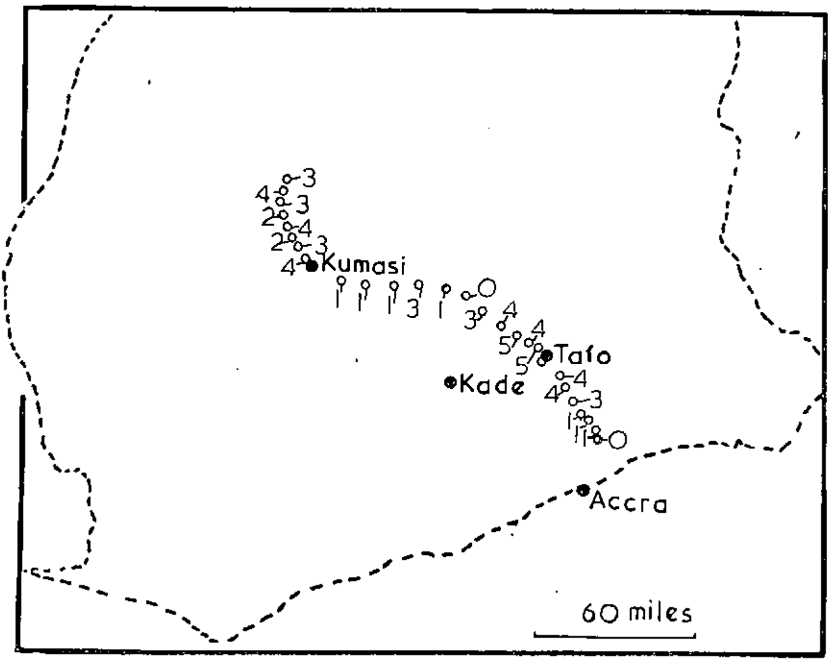

Fig. 2. Variation in flushing intensity in cocoa farms observed along a road traversing the main cocoa growing region of Ghana. The scale ranges from 0 (no flushing) to 5 (heavy flushing).

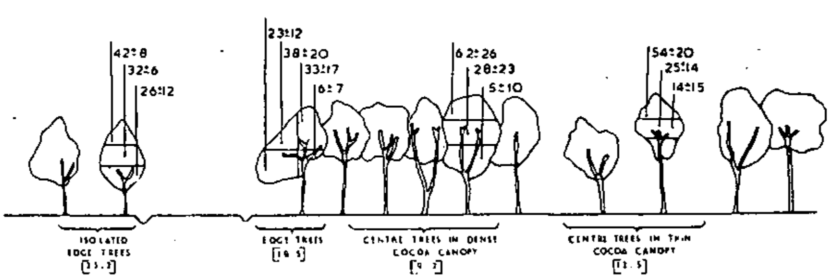

Fig. 3. Percentage variation in flush distribution on cocoa trees in varying degrees of cocoa canopy density and at the edge of a farm. The numbers in brackets indicate the mean flush amplitudes for trees in each category.

Simultaneous recordings of flushing have been provided by Mr. W. V. Hutcheon from Tafo, about 60 km east of Kade (Figure 1). The pattern here was also rhythmic, with the flush at Tafo initially one week in advance of that at Kade. The difference in phase of flushing later changed. Similar phase differences were also observed along a stretch of road from Aburi to Abufaw in April 1971. Flush intensity was high in the Tafo region and just north of Kumasi (Figure 2) with an intervening area of little or no flushing. This may be a section through bands of differing flush phases which may be related to local climatic conditions. It is perhaps significant that the two areas of high flushing are areas of intermediate rainfall while the rainfall in other areas is more extreme (17).

2. Distribution in Space

The trees in the centre of the plot that were shaded by cover trees flushed significantly less frequently and with a lower amplitude than unshaded trees. The flush on the unshaded trees also commenced between 1 and 15 days earlier and lasted between 0·5 and 2·6 weeks longer than on the shaded trees. Periodicity was unchanged by the shade regime.

Differences in flushing were also apparent between the edge and centre trees. The edge row of trees flushed with between 2·5 and 3·0 times the intensity of the centre trees during the minor flushes although this edge-centre gradient was not marked during the major flushes. The edge effect was reduced in cocoa facing high vegetation. The unequal distribution of flushing was not confined to separate trees. In dense cocoa canopy flushes were largely confined to the top third of the canopy (Figure 3) while trees in thin cocoa canopy had about 50 per cent of the flushes here. The distribution of flushes was even more uniform in the canopy of isolated cocoa trees. Flush intensity was greatest on the upper front of the canopy of edge trees and least on the lower surface facing inwards. Flushing is therefore concentrated on the parts of the trees receiving most insolation (the parts most likely to experience moisture stress). The mean flushes per tree for the four tree categories also indicated that more exposed trees flushed with a greater intensity suggesting that the intensity of flushing is decreased by any type of shade; both topshade and shade from adjacent cocoa trees will reduce flushing.

The cocoa fauna was sampled concurrently with the flush recordings in the cocoa plot where most of these recordings were made.

Discussion and Relevance to Inset Distribution

Cocoa leaf production is rhythmic with a mean periodicity of 9·4 weeks. This may arise from a rhythm of differentiation of leaf primordia (11) or from the attainment of a certain physiological state in the stem apex which is in turn dependent on the previous flushing and environmental conditions (4). If the rhythm theory is favoured one might look for a Zeitgeber controlling the rhythm. However there does not appear to be any short-term diurnal or long-term seasonal cycle likely to produce a ten-week rhythm. Photoperiod may be discounted since Tafo and Kade trees experienced similar photoperiods while flushing out of phase. The rhythm acts independently of temperature since the phase is unaltered when flushing is inhibited by the sub-threshold air temperatures. Leaf abscision is known to stimulate flushing through a hormone link (2, 3) but the two peaks of leaf fall, in January-March and in October, could hardly account for a 9·4 week rhythm.

Possibly the rhythm is inherent. Relief from periods of water stress is known to stimulate flushing (2, 9, 14) and the phase of the rhythm is lost following continuous irrigation (16) suggesting that rainfall may play a part in setting the rhythm. The December flush was late or was missed at Tafo although a large January flush followed an early storm; as a result the patterns at Kade and Tafo continued four weeks out of phase. The premature storm might have been responsible for resetting this rhythm at Tafo (Figure 1), which lends support to these earlier observations (16).

Thus at this stage one can still only speculate on the nature of the flush rhythm and the factors influencing it. The factors influencing the intensity of the flush are clearer. Flushing is clearly more intense on branches receiving the most sunlight, supporting Alvim's (1) suggestion that flushing is correlated with longer periods of high insolation and of higher moisture stress (2). It is difficult to say whether light or temperature is the governing factor here since increased temperature also results in greater numbers of leaves being produced (13). In view of the large within-canopy differences in flush distribution where temperature differences are small, light is probably the principle cause.

With the available data, it is possible to explain the behaviour of flushing within the cocoa farm (Figure 4). Leaf abscision is high in the cocoa and topshade trees in the dry-sunny season between December and March (5). In addition to the resulting reduction in topshade, there is a gradual thinning of the cocoa canopy density until March. The first major flush is triggered by the first rains (8) and, because the amount of sunlight is high and tree shading low, the flush intensity is particularly high. There is little difference in flush intensity between the edge and centre of the farm since trees at the centre receive almost as much insolation as those at the edge. The new growth results in a thickening of the cocoa canopy and recovery of the topshade. The subsequent minor flushes are of lower intensity, partly because of the reduced insolation and partly because of the shade cast by topshade trees and adjacent cocoa trees. The edges are still well insolated so the difference in flush intensity between edge and centre of the farm is high. The small peak of leaf abscision in October, and the increased sunshine level, results in a second major flush although this is seldom as intense as the March flush. Enclaves of heavily flushing trees may occur in the centre of the farm in clearings or where topshade is absent. The increased flush when insolation is high is probably part of a natural homeostatic mechanism for maintaining the canopy of the tree. This compliments the physiological mechanism whereby moisture stress and leaf abscision stimulate leaf production (2, 3).

Previous seasonality studies of cocoa insects have shown that the flush associated insects exhibit two annual peaks, one with each of the major flushes (5). A routine pyrethrum knockdown sampling programme of the cocoa canopy insects revealed similar trends at Kade. There were no significant increases in numbers of these insects during the minor flushes. Samples taken from the two rows of trees along the edge during the minor flush of August 1971 revealed high numbers of flush associated Coleoptera, Homoptera, Tettigoniidae and lepidopterous larvae. Many of these species had not been found in samples from the centre of the farm after the March flush. Although this could have resulted from the migration of insects from the adjacent forest, an analysis of the Coleoptera from the edge samples revealed a species composition more like the major flush fauna with characteristically high numbers of leaf and shoot feeders

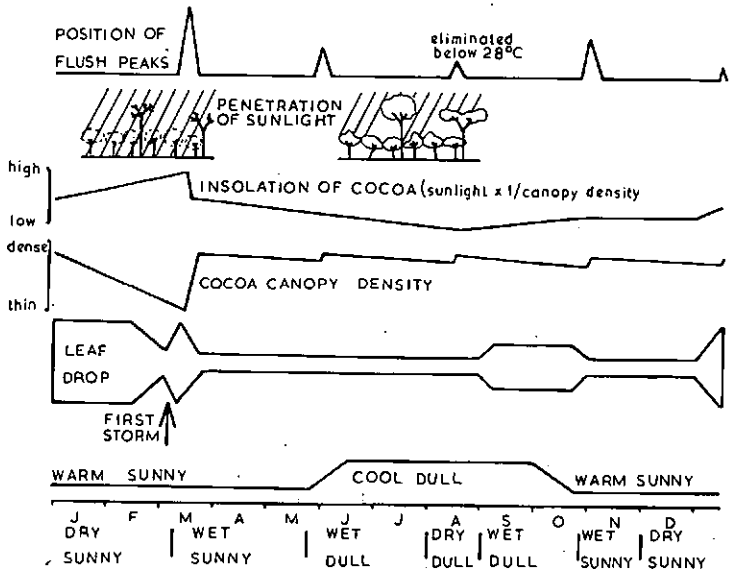

Fig. 4. A suggested scheme integrating the results of past workers with the present findings on the factors which influence the distribution and intensity of flushing in cocoa.

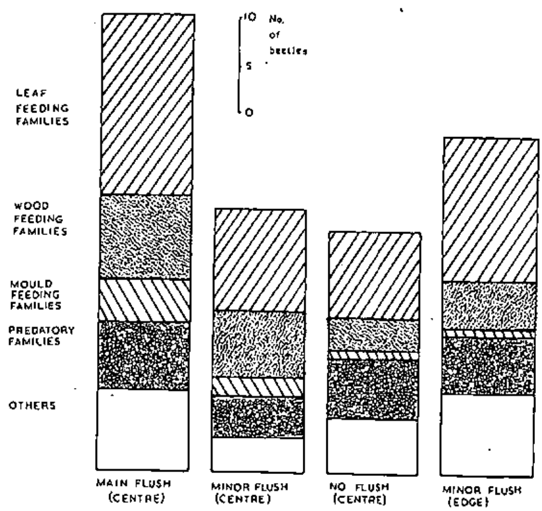

Fig. 5. Mean numbers of beetles grouped according to feeding habits in the major flush samples, the minor flush samples, the centre samples taken when there was no flushing and the minor flush edge samples.

(Figure 5). Such a faunal composition is unlikely to arise by migration from forest alone.

This brief study suggests that there is a build-up of flush associated insects outside the major flushing periods at the insolated edges of cocoa farms. This may act as a pest reservoir which rapidly spreads into the centre of the farm when conditions become suitable. Although this needs to be examined in greater detail, it may well be that it is economically valuable to apply additional chemical controls to the edge tree rows in order to control this pest reservoir. Alternatively farm size should be as great as possible in order to minimise the edge effect, while a tall growing, non-deciduous, non-competing crop such as coconut grown around the circumference of the farm would shade the edge trees and thus reduce flushing during the minor flush periods.

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A Graphic system for presentation of fertility of cocoa soils

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From 1966–1973 the Soils Division at the Centro de Pesquisas do Cacau (CEPEC) at Itabuna in Brazil has analysed over 125,000 soil samples and provided recommendations on fertiliser use for cocoa and other tropical crops. By combining knowledge of the cocoa production for many of the areas with the results of many fertiliser experiments carried out in both field trials and pot experiments in the greenhouse, it has been possible to establish certain empirical values to identify high, medium and low fertility soils (Table 1). From the soil analysis data a computer programme is used to give the individual recommendations for different types of soil.

The interpretation of soil analysis is often a difficult and somewhat confusing process for a layman. The farmer is usually given by his extension officer a table of unrelated figures and he may well be unclear as to the ideal values for particular fertility components. The most important components of soil fertility are: soil acidity (pH), percentage of organic matter, phosphorus content, potassium content, total of the calcium and magnesium contents and the percentage of aluminium in the total of exchangeable bases.

CEPEC has developed a technique to make interpretation of soil analysis data easier for the farmer by improving the visual presentation. The technique illustrates the six fertility parameters listed in Table 1 by plotting one parameter on each of six axes (Fig. 1). The greater the area within the hexagon formed by joining the various points on the axes then the higher is the fertility of that particular soil. The percentage of aluminium saturation is inversely correlated with soil fertility and so this is plotted inversely on the scale whereas the other parameters increase from the centre outwards.

To illustrate this graphic method, Figure 2 presents nine different soil types where CEPEC is currently carrying out soil fertility experiments. Five of the soils are from the Bahia cocoa region ("Cepec", "Hydromorphic", "Rio Branco", "Itabuna" and "Colonia"), three from the Ouro Preto Project in the Territory of Rondonia ("Ouro Preto", "Paraiso" and "Vermelhao"), and one from the Transamazonian Highway ("Itaituba") in the State of Para.

In addition to showing the farmer and extension officer more clearly the deficiencies and nutritional imbalances between soils, this method has the added advantage of simplifying comparative studies between soils of different origins or soils which have been submitted to different analytical treatments. For example by studying Fig. 2 we can see that the soils "Vermelhao, "Colonia" and "Itaituba" would not be of high enough fertility to establish plantations of cocoa, without the application of lime and chemical fertilisers—especially phosphorus. Other

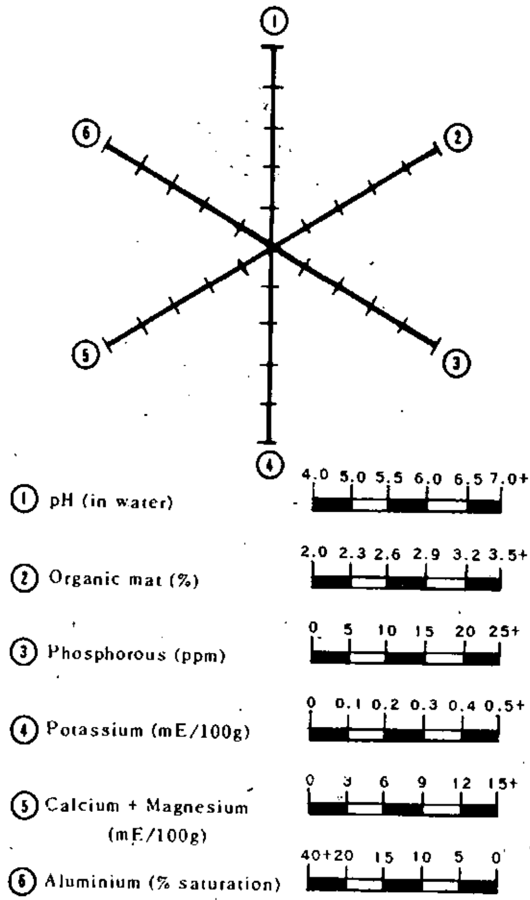

Fig. 1. A hexagonal diagram illustrating six parameters of soil fertility.

crops, which have lower requirements of fertility or have a greater tolerance to acidity and relatively high concentrations of aluminium, could be cultivated on these soils and in fact rubber and oil palm have been cultivated with relative success in poor soils such as "Colonia" with only small quantities of lime.

Table 1

Characterisation of low, medium and high fertility Brazilian cocoa soils in top 20 cm of profile

Parameters	Relative Fertility		
	Low	Medium	High
1. pH (in water 1:2½)	<5·0	5·0–6·0	6·0–7·5
2. % Organic matter .. .. (moisture combustion)	<2·5	2·5–3·5	>3·5
3. Phosphorus (ppm) .. .. (Melich method)	<5	6 –15	>15
4. Potassium (mE/100g) .. .. (Melich method)	<0·11	0·11–0·30	>0·30
5. Calcium+Magnesium .. .. (mE/100g)	<3	3–6	6–12
6. % Aluminium Saturation .. (Potassium chloride extraction)	>25	10–25	0–10

(Source: Comunicacoes da Equipe de Fertilidade do Centro de Pesquisas do Cacao Apresentadas na IX Reuniao Brasileira de Fertilidada do Solo CEPLAC, Itabuna, Bahia 1974).

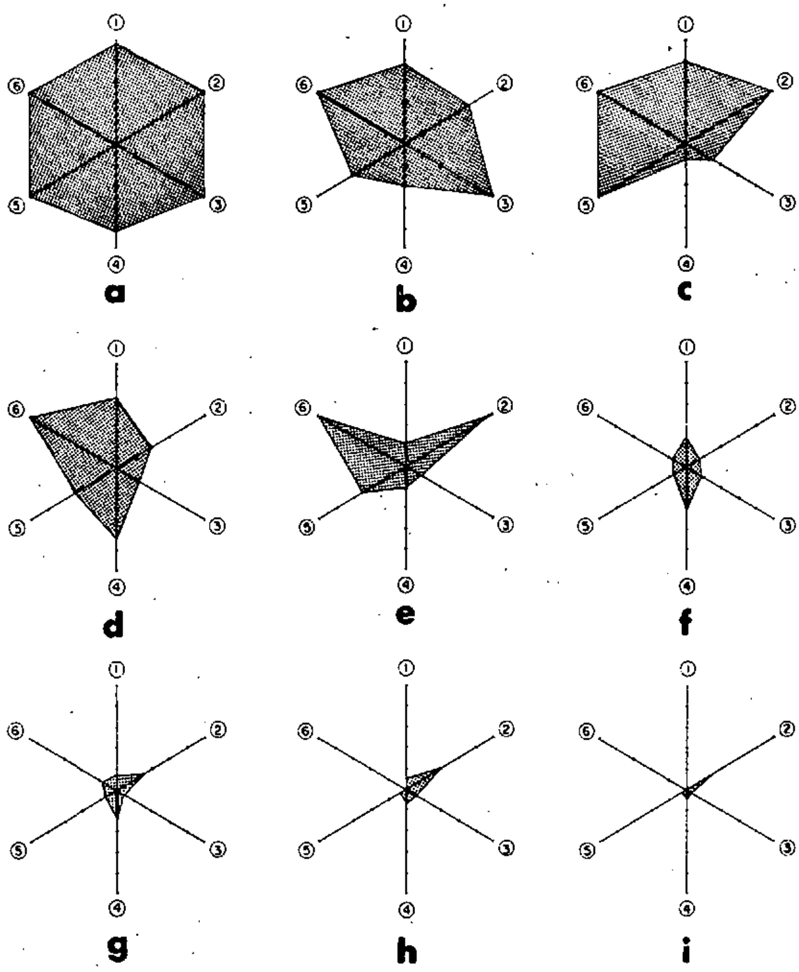

Fig. 2. Hexagonal diagrams illustrating fertility of some soils in Brazil.:

(a) CEPEC, Bahia, (b) Hydromorphic, Bahia, (c) Rio Branco, Bahia, (d) Paraiso, Rondonia, (e) Itabuna, Bahia, (f) Ouro Preto, Rondonia, (g) Vermelho, Rondonia, (h) Colonia, Bahia, (i) Itaituba, Para.

Book Reviews

Phytophthora disease of Cocoa. Ed. P. H. Gregory. Publ. Longman Group Ltd., 1974. £17·50. xii+348 pp.

Texts devoted to the scholarly treatment of a single host-pathogen complex are rare, and this one provides splendid justification for the efforts of twenty-five individual experts and for the enthusiasm, dedication and expertise of the Editor—P. H. Gregory. Without doubt, this book is essential reading for all interested in cocoa and its major fungal pathogen. It could, if produced in a cheaper version, also become recommended reading for plant pathologists and agronomists in many countries, presenting as it does a truly integrated study of an economically very important disease.

The value of this book is much more than the sum of its individual parts, the style, presentation and content of which vary considerably since the authors hail from many parts of the World. There is, of course, some overlap and reiteration, but this is not a criticism since important concepts stand repeating in different contexts.

The book opens with a description of the origin, distribution, botanical features and agronomic aspects of the host plant (J. Braudeau) and a history of the disease up to 1930 (C. A. Thorold). With the scene thus set, there follows a most useful Chapter by R. Lotodé and R. A. Muller on the problems to be considered in experiments with cocoa which is genetically, physiologically and topographically so very variable. The authors correctly stress that their conclusions may not apply in all parts of the World, but they do form the basis for a sensible approach to a real problem.

The pathogen—*Phytophthora palmivora*—and related species are described in detail by Grace Waterhouse—an acknowledged world authority—while the Section by K. H. Chee on the pathogen's extremely wide host range makes fascinating reading. Not surprisingly, such a ubiquitous pathogen exhibits considerable variability—an aspect thoroughly dealt with by G. A. Zentmyer, who has assembled a World-wide collection of isolates in California.

The physiology of the fungus and histology of some infections (M. Tarjot), pod rot (L. K. Opeke and A. M. Gorenz), root infection (A. Asare-Nyako and J. T. Dakwa), stem canker (I. D. Firman), cushion infection (A. L. Wharton) and chupon wilt (G. A. Manço) are all competently dealt with in successive Chapters.

Meteorological factors affecting pod infection (G. A. R. Wood) are most important in the epidemiology of the disease, since, for example, temperature has been cited as being of prime importance. Perhaps this subject could have been dealt with in even greater detail with more emphasis on the relationships between the climate world-wide and *P. palmivora* incidence. Apparently the climate of the Amazon basin, the host's home, is quite unsuitable for the disease.

The importance of inoculum in the soil has still to be clarified (E. K. Okaisabor), although good phytosanitary measures are definitely to be encouraged (R. A. Muller). Breeding for resistance may offer the best long-term solution to the disease (J. Soria V) and the problems and relevance of methods of testing (G. Blaha) are crucial.

The heterosis method of breeding cocoa and the selection of resistant hybrids is discussed by H. Toxopeus, who stressed the need for a large germ plasm bank and the desirability of avoiding inbreeding which reduces hybrid vigour. Practical results from a number of breeding programmes (H. M. Rocha) in which the resistance characters have been transmitted provide justification for more detailed studies. Clearly, field resistance involving multiple genes is preferable to specific resistance against such a variable pathogen.

Chemical control is a practical partial solution in some regions, and the Chapter on the choice of machinery is helpful (A. E. H. Higgins and J. E. Clayphon). The range of effective chemicals is not wide, despite numerous tests, but the economics of spraying can be attractive (A. M. Gorenz). Since there is no one solution to this disease, the Chapter by R. A. Muller on integrated control is pertinent.

There follows five Chapters dealing with pathogens of cocoa other than *P. palmivora* which, while not strictly covered by the title of the book, are valuable if they help avoid incorrect identifications and provide bases for comparison.

The Editor closes the text with a concise and penetrating Chapter entitled "Prospects", and few could fail to agree with his suggestions and conclusions.

Lastly—and most importantly—this book contains some 800 References which seem to include most of the relevant literature.

E. C. HISLOP

Cacao in West Africa by L. A. Are and D. R. G. Gwynne-Jones, published Oxford University Press, Ibadan, 1974. Naira 3·50. xiv+146 pp.

Dr. L. A. Are and Mr. D. R. G. Gwynne-Jones are to be congratulated on the effort put into preparing this book recently published by Oxford University Press. In setting out to cover the whole range of cocoa matters, from the history of its introduction to West Africa, to quality control, research, and even the rudiments of manufacturing, the authors undertook an immense task which they have carried out admirably, particularly in view of the difficulty in obtaining basic data from all the countries concerned. The authors have written this book primarily for use by Certificate and Diploma students at Agricultural Training Centres in West Africa, who will be in contact with the cocoa farmer, and entrusted with helping him to improve his cocoa farming and hence his returns and standard of living. We may take the view that West African farmers have, over the past seventy years, produced a vast amount of cocoa largely without what we now call technical advice and guidance, but on the other hand it cannot be denied that there is today room for a younger generation of cocoa farmers, with new ideas and new targets and this book will provide a very adequate background to the "regeneration" of cocoa growing in West Africa.

The authors have done an excellent job in sifting and putting together this vast amount of factual data which is an essential background in appreciating farmers' problems in cocoa cultivation. There are a few instances where the specialist scientist might dispute the accuracy of statements made, but by and large the wealth of detailed information is relevant and up to date. It may be argued that more emphasis could have been placed on analysing and discussing the cultivation techniques developed over the years by the farmers themselves, because in the future scientific recommendations will no doubt be modified by the farmers to reconcile optimum techniques with economic reality. In this context the co-operative aspects of cocoa farming might have received more emphasis, particularly in view of the growing need for this approach in order to implement technical advances.

"Cacao in West Africa" is generously supplied with useful diagrams and photographs and the maps of cocoa producing areas are particularly interesting. The publication of this book helps to fill the growing gap between the educated scientific outlook and the realities of practical farming for profit and it is to be hoped that it will find a wide and appreciative use by the growing numbers of persons concerned with improving the efficiency of cocoa production in West Africa.

P. S. HAMMOND

Forthcoming Publication

"Cocoa" 3rd Edition, G. A. R. Wood. Longman £7·50

This re-written edition will be published on April 7th

Cocoa Abstracts

These abstracts are reprinted from "Tropical Abstracts", published by The Royal Tropical Institute, Amsterdam.

December 1973

Brown, D. A. Ll. Cocoa in Ghana: an essay in understanding the agronomy of mature cocoa. C.M.B. Newsletter 53, p. 5–6 (1973).
The author attempts to make clear that, due to the great number of agronomical factors and their interactions which make up the rural economy of cocoa farms and crop husbandry practised by smallholders in Ghana and elsewhere, it is hardly surprising to find that the best system for the privately-owned farm largely remains an art, that foreign experts easily give the wrong advice and that recommendations given by them are seldom followed exactly.

Matovu, S. (Kawanda Res. Stat., P.O. Box 7065, Kampala, Uganda). **A survey of cocoa diseases in Uganda.** E. Afr. Agr. and Forestry J. 38, 3, p. 218–28 (1973).
During an extensive survey conducted from 1958–66 on cocoa plantings in all producing districts of Uganda, particular attention was paid to the fungus disease situation. *Verticillium* wilt appeared to be the most important disease; trees coming into bearing are readily attacked and mostly do not recover; suitable control methods are not available. *Phytophthora* pod rot probably becomes important in due time. Information presented also concerns *Armillaria* collar crack, *Calonectria* canker and cherelle wilt. There was no evidence that swollen shoot virus disease was present. Tables. 15 refs.

Soria, V., J. (Inst. Interamer. Ciencias Agr., Turrialba, Costa Rica). **Influencia de la edad de las plantas en la aparición de los síntomas de susceptibilidad a Ceratocystis fimbriata en cacao.** (Influence of plant age on the appearance of symptoms of susceptibility to *Ceratocystis fimbriata* in cocoa). Turrialba, Rev. Interamer. Ciencias Agr. 23, 2, p. 231–3 (1973). Counts of losses by *Ceratocystis fimbriata* in trials with clones and progenies in Costa Rica show large differences in susceptibility between clones which are transmitted to their progenies. In general, criollo and trinitario types are more susceptible than Amazon types but SCA-6 is an exception to the rule. Even highly susceptible types, however, are seldom attacked by the fungus until they are over 6–8 years old. English summary. Tables. Graph. 17 refs.

Conway, G. R. Pests of cocoa in Sabah and their control (with a list of the cocoa fauna). W.pl. (Sabah, Malaysia), Kementerian Pertanian dan Perikanan, 1971 (received 1973). III, 125 p.
This publication informs on cocoa growing in Sabah, E. Malaysia, and brings together in a succinct way available knowledge on common insect and other pests of cocoa, with particular attention to methods of control. Appendix. Tables. Graphs. Figs. Photos. Maps. Refs.

Abreu, J. M. de, and Silva, P. Pragas potenciais do cacauairo na Bahia e no Espírito Santo. (Potential cocoa pests in Bahia and Espirito Santo). Cacau Atualidades 9, 3, p. 4–9 (1972).
Brief descriptions are presented of the bugs *Eocader vegrandis*, *Dysdercus longirostris*, and *Monalonion dissimulatum*, the caterpillar and moth of *Stenoma decora*, and the buprestid beetle *Euchroma gigantea*. These insects have been observed feeding on cocoa in the Brazilian States of Bahia and Espírito Santo but at present are of no economic importance. They may, however, develop into serious cocoa pests as the result of elimination of their natural host plants and the injudicious use of insecticides. Figs. 8 refs.

Youdeowei, A. (Cocoa Capsid Res. Unit, Dep. Agr. Biol., Univ. Ibadan, Ibadan, Nigeria). **Some Hemiptera-Heteroptera associated with cacao farms in Nigeria.** Turrialba, Rev. Interamer. Ciencias Agr. 23. 2, p. 162–71 (1973).
A list is presented of 84 species of *Heteroptera* found in cocoa fields in W. Nigeria; their occurrence and feeding habits are briefly described. Only 11 species were found to feed on cocoa; apart from the mirids, the only important pest among them is the pentatomid *Bathycoelia thalassina*. Potentially important pests are 4 coreids, in particular *Pseudotheraptus devastans* which causes considerable pod losses in Ghana, and the pyrrhocorid *Callibaphus longirostris*. More species may develop into cocoa pests as the result of forest clearing and insecticidal control of other insects. Spanish summary Table. Graph. Map. 13 refs.

January 1974

Atanda, O. A. (Agr. Res. Counc. Nigeria, P.M.B. 5382, Moor Plantation, Ibadan, Nigeria). **Establishment, growth and yield of cocoa selections tolerant of swollen shoot virus.** Turrialba, Rev. Interamer. Ciencias Agr. 23, 1, p. 79–83 (1973).
Breeding for high-level tolerance to cocoa swollen shoot virus (CSSV) started in Nigeria in 1959 with the screening of local and imported germplasm. Of the promising progenies, 12 were finally selected in 1964 for a field trial aimed at assessing their commercial characteristics. Results of establishment, vegetative growth and the first 3 year-pod production of the progenies are given. Progeny differences in survival rate and early bearing are significant at 5% level while canopy development and growth in girth are not. The results are discussed. There is need for improving upon the establishment ability when making further selections for CSSV tolerance/resistance. From author's summary. Spanish summary. Tables. 35 refs.

Muller, R. A. Bilan des connaissances pratiques concernant le Phytophthora palmivora sur cabosses. Les inconnues. (Assessment of practical knowledge concerning *P. palmivora* on cocoa pods. Unknown factors). Cah. O.R.S.T.O.M.; Sér. Biol. 20, p. 9–14 (1973).
The author presents a critical review of methods of controlling cocoa pod rot due to *P. palmivora*, pointing out inherent difficulties and unsolved problems. The 3 sections following the introduction discuss, respectively: (1) the feasibility of fungicidal control in relation to climatic conditions, the etiology of the fungus, and the yield level; (2) prospects of finding cultivars that escape infection through a deviating rhythm of flowering; and (3) selection and breeding for resistance to the pathogen.

Séminaire international sur le Phytophthora palmivora organisé par l'Office de la Recherche Scientifique et Technique Outre-Mer, Brazzaville 14-17 mars 1973. Seconde réunion du sous-groupe de travail Afrique sur le Phytophthora palmivora. (International seminar on *Phytophthora palmivora* organised by O.R.S.T.O.M., Brazzaville 14–17 March 1973. Second meeting of the Africa sub-group on *P. palmivora*). Cah. O.R.S.T.O.M.; Sér. Biol. 20, p. 1–104 (1973).
Subjects discussed in 21 papers include the chemical control of *Phytophthora* pod rot of cocoa, preventive measures to reduce its incidence, testing and breeding for resistance, heredity of resistance, the chemical bases of resistance, strains of the fungus, differential hosts for these strains, and sexual reproduction and genetics of *P. palmivora*. Most contributions relate to cocoa, a few to *Hibiscus sabdariffa*. Some papers will be separately abstracted. Tables. Graphs. Figs. Photos. Map. Refs.

Asare-Nyako, A., and Amponsah, J. D. (Cocoa Res. Inst., New Tafo, Ghana). **Reaction of cocoa seedlings to artificial inoculation of Phytophthora palmivora.** Cah. O.R.S.T.O.M.; Sér. Biol. 20, p. 21–3 (1973).
In Ghana, pregerminated seeds from crosses between cocoa clones differing in their field resistance to *Phytophthora* pod rot were inoculated with the fungus before planting. Reactions of the seedlings to the pathogen are described. The percentage of susceptible seedlings was 50–58 in 5 crosses with the resistant clone T79/501 as the female parent and 73–84% in 7 crosses with the susceptible Na 32 irrespective of the degree of susceptibility of the male parent, 78% in the cross T79/501 × Na 32. Table. See also ibid. p. 35–40: Amponsah, J. D., and Asare-Nyako. A Screening of cocoa seedlings for resistance to *Phytophthora palmivora*. Tables. 31 refs.

Asare-Nyako, A., and Amponsah, J. D. (Cocoa Res. Inst., New Tafo, Ghana). **Indications of heritability of resistance of a cocoa cultivar to Phytophthora palmivora pod rot in Ghana.** Cah. O.R.S.T.O.M.; Sér. Biol. 20, p. 47–9 (1973).
Of 20 cocoa clones compared in Ghana during 1960-65, Y44 and S27 had the lowest proportions of black pod, viz. 16 and 18%, respectively. When seedling progenies were inoculated with *P. palmivora*, the proportion of susceptible seedlings was 52% in Y44 selfings, 53% in a cross of Y44 with another resistant clone, about 25% in crosses of Y44 with 2 susceptible clones, 55–61% in 3 selfed progenies of resistant descendants of Y44. This indicates that resistance to the pathogen in Y44 is genetic, probably depending on more than 1 gene. Selfings of S27 had 89% of susceptible seedlings, indicating that this clone has no inherent resistance but escapes infection owing to its flowering pattern. Tables. 4 refs.

Filani, G. A. The chemical control of Phytophthora pod in Nigeria. An evaluation of the present situation. Cah. O.R.S.T.O.M.; Sér. Biol. 20, p. 91–4 (1973).
Fungicidal control of *Phytophthora* pod rot has become an accepted standard practice among Nigerian cocoa farmers. A summary of spraying trials in 1961–70 indicates that Bordeaux mixture is still the best fungicide; however, its effect is often limited owing to faulty spraying techniques and washing-off by rain. Expected developments of control techniques include the use of more adhesive and/or more potent fungicides, control of the fungus in the soil, chemical control of insect vectors, and reduction of the air humidity by shade management. Table. 27 refs.

Dominguez, R., P. F., and Velasquez, F. (Cátedra Cultivos Trop. II. Fac. Agron. Univ. Central Venezuela, Maracay, Venezuela). **Selección de plantas de cacao (Theobroma cacao L.) por resistencia al hongo Ceratocystis fimbriata.** (Selection in cocoa for resistance against the fungus *Ceratocystis fimbriata*). Rev. Fac. Agron., Univ. Central Venezuela 6, 4, p. 57–73 (1972).
The cocoa disease caused by the above fungus is called "stem-necrosis". Two types of 6 month-old seedlings, from self-pollination (SP) and from cross-pollination (CP), were inoculated with spores in this experiment in Venezuela. A 2nd inoculation, below the cotyledonal cicatrix followed. SP-seedlings showed a loss from 85·5 to 98·0%; CP-seedlings from 50·0 to 94·0%. OC-63 proved to be the best SP, and OC-61 × OC-77 the best CP. Clone OC-61 demonstrated the best combining ability. English summary. Tables. Graphs.

Ehsanullah, L. Mechanical drying of cacao. World Farming 15, 2, p. 5–7 (1973).
A discussion of the pros and cons of mechanical versus sun drying of wet fermented cocoa beans is followed by a description of several types of platform and rotary dryers, and of their operation and performance. Newer features of dryers are, *inter alia:* (1) an agitator in a platform dryer, consisting of a set of tines moving through the beans and so reducing drying time; (2) aluminium instead of galvanized wire mesh as floor material in a platform drier, because of its resistance against corrosion; (3) drying drums with several compartments, making it possible to adapt the dryers' capacity to seasonal fluctuations in the amount of beans to be dried. Photos.

February 1974

Upton, M. (Dep. Agr. Econ., Univ. Reading, U.K.). **Development of tree crop production in Southern Nigeria.** World Crops 25, 3, p. 152–6 (1973).
Brief information on the agriculture in Southern Nigeria is followed by more detailed data on the development of oil palm, rubber and cocoa cultivation, processing and marketing. Attention is paid to the respective roles of private and government intervention in this development, and to some of its effects on land tenure, farm size, and social status of the farmers. A critical note is raised against several cases of government intervention, such as the introduction of pioneer oil mills, the encouragement of rubber processing co-operatives, and the establishment of marketing boards. French and Spanish summaries on p. 122. Photos. 21 refs.

Berry, S. (Dep. Econ., Indiana Univ., Bloomington, Indiana, U.S.A.). **Migrant farmers and land tenure in the Nigerian cocoa belt.** LTC (Land Tenure Centre) Paper 79, p. 1, 1–32 (1972).
The migrant farmers discussed here are largely Yorubas from savannah areas who have been coming to the western Nigerian forests since the late 1930's in order to grow cocoa. They were not the pioneers of cocoa growing in Nigeria but they have played an important role in the post world war II expansion of cocoa production. Examples are given of the process by which they became involved in cocoa. In this connection, the ownership of farmland, as a basic economic aspect is described. Appendix. Tables. Maps. Refs in foot-notes.

Boyer, J. (Lab. Physiol. IFCC, Yaoundé, Cameroon). **Etude particulière des facteurs hydriques de la croissance des cacaoyers.** (Special study of factors of cocoa growth related to moisture supply). Café Cacao Thé 17, 3, p. 189–204 (1973).
Observations of old cocoa trees in a humid region of the Cameroon Rep., and experiments with young plants grown in containers, confirmed that cocoa is very sensitive to the soil moisture content. Drying-out of the soil results in a progressive closure of the stomata, whereby the elongation growth of young plants and the size of new-formed leaves are considerably reduced. Prolonged saturation of the soil has a similar but much smaller effect. The moisture content of the leaf tissue is not appreciably reduced until the soil moisture content approaches the wilting point. English, German, and Spanish summaries. Tables. Graphs. 23 refs.

Dublin, P. Note sur l'utilisation d'un marqueur génétique dans les recherches d'haploïdes chez le cacaoyer (Theobroma cacao L.). (Note on the use of a genetic marker in the search for haploid cocoa plants). Café Cacao Thé 17, 3, p. 205–10 (1973).
The search for haploid cocoa seedlings resulting from pollinations can be greatly facilitated by using axil spot as a marker. In the Ivory Coast, artificial pollination 24 hrs after anthesis of flowers of a tree without axil spot, using pollen from a clone homozygous for this character, yielded 1,228 seedlings of which only 5 had no axil spot and could therefore be haploids. Cytological examination showed that 1 of these was indeed haploid. Pollination 24 hrs before anthesis resulted in a low fruit-setting percentage and yielded no haploids. English, German, and Spanish summaries. Photos. 43 refs.

Muller, R. A. La pourriture brune des cabosses (P. palmivora) dans la province occidentale du Cameroun. Existence d'une limite écoparasitaire à la culture du cacaoyer. (*Phytophthora* pod rot in W. Cameroon. Existence of an ecoparasitic limit to cocoa growing). Cah. O.R.S.T.O.M.; Sér. Biol. 20, p. 95–100 (1973).
Pod losses from *Phytophthora* were assessed during 1967–71 in 2 plantations in a region of W. Cameroon with a very wet rainy season. In 1970, fortnightly spraying with a copper fungicide increased the proportion of harvestable pods from 45 to 88% of all pods produced at Tiko and from 19 to 42% at Tombel. The proportion of harvested pods attacked by *Phytophthora* was reduced from 86 to 12% at Tiko, from 86 to 64% at Tombel. It is concluded that the incidence of pod rot can render cocoa growing uneconomic in humid climates although vegetative development of the cocoa is excellent. Table. Graphs.

March 1974

Atanda, O. A. (Cocoa Res. Inst. Nigeria, Ibadan, Nigeria). **Heterosis in crosses of Theobroma cacao.** Exp. Agr. 9, 1, p. 23–9 (1973).
Heterosis or hybrid vigour occurs when a hybrid is evidently superior to either of its parents, in a given attribute of performance. This study reports the pod production of cocoa trees in Nigeria, derived from 3 different crosses between a Nigerian local selection (N38) and 3 Trinidad introductions (CF47, CF56, and CF207). The hybrids consistently outyielded the inbreds throughout the first 19

years of pod production. N38 × CF56 hybrids produced the highest number of pods per tree, closely followed by N38 × CF47 hybrids. N38 × CF47 hybrids showed the best heterosis response. Pod production of $(CD207)^2$ and $(CD302)^2$, both double inbreds of N38, support the hypothesis that N38 is a Trinitario × local selection hybrid which segregates for pod production. Table. Graphs. 20 refs.

Hutcheon, W. V., et al. (Cocoa Res. Inst., Tafo, Ghana). **Effect of irrigation on the yield and physiological behaviour of mature Amelonado cocoa in Ghana.** Trop. Agr., Trinidad 50, 4, p. 261–72 (1973).
Sprinkler irrigation was imposed for 3 years on an existing shade and fertilizer trial for mature cocoa to maintain the soil at field capacity. The overall responses during 2 years, with rainfall being about average, were 12 and 17 %. In a year with a very severe dry season, irrigation increased yield by more than 40 %, to the level obtained in years with favourable rainfall. Irrigation suppressed flushing, stimulated flowering and fruit setting, reduced cherelle wilt and had little effect on the phenology and cropping pattern. Recent studies have suggested that irrigation has only a small effect on the soil moisture during an average dry season and that stress develops under high evaporation conditions regardless of soil moisture status. Tables. Graphs. 28 refs.

Lockwood, G. (Cocoa Res. Inst. (C.S.I.R.), P.O. Box 8, Tafo Ghana). **Effects of Ghanaian cocoa swollen-shoot virus on young bearing trees of a range of varieties.** Exp. Agr. 9, 1, p. 31–9 (1973).
First a brief review is given of previous work done in finding cocoa trees tolerant to the swollen-shoot virus disease. Then 4-year-old seedlings of 28 hybrid progenies were infected with the Ghanaian virus strain A; all were too severely affected to be of practical value in combating the disease. Sensitivity was assessed by comparison with non-inoculated controls. Reduction in crop and in growth and deterioration of canopy were correlated. The Amelonado × Amazon crosses were no more sensitive than the better inter-Amazon progenies. The rapid decline of the infected trees may have been partly due to infection coinciding with the slowing down of vegetative growth as cropping commenced. Tables. 17 refs.

April 1974

Carletto, G. A., and Soria V. J., (Div. Genética, CEPEC, Itabuna, Bahia, Brazil). **Testes de graus de autocompatibilidade em cacaueiro (Theobroma cacao L.).** (Tests for degrees of self-compatibility in cocoa). Rev. Theobroma 3, 1, p.26–35 (1973).
Diallel crosses between the 3 self-compatible cocoa clones ICS.1, UF.667 and UF.29 were made at Turrialba, Costa Rica. The fruit setting percentages did not support Coral's hypothesis that there are various genetically determined degrees of self-compatibility. Dissection of young fruits resulting from selfings showed that the proportion of gametic fusion was around 75 % in all 3 clones. The results are discussed in the light of Knight and Roger's and Cope's theories concerning the genetic basis of compatibility. English summary. Tables. 14 refs.

Adejuwon, O. Agricultural areal differentiation in the cocoa producing areas of Western Nigeria. J. Trop. Geogr. 35, Dec., p. 1–10 (1972).
The geographical pattern of the belt in W. Nigeria is described on the basis of information on Ibadan Division used as a sample area and on topographical data. It appears, among other things, that subsistence-food cropping around villages and towns has persisted. Cocoa and field crops make out 25% and 21% of the land, respectively, the remaining is under fallow (14%), thickets (33%) and forest (6·6%). Cocoa has ultimately become established in the physically more suitable areas away from old areas of settlement. The remaining land is largely under shifting cultivation. The pattern is of the fine-grained mosaic type comprising very small plots. Attention is drawn to factors which have influenced this pattern, including climate, history of development and soil quality. Table. Maps. 7 refs.

Atanda, O. A., and Jacob, V. J. (Cocoa Res. Inst. Nigeria, Ibadan Nigeria). **Comparative field-pod value of West African Amelonado and Amazon cacao in Nigeria.** Ghana J. Sci. 13, 1, p. 72-7 (1973).
Pods from a W. African Amelonado cocoa population and from a seed garden contanining 11 F_2 Amazon cocoa clones were sampled 14 times during October 1968–Jan. 1969. The mean pod value, i.e. the total weight of dry peeled beans per pod, was 43·2 g in Amelonado and only 37·9 g in Amazon cocoa; the difference was mainly due to a higher number of beans per pod, viz. 39·8 in Amelonado and 35·4 in Amazon cocoa, single-bean weights being about equal in both types. The mean pod weight was much higher in Amazon cocoa (637 g) than in Amelonado cocoa (381 g). It is thought desirable to introduce the high bean number of the Amelonado type into the Amazon type. Table. Graph. 12 refs.

Silva, P., and Costa, A. da S. (Div. Entomol., CEPEC, Itabuna, Bahia, Brazil). **Nova praga do cacaueiro no Brasil (Insecta, Coleoptera, Curculionidae).** (A new pest of cocoa in Brazil). Rev. Theobroma 3, 1, p. 42–3 (1973).
Leaves of cocoa at Belém, Brazil, were severely damaged by an unknown weevil subsequently described as *Plectrophorus incertus* Voss n. sp. The 8 other species of the genus have never been seen to damage crop plants. Text also in English. 2 refs.

May 1974

Ingham, B. M. (Univ. Salford, Salford, U.K.). **Ghana cocoa farmers — income, expenditure relationships.** J. Development Stud. 9, 3, p. 365–72 (1973).
This paper examines the hypothesis that the cocoa farmer of Ghana is to be regarded as a rural capitalist rather than a stereotyped peasant producer. To test this, 1 aspect of entrepreneurial behaviour of particular interest to the economist is selected, viz. low marginal propensity to consume. The limited evidence on Ghana cocoa farmers' income and expenditure is analysed. At the very least no refutation of the hypothesis is apparent. From author's summary. Tables. Graph. 12 refs.

Essang, S. M. (Dep. Agr. Econ. & Ext., Univ. Ibadan, Ibadan, Nigeria). **Institutional arrangements and income distribution in a primary export economy (Western Nigeria).** J. Assoc. Advancement Agr. Sci. Africa 1, Suppl., p. 91–101 (1973).
The influence of certain institutional arrangements on income distribution among Licensed Buying Agents and cocoa farmers in Western Nigeria has been investigated. The operations of the Marketing Board, in particular, are an important factor underlying the unequal distribution of income. This inequality has also been found related to inequality of access to sources of loanable funds, extension services and inputs embodying new technology. A strong relationship seems to exist between the distribution of political positions, the distribution of income, the distribution of access to the formal sources of credit and extension services measured in man-hours. Suggestions are made to the authorities for a more equal income distribution. French summary. Tables. Graphs. Refs.

Ghosh, B. N. (Centro Pesquisas Cacau, Itabuna, Brazil). **Drying cocoa beans by gas.** World Crops 25, 5, p. 232–7 (1973).
In Brazil, a new drying system of cocoa beans has been developed where sun and artificial drying can be carried out, using the same installation, either independently, or as complementary to each other. Instead of wood, low-cost household gas and infra-red heaters are used. In this connection problems in cocoa drying are discussed, and various drying systems are compared for design, installation costs, drying costs, efficiency, etc. French and Spanish summaries on p. 221. Figs. Photos. 10 refs.

Couprie, F. (IFCC, 34, rue des Renaudes, 75017 Paris, France). **Contribution à l'étude du cacaoyer et à la préparation du cacao en Ouganda.** (A contribution to the study of the cocoa tree and cocoa preparation in Uganda). Bull. Inst. Franc. Café et Cacao 12, p. 11–8 (1974).
The high rainfall and cool nights of the Uganda cocoa areas required the development of a special processing method: 3 days of fermentation on trays enclosed in a softboard case and with drainage boards separating units of 3 trays, followed by 3-4 days of box fermentation, soaking for 12 hrs. and drying on a Samoa dryer. Investigations were started on fertilizer requirements of cocoa, breeding and selection for larger beans, the effect of weather on shoot and fruit development, and artificial pollination. Effective control of monkeys and mirids is indispensable for satisfactory yields. Text also in English. Photos. Refs. in foot-notes.

June 1974

Cadima Z., A., and Alvim, P. de T. (Sector Física Suelas, Div. Suelos, CEPEC, Caixa Postal 7, Itabuna, Brazil). **Algunos factores del suelo asociados con la productividad del cacaotero en Bahia, Brazil.** (Some soil factors associated with the productivity of the cocoa tree in Bahia, Brazil). Rev. Theobroma 3, 2, p. 13-26 (1973).
On each of 14 cocoa farms in Bahia, Brazil, a comparison was made between a high-yielding and a low-yielding field of similar age and shade density and situated on the same soil type. The average yield of the good fields was 3 times

that of the bad fields. The difference was mainly due to less good development of the root system in the low-yielding fields, resulting from less favourable physical soil factors. Differences in the chemical composition of the soil, though not negligible, were much less important. English summary. Tables. Graph. 7 refs.

Vernon, A. J. The first five year's results of the cocoa pruning experiment at Waimaro. Fiji Agr. J. 35, 1, p. 1–10 (1973).
In Fiji, 10-year-old hitherto strictly pruned Amelonado cocoa trees were subjected to different pruning treatments. The results obtained during the first 5 years allowed to conclude, among other things, that relaxation of pruning would not depress yield in the long run and was necessary to some extent to maintain yield as the original stem and branch structure became diseased or weak. However, black pod loss in unpruned cocoa was higher. The extra height of unpruned trees remained from the practical point of view a controversial question and as to hurricane damage no conclusion could be drawn. The trial could not be continued since it was destroyed by a hurricane. Appendixes. Table. Fig. Map. 26 refs.

Tarjan, A. C., and Jiménez, M. F. (Univ. Florida Agr. Res. and Educ. Center, Lake Alfred, Florida 33850, U.S.A.). **Debilitation of cacao in Costa Rica by plant nematodes.** Nematropica 3, 1, p. 25–8 (1973).
In a pot experiment conducted in Costa Rica, 10-week-old cocoa seedlings (cv. UF 676 × IMC 67) were transplanted into 4 different soils collected at the Cacao Experiment Station and also into an autoclaved mixture of the 4 soils. Observations conducted after 7 months showed that plants in autoclaved soil mixture were significantly better developed than those growing in untreated soils. Plant parasitic nematodes found to be predominant in the soils, viz. *Helicotylenchus*, *Hoplolaimus* and *Tylenchus* spp., are held directly responsible for the decline of cocoa plants observed in the experiment. Spanish summary. Tables. 7 refs.

Morgan Williams, J. (School Biol. Sci., Univ. Bath, Bath, U.K.) **Rat damage assessment and control in cocoa.** Fiji Agr. J. 35, 1, p. 15–25 (1973).
Rat damage to cocoa is widespread in Fiji, losses sometimes exceeding 400 kg dry cocoa per ha. Information is presented on observations and investigations conducted on type and distribution of damage and methods of control, including the use of poisoned baits. Two to 3 applications of whole wheat grains impregnated with 0·05% warfarin and set in sufficient wax to hold the grains together was found most practical and most efficient if applied early in the cropping season. The method is not considered economically viable for scattered smallholdings. Tables. Graphs. 25 refs.

Abreu, J. M., and Smith, F., G. E. (Div. Entomol., CEPEC, Itabuna, Brazil). **Controle quimico dos Insetos filófagos do cacaueiro na Bahia e Espirito Santo.** (Chemical control of phyllophagous insects on cocoa in Bahia and Espirito Santo, Brazil). Rev. Theobroma 3, 2, p. 27–32 (1973).
Three trials comparing the effect of several insecticidal dust formulations on leaf-eating beetles were conducted on cocoa farms. Of 2 chrysomelid spp., *Colaspis sulcata* appeared to be somewhat more resistant to insecticides than

Maecolaspis ornata; no formulation was more effective against these 2 species than 1 % BHC or 0·2 % lindane. In 1 trial, however, near-complete mortality was obtained with several insecticides. Curculionids (mainly *Lordops aurosa* and *Naupactus bondari*) seemed to be still more resistant, in particular to trichlorphon. English summary. Tables. 13 refs.

July 1974

Dakwa, J. T. (Cocoa Res. Inst., P.O. Box 8, Tafo, Ghana). **The relationship between black pod incidence and the weather in Ghana.** Ghana J. Agr. Sci. 6, 2, p. 93–102 (1973).
The proportion of pods affected by *Phytophthora* in a plot of Amazon cocoa at Tafo, Ghana, in the months from Apr. 1965 to Sept. 1969 was compared with monthly means of temperature, rainfall and humidity measured in the open at a distance of 1·6 km. Single and multiple correlations of black pod incidence with meteorological factors were computed. Black pod incidence was found to be more closely associated with rainfall frequency and vapour pressure deficit, the factors determining how long pods remain wet, than with the amount of rainfall and relative humidity, respectively. French summary. Tables. Graphs. 14 refs.

Soria, S. de J. (Div. Entomol., CEPEC, Itabuna, Brazil). **Locais de coleta e distribuição de Forcipomyia (Diptera, Ceratopogonidae) relacionadas com a floração e frutificação de cacaueiro na Bahia, Brasil.** (Collection sites and distribution of *Forcipomyia* spp. connected with flowering and pod setting of cocoa in Bahia, Brazil). Rev. Theobroma 3, 2, p. 41–9 (1973).
Ceratopogonid midges on cocoa trees were found most frequently on flower buds; 2 *Forcipomyia* spp. known to be natural pollinators were the only species often encountered on staminodes of open flowers. The unequal distribution of the midges over the trees of the field studied may be connected with factors such as proximity to breeding places and differences in the attractiveness of flowers from individual trees. English summary. Tables. Fig. 16 refs.

Menezes, J. A. de Souza. Análise da produtividade de insumos modernos na produção de cacau. (Analysis of the productivity of modern inputs in cocoa production). Rev. Ceres 20, 109, p. 202–18 (1973).
Data from 80 cocoa farms in Bahia, Brazil, which had applied fertilizers and pesticides following the recommendations of the research station were used to calculate the profitability and marginal rates of returns for the principal input factors. The conclusion is that expenditure on agricultural chemicals is profitable but that the optimum combination of inputs has not yet been attained. English summary. Tables. 9 refs.

Amuh, I. K. A., and Amoako-Atta, B. (Nat. Centre Radioisotope Appl., Ghana Atomic Energy Comm., Legon/Accra, Ghana). **On the ability of Ephestia cautella (Walker) to mate in confined spaces in stacks of cocoa.** J. Stored Prod. Res. 9, 4, p. 221–4 (1973).
The oviposition behaviour of adults of *Ephestia cautella* which emerge within cocoa stacks was studied using glass tubes of various dimensions to simulate

the sizes of spaces which normally occur between bags in a stack. When the moths were able to leave the stack they would do so, but when they were unable to leave the stack they could mate and lay eggs within it unless the size of the space was too small. When mating was not possible only sterile eggs were laid. Authors' summary. Tables. 5 refs.

Ram, A., et al. (Div. Plant Pathol., CEPEC, Itabuna, Brazil). **Colletotrichum crassipes associated with cocoa wilting in Bahia, Brazil.** Rev. Theobroma 3, 2, p. 33–40 (1973).
In 1971, trees of the cocoa clone SIAL 698 growing in Bahia, Brazil, showed wilting symptoms due to invasion of the root system by a vascular parasite. A fungus was isolated from diseased roots and its pathogenicity proved by inoculation trials with young cocoa seedlings. The pathogen was identified at Baarn, the Netherlands, as *Colletotrichum crassipes* a description is provided and differences with *C. gloeosporioides* are pointed out. Portuguese summary. Tables. Photos. 2 refs.

August 1974

Boyer, J. Etude écophysiologique de développement de cacaoyers cultivés au Cameroun. I. Relations entre le cycle climatique annuel et l'activité végétative. II. Influence des facteurs climatiques prépondérants sur la floraison et la fructification. (Ecophysiological study of the development of cocoa trees grown in the Cameroon Rep. I. Relations between the annual climatic cycle and vegetative activity. II Influence of the main climatic factors on flowering and fruit formation). Café, Cacao, Thé 18, 1, p. 3–30 (1974).
The effect of weather and of the intensity of shading on the rate of growth, foliar surface index, and seasonal periodicity of vegetative growth, flowering and fruit development in cocoa was studied in the Cameroon Rep. on the basis of 4 years' observations of a 30-year-old trinitario population. English, German, and Spanish summaries. Tables, Graphs. 31 refs.

Santos, U., et al. Atitude, características e tipificação do cacauicultor de Ilhéus, Estado da Bahia, em relação a renovação de cacauais, em 1972. (Attitude, characteristics and typification of the cocoa grower in Ilhéus, State of Bahia, in relation to the renovation of cocoa fields, in 1972). Experientiae 16, 10, p. 195–222 (1973).
The effect of 17 factors on the attitude of 166 cocoa farm owners in the Ilhéus district of Bahia, Brazil, towards replanting of their fields with improved planting material was statistically analysed. The main factors promoting a positive attitude towards renovation were the proximity of the owner's residence to his farm, contact with extension workers, the market price of cocoa beans, and the degree of schooling. Important factors showing an inverse relation to this attitude were the production level of the farm and the time spent on the farm. English summary. Tables. Maps. 17 refs.

Blencowe, J. W., and Hubbard, F. T. P. (Rubber Res. Centre, Hat yai, S. Thailand). **Thinning and shaping of densely-planted cocoa.** In: Cocoa and coconuts in Malaysia, Kuala Lumpur, 25–27 November 1971, p. 86–101 (1972).

Dense planting of cocoa has several advantages but requires thinning after some years. Methods of thinning are discussed; because of the high correlation between trunk girth and yield, thinning by girth may be the most practical method. Simple calipers and gauges have been devised to measure trunk girths with sufficient accuracy for thinning purposes. An alternative to thinning would be pruning to 2 fan branches. Several methods are being compared in 2 trials in W. Malaysia. Graphs. Figs. Photos. 7 refs.

Teoh, C. H., and Shepherd, R. (Prang Besar Rubber Res. Stat., Kajang. Selangor, Malaysia). **Age at planting of cocoa seedlings in relation to month of planting.** In: Cocoa and coconuts in Malaysia, Kuala Lumpur, 25–27 November 1971, p. 76–85 (1972).
A trial in W. Malaysia compared field planting with germinated cocoa seeds and with 1- to 6 month-old nursery seedlings raised in plastic bags. Survival, initial growth and earliness of bearing increased with the age at transplanting. In view of the higher cost of older material it is advised for the time being to use 2- to 4-month old plants and to await favourable planting weather. When the weather remains unfavourable, the younger seedlings should be transplanted in drier periods and the older plants in wet periods. Tables. Graph. 1 ref.

Keane, P. J., and Turner, P. D. Vascular-streak dieback of cocoa in West Malaysia. In: Cocoa and coconuts in Malaysia, Kuala Limpur, 25–27 November 1971, p. 50–7 (1972).
Vascular-streak dieback of cocoa caused by *Oncobasidium theobromae*, previously known only from Papua New Guinea, has been found to be widespread in W. Malaysia. Characteristic symptoms are leaf yellowing with small islets remaining green, swelling of lenticels, proliferation of lateral buds, and browning of xylem vessels in which the fungus lives. Young seedlings may be killed rapidly. In wet weather the fungus forms white patches around leaf scars, spores are released at night and do not survive daytime conditions. Pruning-off of diseased branches 30 cm below the end of visible streaking of the wood is recommended to stem the spread of the mycelium. Upper Amazon cacao appears to be less susceptible than amelonado. Photos. 2 refs.

September 1974

Olayemi, J. K., and Oni, S. A. (N.I.S.E.R., Univ. Ibadan, Ibadan, Nigeria). **Asymmetry in price response: a case study of Western Nigerian cocoa farmers.** Nigerian J. Econ. and Social Stud. 14, 3, p. 347–55 (1972; received 1974).
A survey held amongst a sample of 262 cocoa farmers in Western Nigeria indicated, that their response to producer price increases was significantly higher than to price decreases. Possible explanations for the observed asymmetry include the ease of expanding the size of holdings relative to that of reducing it; the relative ease of reallocating resources away from cocoa when producer prices decrease; and the lack of an effective substitute cash crop for cocoa in the area under study. Some policy implications of the study are mentioned. Table. 10 refs.

Soria, J., et al. (Trop. Agr. Res. and Training Centre, Turrialba, Costa Rica). **Parental influence of several cacao clones on the yield performance of their progenies.** Turrialba, Rev. Interamer. Clencias Agr. 24, 1, p. 58-65 (1974).
In Costa Rica, an analysis of individual tree bean weight records of 48 hybrids (derived from crosses of 6 Trinitario and 2 Criollo clones with 6 Amazon clones) showed that the Amazon clones P-7, P-12 and IMC-67 had a high general combining ability while SCA-6 and the majority of the Trinitario clones had medium to low combining abilities for yield. Heritability for bean production from 3 year records was 17·3%, but 89% when based on 1 season production. The heritability for total fruit weight was 57%, fruit length 55%, fruit diameter 63%, and number of beans/fruit 43%, all based on 1 season records. From authors' summary. Spanish summary. Tables. 19 refs.

Besse, J. Les Haut-Amazoniens renouvellent les techniques culturales du cacaoyer en Afrique. (The Upper Amazons renew cocoa growing techniques in Africa). Techniques et Développement 11, p. 32–8 (1974).
The introduction of Upper Amazon material into W. Africa has changed cocoa growing methods because the type does not require shade after the canopy has closed. Growing under thinned forest is making way for total clearing; secondary growth is permitted to develop for 1 year before the cocoa is planted, and is then gradually eliminated. Smallholders are advised to grow food crops during 2 years and to plant cocoa under bananas in the 3rd year. The new method demands more labour though mechanization can reduce this, and entails more serious pest problems. However, yields are much higher than with the old method, as data from the Ivory Coast clearly shows. English text in supplement on p. 10–3. Tables. Graphs. Photos.

Saleh, M. (Balai Penelitian Perkebunan Bogor, Jember, Indonesia). **Hubungan antara umur daun dan kadar hara pada tanaman coklat.** (The relationship between age and nutrient content of cocoa leaves). Menara Perkebunan 41, 5, p. 219–22 (1973).
In Indonesia, investigations into the relationship between nutrient contents and ages of cocoa leaves showed that there exists a linear relationship between age and Ca content. As leaves should be sampled at the same age, the nutrient contents should be corrected to a same Ca content; in this case it is 1·2%. For every 0·1% Ca below or above 1·2% Ca, the found N, P and K contents must be decreased or increased by 0·82% N, 0·017% P and 0·063% K, respectively, and for Mn it should be increased/decreased by 6 ppm. There is no necessity for correcting the Mg. No significant differences have been found between the nutrient contents of the 2 clones used. English summary. Tables. Graphs. 4 refs.

Barnes, D. E., and Evans, R. C. (Ansul (M) Sdn Bhd, P.O. Box 465, Kuala Lumpur, Malaysia). **Weed control in cocoa and coconuts.** In: Cocoa and coconuts in Malaysia, Kuala Lumpur, 25–27 November 1971, p. 412–21 (1972).
A chemical weeding programme for young cocoa in W. Malaysia is based on the results of a trial in which 24 herbicides and mixtures were applied to 5-month-old seedlings. All herbicides caused damage when applied to the leaves, MSMA at 2·8 kg/ha being the least harmful; several formulae were well-tolerated when applied to the stems only. Coconut palm fields were successfully kept weed-free by applying mixtures of MSMA with other herbicides; this resulted in an improvement of the appearance of the trees and of their yields. Tables. 5 refs.

Salz, A. G. (ASP (Dryers) Pty Ltd, N. Sydney, N.S.W. 2060, Australia). **Cocoa processing—a practical approach to fermenting and drying.** In: Cocoa and coconuts in Malaysia, Kuala Lumpur, 25–27 November 1971, p. 181–218 (1972). The author describes several types of cocoa bean processing installations for estates of different sizes, pointing out the advantages and disadvantages of the various systems. Low labour costs and the ability to cope with seasonal fluctuations in yield are emphasised. The information presented is based on 20 years' experience in Papua New Guinea. Tables. Graphs. Figs. Photos. 13 refs.

Cocoa and coconuts in Malaysia; the proceedings of the conference held in Kuala Lumpur, 25-27 November 1971; ed. by R. L. Wastie and D. A. Earp. Kuala Lumpur (Malaysia), The Incorporated Society of Planters, 1972. XI, 464 p. Discussions. Appendixes. Tables. Graphs. Figs (1 p). Photos (1 coloured). Maps. Refs.
The 44 papers delivered at this conference were concerned with the cultivation, nutrient requirements, and diseases and pests of cocoa and coconuts, the processing of their products, the world situation of both crops, and the breeding and selection of cocoa. Though the majority referred to conditions in Malaysia, 20 papers were contributions from other countries. They are divided into 12 groups, each group covering a more or less well-defined topic and followed by a discussion. Separate abstracts of several papers will be published in this journal.

Wessel, M. Cacao cultivation and cacao research in North Sumatra. Medan (Sumatra, Indonesia), Strengthening Research on Rubber and Oil Palm in North Sumatra. UNDP/FAO Project INS/72/004. Document 20, 1973. III, 47 p. Appendixes. Tables. Wes.63C(B).
This document, working paper No. 20 of a series prepared so far in the framework of the joint Indonesian Government/UNDP-FAO project "Strengthening research on rubber and oil palm in N. Sumatra," mainly reports on the present situation of growing in N. Sumatra, Indonesia, and presents suggestions for a future research programme. The annexes include, among other things, notes and instructions on certain technical aspects and a list of detailed reports on 10 cocoa estates visited by the consultant.

October 1974

Winder, J. A., and Silva, P. (Div. Entomol, CEPEC, Itabuna, Brazil). **Pesquisa sobre a polinização do cacaueiro por insetos na Bahia.** (Investigation on cocoa pollination by insects in Bahia). Rev. Theobroma 2, 3, p. 36-46 (1972; received 1974).
Studies in Bahia, Brazil, indicated that cocoa pollination is exclusively due to ceratopogonids. Leaf litter, heaps of pod husks, rotting jack-fruit or banana stems, and bromeliads are suitable breeding places for these insects, preference for certain substrates depending on the species. Their abundance in leaf litter was positively correlated with the soil moisture content, with the result that pollinators are most abundant when flowering is at a minimum, and *vice versa.* Treatment of fields with BHC and copper fungicide had no appreciable effect on the population in the litter but copper appeared to reduce the percentage of flowers. English summary. Tables. Graphs. 19 refs.

Opeke, L. K., and Jacobs, V. J. (Cocoa Res. Inst. Nigeria, Ibadan, Nigeria). **Mutation breeding in cacao (Theobroma cacao L.).** In: Induced mutations in vegetatively propagated plants; Vienna, 1972, p. 137–43 (1973).

Cocoa was introduced into W. Africa about 100 years ago. Since then, several breeding projects have been carried out aiming at increased yield and commercial quality, drought resistance and virus tolerance. A mutation breeding programme was initiated in Nigeria in 1964, aiming primarily at the production of clones highly resistant to the black pod disease, *Phytophthora palmivora*. In addition it is hoped that irradiation may affect those genes that condition self and cross compatibilities and incompatibilities in different cocoa clones, thus opening new avenues for progress in cocoa breeding. Recently, the mutation work was extended to kola (*Cola nitida* and *C. acuminata*). Authors' summary.

Velloe, F., et al. (Div. Genética, CEPEC, Itabuna, Brazil). **Produção e selecção de cacaueiros hibridos na Bahia.** (Production and selection of hybrid cocoa in Bahia). Rev. Theobroma 2, 3, p. 15–35 (1972; received 1974).

Results are presented of 7 trials established in Bahia, Brazil, since 1964 to compare a large number of hybrid progenies resulting from crosses between clones of various origins and types; an open-pollinated Catongo progeny was used as a standard in all trials. In general, crosses with an Upper Amazon parent gave the highest yields and were most resistant to *Phytophthora* pod rot, but produced the smallest beans. The largest beans were produced by some Catongo × trinitario hybrids. Butter content varied only between 55 and 58%. English summary. Tables. 9 refs.

Ram, Ch., et al. (Div. Fitopatol., CEPEC, Itabuna, Brazil). **Fungos associados com a morte descendente do cacaueiro na Bahia.** (Fungi associated with die-back in Bahia). Rev. Theobroma 2, 3, p. 3–6 (1972; received 1974).

A high incidence of cocoa die-back was experienced in the northern and central parts of the Bahia, Brazil, cocoa belt in 1971. Fungi isolated from diseased plants were tested for pathogenicity by inoculation of wounds made on 30-year-old trees. *Botryodiplodia theobromae* was found to be the most pathogenic fungus, followed in this respect by *Phoma* sp., *Phomopsis* sp., and *Colletotrichum gloeosporioides*, whereas *Fusarium* spp. were non-pathogenic. English summary. 7 refs.

Maravalhas, N. (Set. Bioquímica Div. Fisiol., CEPC, Itabuna, Brazil). **Fermentação e cura de cacau.** (Cocoa fermentation and curing). Rev. Theobroma 2, 3, p. 7–14 (1972; received 1974).

Cocoa fermentation methods used in Bahia, Brazil, are briefly described; a 1965/66 trial comparing 9 methods was inconclusive owing to differences of opinion among manufacturers. Recent studies showed that: (1) acetaldehyde and ethyl acetate are formed during fermentation but their origin and possible effects on flavour are unknown; (2) an anaerobic phase of fermentation, polyphenol oxidase activity, specific aminoacids or proteins are not essential for flavour precursor development, but anthocyanidins are essential; and (3) an emulsifier is formed during fermentation. English summary. 15 refs.

Report of the Training Seminar on Cocoa Grading, Lagos, Nigeria.

2-6 October 1972. Rome (Italy), Food and Agriculture Organisation of the United Nations. United Nations Development Programme, TA 3195, 1973. V, 205 p. Appendixes. Tables. Refs in foot-notes.

This meeting was convened by FAO to provide additional training for officers engaged in the inspection and grading of cocoa beans for export in African countries. It was attended by 37 participants from 13 countries which account for 94% of African cocoa production, and by an officer from Brazil. Lectures were given by 9 experts in the field from African and European organisations and participants had to do practical work in the laboratory. The subjects treated in the lectures, which are published as appendixes 1-XII to the proceedings, included the importance of quality control for producers and manufacturers, methods and organisation of grading, and mould and insect infestations. Other appendixes contain draft recommendations of the International Standardisation Organisation, a comparison of provisions in the FAO model ordinance for cocoa grading with regulations in Ghana and Nigeria, and Brazilian regulations for grading cocoa beans.

Brown, J. F., and Friend, D. (Univ. New England, Armidale, Australia). **Diseases of cocoa in the British Solomon islands protectorate.** Nouméa (Nw Caledonia), South Pacific Commission. Technical Paper 166, 1973. IV, 38 p. Tables. Photos. Refs.

This paper brings together available information on damage, symptoms, causative fungi and other agents, infection, and ecology of the cocoa diseases known to occur in the Solomon Islands and outlines measures of control.

Purba, Dj., and Hutauruk, Ch. (PNP Marihat Res. Stat., Pematang Siantar, N. Sumatra, Indonesia). **Preliminary observations on the effect of zinc fungicide against pod rot disease (Phytophthora spp.) of cocoa plants and its relation to pod production.** In: Cocoa and coconuts in Malaysia, Kuala Lumpur, 25–27 November 1971, p. 58–63 (1972).

Trials in northern Sumatra, Indonesia, showed that spraying cocoa with zinc carbamate fungicides can control *Phytophthora* pod rot as effectively as spraying with copper fungicides. A dosage of 400 g mancozeb a.i. in 200 l water per ha can be recommended for the time being; spraying at fortnightly intervals was nearly as effective as spraying at weekly intervals. Mancozeb was found to increase pod yields while all fungicides used appeared to reduce damage by mirid bugs (*Helopeltis* spp.). Tables. 2 refs.

Tan, K. S., et al. (Dunlop Res. Centre, Batang Melaka, Negri Sembilan, Malaysia). **The effects of selected herbicides on cocoa shade plants, cover and cocoa seedlings on inland sandy loam soils.** In: Cocoa and coconuts in Malaysia, Kuala Lumpur, 25–27 November 1971, p. 155–64 (1972).

The tolerance of young cocoa and of some plants used as soil cover, temporary shade or permanent shade in cocoa fields to several herbicides was studied in 6 trials in W. Malaysia. Pre-emergence applications at fairly low dosages of diuron (0·56 kg/ha) and of triazine herbicides (1·12 kg/ha), alone or in combination with paraquat, afforded satisfactory weed control without harm to the crops. A weed control programme for young cocoa fields is submitted. *Paspalum conjugatum* was the only important weed that could not be satisfactorily controlled by chemicals. Tables. 6 refs.

Brown, D. A. Ll., and Boateng, B. D. Weed control for young cocoa: current work at the Cocoa Research Institute of Ghana. In: Cocoa and coconuts in Malaysia, Kuala Lumpur, 25–27 November 1971, p. 145–54 (1972).
In weeding trials conducted in Ghana, spraying with paraquat between the rows of young cocoa fields resulted in better growth of the crop than slashing the weeds; spraying with MSMA at 1·0 and 1·5 kg a.i./ha induced symptoms of Zn deficiency. Of several herbicides used in a nursery trial, only paraquat had no adverse effects on the growth of the cocoa seedlings. The merits and demerits of herbicidal weed control versus various methods of slashing are discussed. Literature on the toxicity of several herbicides for cocoa is reviewed. Tables. 31 refs.

November 1974

Dakwa, J. T. (Cocoa Res. Inst., P.O. Box 8, Tafo, Ghana). **The yield and disease patterns in a black pod resistance trial in Ghana.** Ghana J. Agr. Sci. 6, 3, p. 205–11 (1973).
Data on the period of cocoa harvest and disease incidence in a black pod fungus disease (*Phytophthora palmivora*) resistance trial showed that there was no advantage for any cross to bear the bulk of its crop in either the minor (April-August) or the main (September-March) season so as to escape infection. The degree of disease infection for any cropping period was directly related to the duration of the period. Since 66·6–88·8% of the annual crop was harvested between June and November, and 40·9–62·3% was diseased, it is suggested that disease incidence in this period can be used as a fair measure of the annual black pod incidence. Yield pattern affected the availability of inoculum. French summary. Tables. Graphs. 23 refs.

Meza Sanoj, C. (Cátedra Fitopatol., Dep. Fitosanitario, Fac. Agron., Univ. Zulia, Maracaibo, Venezuela). **Efecto de Benlate and Cupravit sobre el combate de la moniliasis y mancha de agua del cacao.** (Effect of Benlate and Cupravit in the control of *Monilia* and water spot disease of cocoa). Rev. Fac. Agron., Univ. Zulia, Venezuela 2, 3, p. 87–94 (1973).
Im *Monilia* control of cocoa in Venezuela, a significant difference was found between the rates and intervals of the application of Benlate which might be due to the high incidence of *Mecistorrhinus tripterus*, the main vector of *Monilia roreri*. Cupravit and Benlate showed also some control of water spot. Plants treated with Cupravit showed a marked reduction in the number of fruits formed in comparison with Benlate-treated plants. In the latter, production increased with rates of application. English summary. Tables. 13 refs.

Majer, J. D. (Imperial College Field Stat., Silwood Park, Ascot, Berkshire, U.K.). **Seasonality of the cocoa-pod-husk miner (Marmara sp., Lepidoptera, Gracillariidae).** Ghana J. Agr. Sci. 6, 3, p. 177–84 (1973).
In Ghana, a monthly survey (Dec. 1970 to Jan. 1972) of an unsprayed plot (one in which DDT spraying had recently ended) of cocoa showed that percentage of pods damaged by the above miner was high in December, dropped in May for unknown reasons and reached 19% in July. Damage increased rapidly after 1 month delay and reached 95% in December. Insect build-up was slower in a DDT-sprayed plot but reached 99·5% in December. Percentage of damage on 2 trees in both plots showed no significant difference at this time, indicating that there had been no recovery from attack in the unsprayed plot in the 14 months since spraying ended. It is suggested that regular spraying has an adverse effect on the natural enemies of the insect. French summary. Tables. Graphs. 10 refs.

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