COCOA GROWERS' BULLETIN

Number 20 February 1973
Published twice a year

Contents

Cadbury Limited
Bournville

Editorial

Black Pod Disease

This is not the first time that this disease has been the subject of an editorial. In the spring issue of 1969, the survey of research on black pod undertaken by Dr. P. H. Gregory, F.R.S. was mentioned. In his report Dr. Gregory drew attention to the numerous gaps in our knowledge of the disease and he made four recommendations for further research work. So far, three of these recommendations have been implemented.

The first recommendation was to set up an International Black Pod Research Advisory Committee whose main function would be to initiate, co-ordinate and advise on black pod research. This committee has been set up and it has formed two sub-groups — one in Africa, one in the Americas — which meet from time to time to exchange information and put forward proposals.

The second recommendation was to recruit a plant pathologist to work with Dr. Soria at Turrialba, Costa Rica in order to standardize tests for resistance to use on the germplasm collection there. Following a request from the Costa Rican government, the Overseas Development Administration recruited a pathologist for this work.

The third recommendation was to recruit two plant pathologists to study epidemiology at a cocoa research centre. This is a vital subject about which we are still woefully ignorant. The paper by Dr. Evans in this issue draws attention to the part played by insects and other invertebrates in the spread of this disease and the complexity of this aspect is apparent from the diagram on page 14. There are many possible sources of infection both on and off the tree and there is very little information as to which of these sources is important in causing initial infections. Does the disease start from infection in the ground or from the canopy or from old diseased pods? The answer to this question probably differs from one country to another, but without this knowledge it is not possible to apply sprays "rationally, precisely and with conviction".

Cocoa manufacturers of many countries, through the International Office of Cocoa and Chocolate, have recruited two plant pathologists to work at the Cocoa Research Institute of Nigeria. Their work will be aimed at evolving an experimental technique by which the major sources of the disease are revealed. These experiments are expected to provide clear evidence on this point for Western Nigeria, but the technique would have to be repeated in other countries. This work will be followed with keen interest.

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Review of Production and Consumption

February 1973

A. P. Williamson, Cadbury Schweppes Limited

Production

The latest Gill & Duffus forecast of 1972/73 production predicts a world total of 1,494,000 long tons, 50,000 tons less than the revised 1971/72 figure of 1,548,000 long tons.

The principal shortfalls, compared with last season, have been in Ghana, Ivory Coast and Cameroon. In Nigeria the production looks like being similar to last year's level. Purchases in these countries at the beginning of February compared with the figures at the corresponding period last year were:

		1972/73	1971/72
Ghana	8th February	381,137 tons	400,986 tons
Nigeria (West)	6th February	204,000 tons	204,000 tons
Ivory Coast	6th February	164,517 tons	197,080 tons
Cameroon (East)	2nd February	67,168 tons	91,566 tons

It is reported that the Harmattan in West Africa has been severe and doubts are being expressed about the outlook for the summer crops.

In Brazil the main crop is progressing well and reports suggest that it could reach a record 1·7-1·9 million bags compared with last year's total of 1·5 million bags. It is too early to make anything other than an arbitrary estimate of the forthcoming Temperao crop, but taking the average of recent years of 1,500,000 bags, this would mean an increase for the whole year of nearly 700,000 bags or 40,000 tons compared with last year.

Consumption

World consumption in 1973 is forecast by Gill & Duffus at 1,540,000 tons compared with a revised total for 1972 of 1,529,000 tons, an increase of 11,000 tons. This is very modest in relation to the 111,000 ton increase in 1972 and indicates that the effect of the higher price levels is beginning to be felt.

Stocks

After two years of surplus and a year in which supply and demand were in approximate balance it is predicted that there will be a net deficit in 1973 of 61,000 tons.

Gill & Duffus have adjusted their stock figures to an end of season basis, i.e., at 30th September, as opposed to the former end of year basis. Stocks on this new basis over the last 10 years have been:

WORLD COCOA PRODUCTION AND GRINDING DATA

Reproduced from Gill & Duffus Market Report
Dated 2nd February 1973

(Thousand long tons)

Production

	1970/71	1971/72 (Estimate)	1972/73 (Forecast)
Africa	1084	1145	1062
America	312	306	340
West Indies	39	53	47
Asia and Oceania	44	44	45
World Total	1479	1548	1494
Principal Countries			
Ghana	386	457	435
Nigeria	303	251	255
Ivory Coast	177	221	185
Cameroon	110	121	102
Equatorial Guinea	32	22	15
Brazil	179	164	206
Ecuador	60	59	50
Dominican Republic	25	40	34
Venezuela	18	19	19
Colombia	21	22	23
Mexico	27	30	31
New Guinea	29	30	28

Grindings

	1971	1972 (Estimate)	1973 (Forecast)
Western Europe	528	558	566
Eastern Europe and U.S.S.R. ..	209	238	248
North America	291	302	292
Australia and New Zealand ..	17	18	18
Central and South America ..	172	199	205
Asia	55	58	61
Africa	146	156	150
World Total	1418	1529	1540
Principal Countries			
United States	275	284	275
Germany (Federal Republic) ..	131	137	140
Netherlands	119	122	122
United Kingdom	83	96	102
U.S.S.R.	108	130	135
France	41	46	45
Nominal Balance (after allowing for 1% loss in weight)	+46	+4	—61

30th September	1964	588,000 tons	(6·0 months usage)
,,	1965	768,000 tons	(7·2 ,, ,,)
,,	1966	604,000 tons	(5·3 ,, ,,)
,,	1967	557,000 tons	(4·9 ,, ,,)
,,	1968	493,000 tons	(4·3 ,, ,,)
,,	1969	352,000 tons	(3·1 ,, ,,)
,,	1970	421,000 tons	(3·8 ,, ,,)
,,	1971	489,000 tons	(4·2 ,, ,,)
,,	1972	523,000 tons	(4·2 ,, ,,)
,,	1973	465,000* tons	(3·6 ,, ,,)

*Forecast

From these figures it can be seen that stocks are expected to be at a comparatively low level at the end of this season.

Prices

Month end prices for nearby Ghana shipment cocoa have been:

September	£313·0/metric ton
October	£307·0/metric ton
November	£308·0/metric ton
December	£321·5/metric ton
January	£310·0/metric ton

After rising steadily over the first eight months of 1972, prices have stabilised at the higher level.

International Cocoa Agreement

A. P. Williamson, Cadbury Schweppes Limited

After more than sixteen years of talks a draft International Cocoa Agreement was finally adopted in Geneva on the 25th October 1972 at the end of a six-week negotiating conference called by the United Nations Commission on Trade and Development. 53 of the 55 producing and consuming countries present approved the draft, but the United States, the world's largest consumer, and West Germany both reserved their position, although West Germany has since indicated that it will sign.

The object of the agreement is to reduce the wide fluctuations in the price of cocoa and to establish a minimum price. This is to be done by restricting cocoa exports as prices fall, the surplus to be held in a buffer stock and sold when prices rise again. It is hoped to control prices within an agreed range which for the first two years will be from 23 to 32 cents/lb range (£216-£300/metric ton*). It should be recognised however that, while there is a mechanism to prevent the price of cocoa falling below the minimum, there is nothing to prevent the price rising above the top end of the price range once any cocoa in the buffer stock has been sold. The top end of the range is not therefore a maximum price.

All prices quoted in the agreement are based on a daily price calculated by taking the average of the first three delivery positions on the London terminal market converted into cents/lb and the average of the first three delivery positions on the New York terminal market and averaging the two. The indicator price is the average of the daily prices over the previous 15 working days.

The agreement will be controlled by a Cocoa Council, on which all member countries will be represented. The detailed operation of the agreement will be the responsibility of an Executive Committee elected by the Council, which will also appoint an Executive Director as chief administrator, and a Buffer Stock Manager.

Export Quotas

It is proposed that prices should be controlled within the agreed range by means of export quotas. Quotas will not be applied to small producing countries exporting less than 10,000 tons, nor to producers of fine and flavour cocoa. The countries classified as fine or flavour cocoas in the agreement are shown in table 1.

*All prices have been converted into sterling at $2.35/£.

Table 1

Fine or flavour cocoa producers

1 Countries producing exclusively fine or flavour cocoa:

Dominica	Sri Lanka
Ecuador	St. Lucia
Grenada	St. Vincent
Indonesia	Surinam
Jamaica	Trinidad and Tobago
Madagascar	Venezuela
Panama	Western Samoa

2 Countries producing fine or flavour cocoa, but not exclusively:

Costa Rica	25%	Proportion of production considered fine or flavour cocoa.
St. Tome and Principe	50%	
Australia (Papua New Guinea)	75%	

Prior to the start of each crop year, which runs from the 1st October to 30th September, the Council will decide on the desired level of total world exports of cocoa during the year. This will be based on the forecast level of demand bearing in mind the expected price levels, etc. Allowances will then be made for predicted exports from the small producers not subject to quotas, for exports of fine or flavour cocoas, and exports from non-member producing countries. The balance will be divided among the major producing countries in proportion to their basic quotas to give each an annual export quota. The basic quotas used in calculating annual export quotas are based on each country's highest production over the last eight years and are listed in table 2.

Table 2

Basic Quotas	%
Ghana	36·7
Nigeria	19·5
Ivory Coast	14·2
Brazil	12·7
Cameroon	8·0
Dominican Republic	3·0
Equatorial Guinea	2·4
Togo	1·8
Mexico	1·7
	100·0%

The annual export quotas will be adjusted up or down according to the indicator price ruling at the time on the following basis:

below 24 c/lb	(below £225/metric ton)	90%
24-26 c/lb	(£225-£244/metric ton)	95%
26-27 c/lb	(£244-£258/metric ton)	100%
27·5-29 c/lb	(£258-£272/metric ton)	105%
above 29 c/lb	(above £272/metric ton)	no restrictions on exports

To ensure that countries are in a position to comply with any quota cuts that may be imposed, exports during the first half of the quota year, i.e., to 30th March, are limited to 85% of the country's annual export quota. Exports to the end of the third quarter, i.e., to the 30th June, are limited to 90% of the annual export quota.

Buffer Stock

If a country produces more cocoa than the final quota in effect at the end of the year it will be able to sell the surplus to the buffer stock.

When the buffer stock buys cocoa surplus to quotas it will initially pay the producing country concerned 10 cents/lb (£94/metric ton) f.o.b. When the cocoa is ultimately sold, the producing country will receive the sale price less the costs incurred in shipping and storing it. The buffer stock is limited to 250,000 tons and once this tonnage is reached any further cocoa will be bought by the buffer stock and sold to vegetable oil processers. In these circumstances the producing country will get the equivalent of the f.o.b. sale price.

If the indicator price reaches 31 cents/lb (£291/metric ton) the buffer stock manager may commence selling, and at 32 cents/lb (£300/metric ton) he must sell any cocoa remaining in the buffer stock.

The text as it stands assumes that the buffer stock operation will be financed by a levy of 1 cent/lb (£9·4/metric ton) on all cocoa exported by member producing countries, except producers of fine and flavour cocoas, but the possibility of International Monetary Fund financing is being examined.

The control mechanism envisaged for collection of the levy is that all member producing countries will require a certificate of contribution before allowing cocoa to be exported. Each individual producing country will be responsible for ensuring that its exports are within its quota. Producers of fine and flavour cocoas who are exempt from the levy and all restrictions on exports will conform with the control measures by issuing certificates of origin.

All importing members will require certificates of contribution or origin to be produced at the time of import. Cocoa from non-member producing countries without this certificate will have to pay the levy before being allowed in. In times of quota cuts, member importers will restrict imports from non-members.

Implementation of the Agreement

The proposed agreement will be open at the United Nations headquarters in New York from 15th November 1972 to 15th January 1973 for countries to signify their intention of ratifying the agreement.

It is proposed that the agreement should enter into force between 30th April 1973 and 30th June 1973, after ratification by governments of at least 5 exporting countries having more than 80% of basic export quotas and governments of importing countries consuming more than 70% of total world imports of cocoa. If this is achieved then the agreement could become operational at the start of the next crop year, i.e., 1st October 1973.

It will not be known until 15th January whether sufficient countries have signified their intention of ratifying the agreement and even if this is achieved it will not be known whether sufficient countries have actually ratified the agreement until 30th June 1973*. Only then will the Secretary General of U.N.C.T.A.D. be able to convene the first session of the Council to start making the necessary arrangements for the implementation of the scheme. It is generally felt therefore that it will not be practicable for the scheme to become operational before the start of the following crop year, i.e., 1st October 1974, at the earliest.

The United States reservation is one of principle and concerns the price at which all restrictions on exports of cocoa will be removed. There seems little likelihood of the U.S. withdrawing its reservation and signing the agreement in the immediate future.

The West German reservation was not concerned with the principles of the agreement, but with the implementation of the agreement as it stood without the participation of the United States. Several other consuming countries shared West Germany's concern, but were not prepared to reserve their position on the whole agreement for this reason and, indeed, West Germany has now withdrawn its reservation.

The U.S. represents just over 25% of total world consumption so, if the necessary 70% is to be achieved, almost every other consuming country must ratify the agreement and this may well prove impossible. If insufficient ratifications are received, then there will be a further meeting of those countries that have ratified the agreement to decide whether to carry on with a lower level of participation.

How the Agreement will affect the Growers of Cocoa

In the case of growers in countries defined as fine or flavour producers, the agreement will have no direct effect on them at all. All that they will need to do is to ensure that a certificate of origin or other similar control document is included with the documents so that the buyer will not have to pay any levy on importing the cocoa.

In the three countries where only part of the production is fine or flavour cocoa, it will be up to the governments concerned to decide how they will comply with the agreement, i.e., whether cocoa from certain areas will be classified as fine and flavour and exempt from all controls, or whether all their production will be subject to the levy on a pro rata basis and subject to some export controls.

In the great majority of major cocoa producing countries cocoa is bought from local growers at a fixed price and sold on the world markets by government controlled agencies. In these countries the agreement is unlikely to have any noticeable effect on the growers of cocoa, except to the extent that it should stabilize prices and assist the governments in these countries in their economic planning.

***Footnote**

It has been announced that 6 producing countries with over 92% of basic quotas have signed the agreement but that the importing countries that have signed represent only 69·83% of consumption. The position is being discussed with the governments concerned, but it is expected that the consumer acceptances will be rounded up to the required 70%.

In bulk cocoa producing countries where there are no centralised marketing agencies, principally the small producing countries, then the agreement will have a rather bigger impact on growers. At this stage however, it is impossible to give any details as most of the operating rules will not be worked out until the Council has been formed. Few, if any, of these countries, however, are likely to be subject to quota restrictions as they will be exporting less than 10,000 tons and it seems likely that the only impact will be the necessity for exporters to pay the 1 cent/lb levy to the agent appointed by the Council, getting in return a certificate of contribution which will have to be shown to the customs authorities before the cocoa can be exported. This will involve the exporter in immediate out of pocket expense before he receives payment for his cocoa and although no details are spelt out, the wording of the agreement makes it clear that there will be flexibility about the way the levy shall be paid.

New Developments in Black Pod Epidemiology

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Renewed interest has been focused on *Phytophthora palmivora* pod rot of cocoa following the establishment of a Black Pod Disease Project under the auspices of The Cocoa, Chocolate and Confectionery Alliance. Gregory (7) has comprehensively reviewed the present situation and the setting-up of an International Black Pod Research Advisory Committee has been strongly recommended. Already American and African sub-groups have met separately to exchange ideas and research information. One immediately becomes aware of the vast amount of literature on the disease, especially on its epidemiology. Many possible sources and agents of the disease are listed but the life cycle is still largely confused, not least the part played by insects. Most workers are ready to agree that insects are probably involved in black pod epidemiology but since the pioneering work of Dade (1, 3) this aspect of the disease cycle has been sadly neglected. Recently Nigerian workers (6, 8) have begun to realise the importance of insect vectors but actual pin-pointing of specific vectors has been rudimentary. During work in Ghana the author concluded from observation trials that insects were strongly implicated in the life cycle of *P. palmivora* and experiments were initiated to investigate the insect species involved and the methods of transport of inoculum. With the aid of radio-isotopes and from transmission studies in the field their roles are beginning to be resolved.

Vector Studies

In order to appreciate the life cycle of the fungus one must visualise the cocoa farm from two different dimensions. Firstly, the individual tree, which bears pods at all levels and poses dispersal problems for the fungus within that tree. Secondly, the farm as a whole, with spread of the pathogen from tree to tree within the farm. Viewed from this angle it is possible to split the vectors into those involved in intra-tree or vertical spread and those involved in inter-tree or horizontal spread of inoculum.

1 Vertical Spread

Once a tree has contracted black pod disease there will be a gradual build-up of inoculum in the soil around that tree as rain-splashed sporangia are washed downwards. The amount present will depend upon the number of diseased pods and the density of sporulation. Pods discarded on the ground after harvesting will also contribute to the soil inoculum potential. At a later date spores in the soil may reach healthy pods, and so re-infect the tree, in several ways; by rain-splash, but there is an obvious limit to the distance that soil is carried by this agency, probably no more than 0·5-1 metre, and further the presence of leaf litter greatly diminishes this form of dispersal (8); by crawling insects, particularly ants, which in moving from the ground to on-the-tree sources may carry inoculum on their bodies (8, 9). However, the involvement of ants may

Crematogaster ants removing outer tissues from a hanging black pod be more specific and this is linked with their coccid-tending habits. A large number of ant species tend coccids on pods in cocoa farms and the majority of obligate tenders build tents or shelters around the coccids affording protection from predators, parasites and rain. Only a certain proportion of these species are implicated in black pod epidemiology and this is entirely dependent on the type of material used in tent construction. For this reason *Crematogaster striatula*, a small black shiny ant, stands out as an important vector. This ant uses dead plant tissues, including those of newly-infected and old black pods, to construct discrete, paper-like tents around the pod peduncle, frequently over the stalk-pod depression. Several other ant species use pod tissues but because of their limited occurrence they are not regarded as important vectors, whereas *C. striatula* is a common cocoa ant dominating substantial areas of cocoa under suitable conditions. Other species implicated in disease spread use mainly soil as building material and their tents are usually conspicuous, particularly on pods near the ground. The commonest soil-utilising ants include *Camponotus acvapimensis*, a large black ant, and *Pheidole megacephala*, a small brownish ant, and these frequently occur along the edges of cocoa farms. Their importance as vectors will be directly related to the presence and amount of viable inoculum in the soil around the colonised tree. Once the soil is contaminated there may be a continual re-cycling of inoculum, downwards via rain-splash and upwards via ants. These ants are probably of greatest importance early in the season when they create new infection foci. Obviously ants will use the nearest available building material so their role in horizontal spread will be limited, although radio-active pod tissues were carried to trees several metres away from a labelled black pod heap by *C. striatula*, radio-activity being ultimately detected around pods in the canopy.

This is not to suggest that black pod and tent-building ants go hand-in-hand but the presence or absence of these ants may explain differences in black pod losses between similar climatic areas. In Ghana probably 10-20% of cocoa trees are colonised by tent-building ants.

2 Horizontal Spread

This is still a speculative subject and although wind-dispersed spores have often been favoured they have never been isolated from the air (8, 12, 13). Earlier work (10) on natural spread in the field suggested that the spores were airborne due to the random dispersion of horizontal infections; the obvious answer seemed to be the involvement of flying insects.

Insects were collected from radio-active black pods in the field and assessed for uptake of labelled material; it was then possible to ascertain which species regularly visited black pods in order to feed on pod or fungal tissues. Microscopic examination further delimited those species which carried viable fungal spores, either internally or externally, and these were selected for further studies. A large number of species were discarded either because they visited black pods only irregularly or because viable inoculum was not present. However, the question of how the insects actually spread the disease still remained. A careful observation of the possible vectors revealed that certain species also regularly visit wounded pods, feeding on pod sugars or tissues. In this way the search was narrowed down to two probable vectors: *Brachypeplus depressus*, a small dark brown nitidulid beetle commonly found where the pod rests against the bark;

and *Chaetonerius latifemur*, a long-legged fly not unlike a large mosquito. These insects regularly feed on black pods, the beetle consuming pod plus fungal material and excreting *Phytophthora* spores in faecal pellets, the fly mopping-up sugars and dissolved substances with its sponging mouthparts, sporangia of the fungus sticking to this structure. Both lay their eggs in diseased pods and feed on wounded pods. The beetle invades particularly via borer or rodent wounds whilst the fly feeds externally wherever sugars are present, preferably around fresh insect lesions. Radio-active beetles, previously collected from black pods, were released in a cocoa farm and subsequently recovered from wounded, bait pods. Transmission studies with the fly have given about a 30% infection rate but this is extremely variable (5-60%) with the beetle and is governed by the susceptibility of the sporangia to the digestive enzymes. Beetles may also commonly carry inoculum on their body parts, so two methods of inoculum transport occur in this vector. These insects may also, of course, be responsible for vertical spread of the disease from pods near the tree base to those in the canopy, especially to animal-damaged pods. Both insect species have been observed by the author in Nigeria and the Cameroon Republic.

A bewildering variety of insects, and invertebrates in general, colonise black pods but those which carry inoculum internally are limited to certain beetle, caterpillar, millipede and snail species. Again radio-active studies have shown that these animals commonly feed on black pods, particularly those lying on the ground, and may move considerable distances after feeding, thereby spreading inoculum around the farm via the faeces.

Disease Cycle

The importance of different sources of inoculum and agents of dispersal will undoubtedly vary from region to region and from country to country and an understanding of the life cycle should therefore, be geared to local conditions. Nevertheless, it is still possible to interpret the major or fundamental components of the life cycle and these are summarized in Figure 1.

Control

No revolutionary new control measures can be gleaned from these findings but they do endorse other recommended methods of cultural control and explain their significance.

Removal of black pod heaps and individual pods from the ground after harvesting will greatly reduce the amount of soil inoculum, the feeding and breeding sites of insect vectors, the tent-building material of some ant species, the food supply of herbivorous invertebrates. Obviously these sources can be further reduced by regular harvesting but this is only feasible for large plantations.

Judicious insecticide spraying of black pod heaps, or their burial, together with the elimination of forest fruit-bearing trees, which provide alternate feeding and breeding sites for insect vectors, may reduce vector populations and ultimately reduce black pod losses.

The ant fauna can be manipulated agronomically, and, by removal of dead wood, *Crematogaster striatula* can be replaced by less destructive ant species (4). Thinning of the shade and canopy, as well as reducing humidity, will also discourage this ant which thrives under heavy shade.

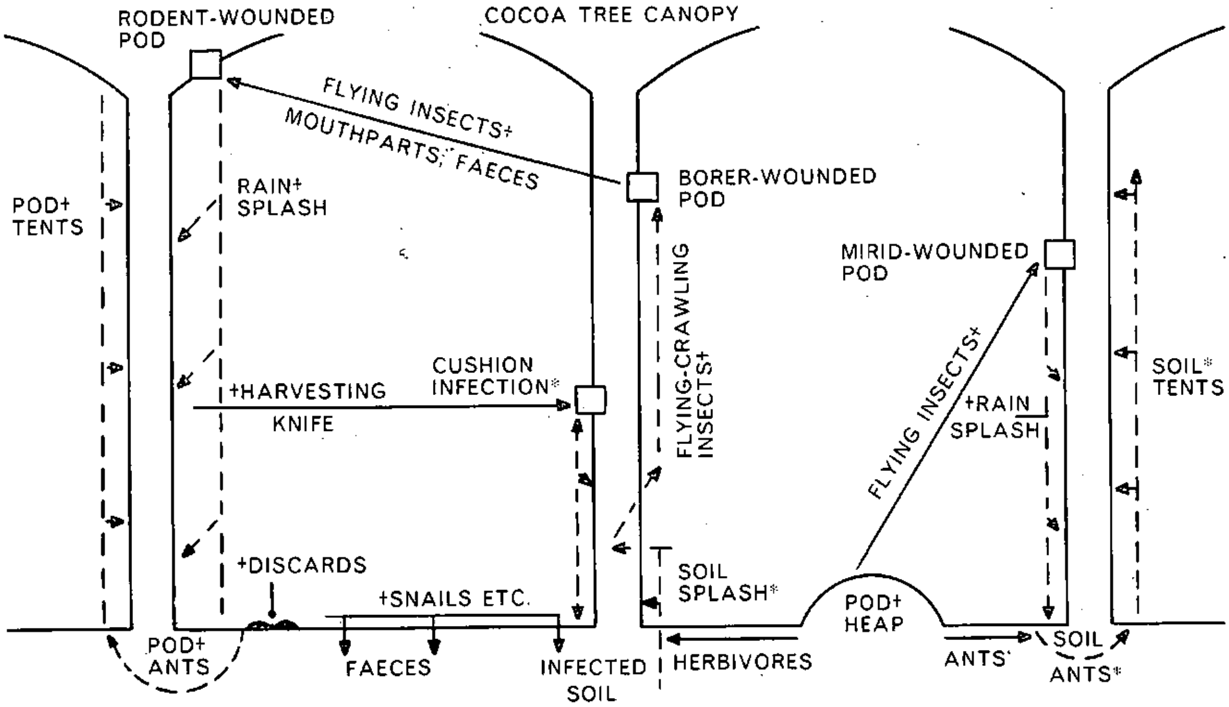


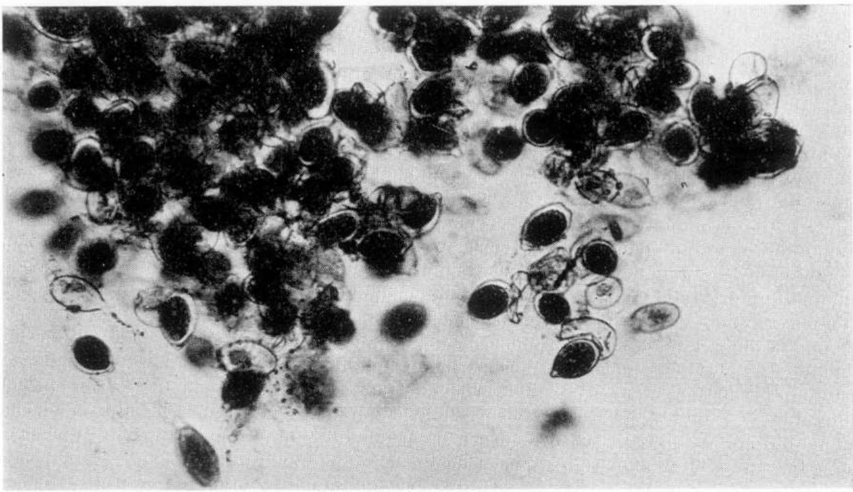
Fig. 1. Schematic representation of the black pod disease cycle within a cocoa farm.
Horizontal spread) indicating direction of
Vertical spread) inoculum movement
**Primary sources of inoculum which could trigger-off the disease cycle.*
+Sources of inoculum or agents of dispersal available once the cycle has started.

Better control of pod-wounding insects and rodents could be an indirect method of reducing disease incidence. Weststeijn (11) and Okaisabor (9) have demonstrated that insecticide sprays can significantly reduce black pod losses, although undesirable side effects, such as increase in borer damage, should be carefully assessed.

Perhaps the best remedy lies in an overall improvement in harvesting methods. Particular care should be taken during harvesting to prevent man-made wounds, implicated by Dade (2) as invariably developing infection, and so reduce the risk of vertical and horizontal spread of inoculum via the harvesting tool. This may also reduce the canker stage which readily develops in cushions where ripe pods have been removed with a contaminated knife (5). Dichotomy of the harvesting pattern, whereby healthy pods are harvested separately from black pods, may pay big dividends.

Acknowledgments

This article is published with the permission of the Director, C.R.I.G. The author is a member of the British Research Team, Overseas Development Administration.



Beetle faeces containing viable and empty P. palmivora sporangia

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Breeding Cocoa For Different Ecological Needs in Nigeria

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Introduction

The ideal goal of cocoa breeding in Nigeria is the development of general purpose varieties which will perform well under the various ecological conditions found in the cocoa growing areas of Nigeria. It is also the policy of Cocoa Research Institute of Nigeria (CRIN) to develop along with the above, cocoa materials with adaptation to specific ecological conditions obtaining in various cocoa growing zones of Nigeria.

1 General Purpose Varieties

The general purpose varieties now available to Nigerian farmers are the bulk F_3 Amazon and the WACRI Series II hybrids, otherwise called 'hybrid' cocoa. F_3 Amazon, as the prefix implies, is the third open-pollinated generation of the eleven approved Amazon 'T' types and have been fully described (2, 22). F_3 Amazon is thus a mixture of many unknown (illegitimate) or semi synthetic genotypes with a broad parental background. They are superior to West African Amelonado in establishment ability, vegetative vigour, precocity (earliness in bearing) and yield (22); they are also tolerant of Cocoa Swollen Shoot Virus (CSSV) and capsid attack (12, 16, 22). For these reasons, and because of its relatively wide parental background, F_3 Amazon is a good general purpose variety. It is, however, equally susceptible as Amelonado to black pod, caused by *Phytophthora palmivora*, and in fact the situation is probably worse with F_3 Amazon due to its higher yielding capacity with consequent increase in black pod losses (21). Also, because of the vigour and higher yields of F_3 Amazon, soil depletion quickly takes place and, unless fertilizers are applied liberally, the peak period of production will be maintained for only 5-6 years, compared with at least 10-12 years for Amelonado.

WACRI Series II hybrids which are mainly crosses between local and Amazon selections (as compared with WACRI Series I hybrids which are inter-Amazon crosses) are superior to F_3 Amazon as general purpose varieties and this was recognised when it was found that they grew more rapidly then the F_3 Amazon (6). The WACRI Series II has been described by Opeke and Toxopeus (19) and is made up of the crosses listed in table 1. The mixed series II hybrids are generally more vigorous, more precocious, higher yielding, and with higher pod value than the F_3 Amazon (3, 5, 6, 19). The average superiority in yield of these varieties over ordinary F_3 Amazon cocoa has been estimated in Ghana at about 200 lb dry cocoa per acre per annum (8).

Though the development of general purpose varieties superior to F_3 Amazon, and based largely on the recent Trinidad introductions, is at an advanced stage, the 'hybrid' cocoa or selected WACRI series II hybrids remain the most promising general purpose variety. In fact, the cocoa development scheme of Western State is relying heavily on series II hybrids.

Table 1

Estimated Dry Bean Yields (lb/acre) of WACRI Series II Progenies in Western Nigeria

(After Opeke and Toxopeus 1967)

Code	Genotypes*	Location			
		April '61-March '63		April '65-March '66	
		Ibule	G.E.S.	Ibule	G.E.S.
A	C18 x C74	N.A.	184·5	N.A.	100·8
B	C25 x C75	1034·0	223·5	822·2	132·3
C	C23 x C74	872·7	266·0	909·5	98·6
E	C68 x C26	1072·1	N.A.	980·6	N.A.
F	C67 x C77	242·7	N.A.	179·6	N.A.
G	C42 x C43	N.A.	92·9	N.A.	51·8
H	C27 x C77	1058·9	469·7	1202·4	224·6
K	C14 x C75	873·6	198·5	871·7	104·9
L	C75 x C14	814·7	N.A.	1103·4	N.A.
X	F3 Amazon	732·3	156·2	925·7	77·9

*Full details of these crosses were given in Glendinning, D. R. "New Cocoa Varieties in Ghana". *Cocoa Growers' Bull.*, **8**, 19-25.

Table 2

List of 'CRIN Establishment Ability' elites (After Jacob, Atanda & Opeke, 1971)

(1)	T7/12	x	Na32 (or C64)
(2)	T12/5	x	Pa35 (or C65)
(3)	T17/11	x	Na32
(4)	T20/21	x	Na32
(5)	T30/10	x	Na32
(6)	T65/7	x	Na32
(7)	T85/5	x	Pa35
(8)	T86/45	x	Na32
(9)	ICS1	x	Na32
(10)	ICS7	x	Na32
(11)	T85/799	x	E1: C43/270
(12)	T85/799	x	C64
(13)	T85/799	x	T79/501 (WACRI Series IIF)
(14)	T63/967	x	W41 (WACRI Series IIK/L)
(15)	T16/613	x	E1: C43/291 (WACRI Series IID)

2 Varieties for Marginal and Dry Cocoa Growing Zones

In parts of Nigeria, the dry season is protracted and severe from November to March, and this, aggravated by the modern practice of wider spacing, has made establishment of Amelonado virtually impossible. As mentioned earlier, F_3 Amazon has superior establishment ability to Amelonado as do some of the WACRI series II hybrids. Specifically, progenies of WACRI series II K/L (C14 x C75) appear best adapted to dry conditions followed by plants of series IIE (C68 x C26) (19).

In an effort to obtain cocoa varieties with better establishment ability, about seventy progenies were tested in 1963 and 1964 at four locations of Western State as follows:

1. Ibule (near Ondo) — an average cocoa area with 60-65″ rainfall per annum with good deep soil.
2. Ogbere (near Ibadan) — marginal cocoa area with 40-45″ rainfall per annum and structurally fair but well drained soil.
3. Ilaro (in Abeokuta province) — marginal cocoa area with 50-60″ rainfall per annum. The soil is relatively sandy and severely leached.
4. Ikija (near Ijebu-Ode) — marginal cocoa area with 40-45″ rainfall per annum. Well drained soil.

The available germplasm drawn upon were (a) Trinidad genotypes available at the Gambari Experimental Station of Cocoa Research Institute of Nigeria (G.E.S.); (b) The 1957 Na32-Pa35 biclonal seed orchard at G.E.S.; (c) WACRI 'C' clones to reproduce promising WACRI series II progenies; (d) Virus tolerant selections of Longworth & Thresh and (e) The selections N(T)38, CF62 and CF176 of the first Nigerian Breeding Programme. Typically, the experimental plot was an unshaded, clean weeded area. The design was a randomised block with four replications containing 49 plants per plot; spacing was 7′ × 7′. Side shade was provided at the time of planting in May-June and again at the onset of the dry season. The side shade was made up of two pieces of palm frond of the same length as the seedling height and put vertically in the ground close to the plant on either side of the east-west axis so as to provide for maximum side shade. Selection for outstanding progenies were made two or three years after planting. Criteria for selection were percentage survival and canopy development including retention of reasonably good canopy in the dry season. From the various trials, CRIN establishment elites were selected by Toxopeus in 1969 (table 2). A few of these "CRIN establishment" elite selections are now undergoing trials with and without fertilizer with a view to ascertaining the influence of fertilizer on the establishment ability of the best and the average of the selections. Investigations have also commenced on whether the establishment ability resides in the root or shoot system or both. It is projected that mixed CRIN elite progenies will soon be released to the Nigerian farmers. With the newly assembled germplasm, CRIN is now initiating a more comprehensive establishment ability trial with a broader gene base and superior establishment ability than the present "CRIN establishment" elites. Perhaps the greatest limitation to establishment ability trials is the shortage of seedlings due to low fruit set and small number of parent trees.

3 Varieties for rehabilitating Cocoa Swollen Shoot Virus (CSSV) infected Areas

The cocoa swollen shoot virus (CSSV) strains in Nigeria have mild effects compared with those in Ghana. The former, alone, do not affect the yield of local Amelonado variety (14). Infected trees are, however, debilitated and easily succumb to secondary pathogens and pests (11). Areas totalling more than 1,000 square miles in two different parts of the cocoa belt were designated as "areas of mass infection", and then abandoned (13, 20). As there is no known immunity to CSSV, this vast area could only be rehabilitated with varieties tolerant of CSSV.

Breeding for tolerance to CSSV was started in Nigeria in 1959 by screening available T (Trinidad) types, WACRI "C" clones and WACRI series II hybrids. Screening of "T" types was intended as a preliminary study of the reaction of different cocoa groups to a typical virulent strain of virus. The WACRI "C" clones were screened to reveal types for use in breeding tolerant varieties; as these clones had been selected as good parents from the point of view of yield and vigour, and were crossed to produce the series II hybrids (15). In 1961, field trials testing the WACRI series II hybrids and progenies of promising parents were laid out and the trees infected a year later (16). Several promising progenies were selected from the trials, the tolerant selections being found among the introduced genotypes, while West African Amelonado did not show any detectable CSSV tolerance (10). The tolerant selections were planted in two further trials in 1965, aimed at:

1. Evaluating their commercial characters.
2. Studying the rate of spread of CSSV on selected progenies when artificially infected.

The results of the first trial showed that in terms of establishment ability, precocity and estimated long term yield performance, none of the CSSV selections studied is significantly worse than F_3 Amazon. The second trial was slowed down by the relatively slow development of canopy, but other work showed that a close canopy is an essential aid to rapid spread among susceptible trees; but among tolerant trees, virus is likely to spread slowly because the mealybugs do not readily acquire virus from them (16). Meanwhile, new selections are being made from the existing CSSV trials and the newly assembled germplasm at Gambari. The genetic basis of CSSV tolerance is also being investigated (5) but the pace of progress here is being slowed by the high level of self-incompatibility in the selected trees which makes it difficult to obtain inbred progenies.

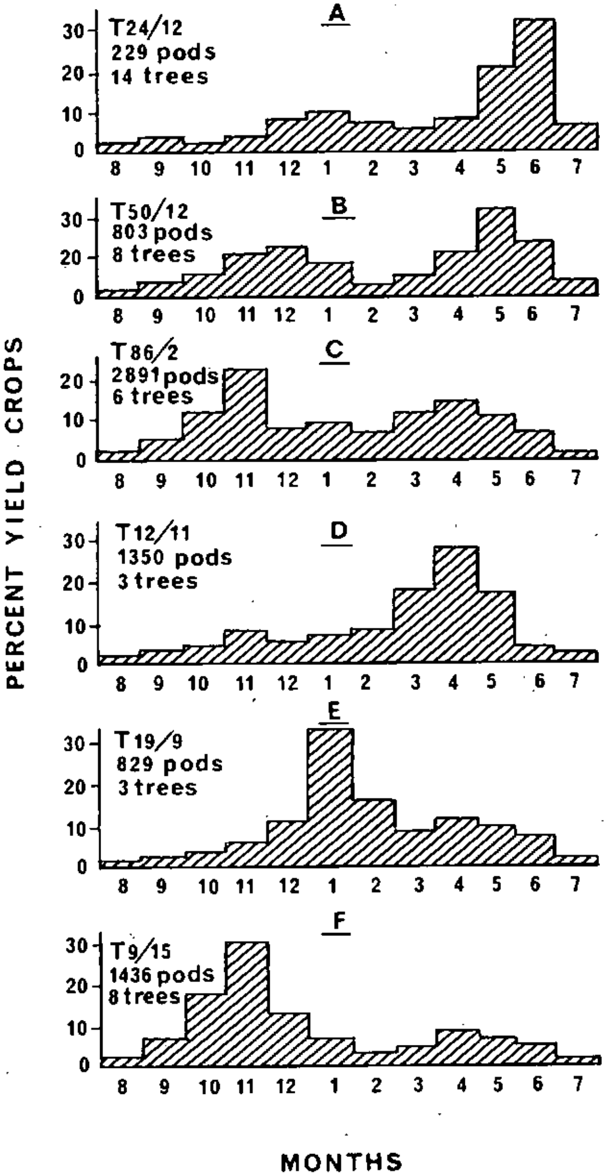
The pace of assessment also continues to be slowed down by the unsolved problem of obtaining healthy budwood from an infected tree (10). The assessment for CSSV tolerance has also been made difficult by the varying length of the period of latent infection.

4 Varieties for Ecological Zones more liable to Black Pod Attack

Black pod is a major disease of cocoa in Nigeria. Losses are in the order of 30-40% and 90% in the Western and South Eastern States respectively and could be reduced by breeding for black pod resistance/tolerance or escape.

Fig. 1

Pod Production Patterns of Black Pod Resistant and Escape Cocoa Genotypes



After four years of observations on a collection of about 100 clones, the following were selected for apparent resistance or escape, Fig. 1 (23):

T24/12 and T12/11: almost complete escape

T9/15 and T86/2: resistant/tolerant

T50/12 and T19/9: part escape

The black pod "escapers" produce the bulk of their crop in the period when the climatic conditions are least conducive to the disease. The "escapers" will have slightly lower pod value due to dry season effect (1, 9), but in areas like Ikom in the South Eastern State, one can afford to sacrifice a certain level of pod value rather than lose 90% or more of the crop to black pod disease during the rainy season. In breeding for black pod resistance or escape continuous vigilance is being paid to the evolution of new and perhaps more virulent strains of the fungus. Meanwhile the F_2 Amazon population in Nigeria continues to provide a source of black pod resistance or escape (10) and so will the recent Trinidad introductions.

General

Self and cross-incompatability in Amazon genotypes constitute a major impediment to the execution of a cocoa breeding programme. Only a few of the Amazon types which form the bulk of germplasm drawn upon for these breeding programmes can be selfed, and even then with varying degrees of success. As the production of inbred progenies is indispensable to a proper understanding of the genetic basis of any breeding programme, studies have been carried out in CRIN to overcome self-incompatibility in cocoa. Glendinning (7) produced 10% selfings from Na32 by mixed pollination involving simultaneous application of self pollen and pollen from a compatible genotype carrying a "marker" gene for axil spot in the seedlings. At CRIN up to 80% of selfings have been obtained from self-incompatible genotypes through delayed mixed pollination (17). It involves the application of compatible pollen carrying a "marker" gene four hours after self-pollination.

This paper is perhaps best concluded by emphasising once more the ideal objective of CRIN which is to evolve general purpose varieties combining a high degree of establishment ability, favourable yield factors and resistance/tolerance to the major pests and diseases in Nigeria.

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Book Review

"Pests of Cocoa", P. F. Entwistle, Longmans £15

In his preface, the author states that "this book is an attempt to bring together all that is known of insects in relation to cocoa". The result is a large book, no less than 780 pages, and as it was "written outside normal working hours" the reviewer is full of admiration for the enormous effort that was involved.

In pursuing his objective the author has been successful. He has brought together all that is known or, more accurately, all that was known at the time the book was written, about cocoa insects. Obviously this book, like any other text book, will become out-of-date, but it will be many years before anyone attempts this task again, and the book is bound to remain the standard reference on this subject for a long time.

This book is designed, like others in the Tropical Science Series, for the scientist; for the cocoa grower and extension worker, the book is too detailed, but nevertheless they would find it helpful. The information on each pest is presented in a logical sequence and the style is generally readable. There is a useful guide to pest identification in Appendix I, from which pests can be identified according to the type of damage caused and also by insect types, and the reader is referred to the excellent line drawings which illustrate all but the most minor pests. There are many other photographs and no less than 29 colour plates, but these have been crowded onto 4 pages and not all of them are very clear; it might have been better to have had fewer, larger illustrations.

A second appendix lists the insects that have been recorded as feeding on cocoa and this amounts to the awesome total of 1,400 species, but naturally only a portion of these are dealt with in the text. The book starts with three chapters on the cocoa tree, its relation to insects and the general principles of their control. The following chapters deal with insects by family. Long chapters are devoted to mealy bugs and their association with virus disease and to capsids, both subjects being covered thoroughly, virus diseases possibly too thoroughly for a book on insect pests.

The chapter on capsids concludes with a section on control. The author rightly states that insecticidal control will continue as the standard method of control in West Africa. Integrated control schemes, involving a degree of biological control, seem unlikely to be practical and have a long way to go before being technically feasible. The continuance of insecticidal control will mean a continued, if not continuous, search for alternative insecticides and also for the feasibility of using pheromones or sex attractants, which have been shown to exist in one capsid species.

The chapter on pollination which may seem out of place in a book on pests, serves to emphasise the lack of knowledge on this subject. With hindsight it seems remarkable that the agents of pollination were not identified until 1941 and even then there was some uncertainty owing to the minute nature of the midges involved. It is, perhaps, even more remarkable that, having identified the pollinating insects some 30 years ago, we still have very little knowledge about them. Granted, they are small and elusive but there have been very few population studies and only rather scanty evidence as to the distance they travel. These points are very important as it may well be that in some countries the population of pollinating midges is too small at certain seasons of the year for effective pollination and this could prove to be a limiting factor. For that matter cocoa has been planted in many new areas during recent years in the faith that the pollinating insects would be present; so far, that faith has not been misplaced.

The effect of insecticides applied to control pests on the pollinating midges has often been considered but the studies are inconclusive. Evidence indicates that some pesticides are harmless in this respect while others may influence pod setting but it is pointed out that the effect of insecticides on pollination will be affected by the area sprayed, the period over which treatment is effected and the conditions under which the cocoa is grown. There is probably little danger to the population of pollinator species under West African conditions, with small farms and jungle shade, but where there are large estates with little shade, the prolonged use of insecticides might affect it.

The section on *Bathycoelia thalassina* rightly describes this pest as a potentially serious one on Amazon and hybrid cocoa. On control the author quotes the published work on trials at Tafo, Ghana which indicated that organo-chlorines were ineffective. This may have been due to prolonged spraying with gamma-BHC against capsids, as unpublished work in Cameroon, where a severe attack reduced yields by 60-70%, showed that BHC and endosulfan were effective, though not as effective as fenitrothion.

The section on control of rodents is rather brief. The planter who is suffering from rodent losses might wish rather more detail on the use of baits.

The final chapter deals with pests of cocoa in storage. The most important storage pests are the moths *Cadra cautella*, a tropical species and *Ephestia elutella* a temperate species. The author states that *C. cautella* does not breed in Great Britain; while it will not breed at ambient temperatures, this species breeds readily in any heated premises and is therefore a great danger to cocoa and chocolate factories. From the manufacturers' point of view, this is the most important storage pest, against which stringent and expensive precautions have to be taken.

Both author and publisher deserve praise for this book, but, regretably, its distribution will be restricted by its high price.

G. A. R. Wood

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Cocoa Abstracts

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

June 1972

Mainstone, B. J. (Dunlop Res. Centre, Batang Melaka, W. Malaysia). **Environmental influences and the importance of covers and shade for cocoa.** Planter 47, 547, pp. 437-48 (1971).

Information currently available concerning the effects on cocoa physiology of temperature, humidity, light intensity and the availability of soil water is presented. Following on the literature relating to the establishment of cocoa in association with mulches, use of ground covers and shade plants is discussed. This leads to a consideration of the findings of shade experiments with mature cocoa. From author's summary. Tables. Graphs. 47 refs. To be continued.

Vello, F., et al. Renovação de cacaueiros velhos na Bahia. (Rejuvenation of old cocoa fields in Bahia). Cacau Atualidades 8, 1, pp. 3-11 (1971).

Large-scale rejuvenation of cocoa in Bahia, Brazil, is held back by an insufficient supply of improved seed. Hand-pollination of white-seeded Catongo with pollen of several purple-seeded clones (which eliminates the need of flower isolation) provides a few million seeds a year; the production will, however, be substantially increased when seed gardens become productive. A comparison of man-hours and materials required for, and of the growth of seedlings under 2 systems of rejuvenation shows that replanting in old fields with subsequent removal of the old trees is more profitable than clearing before replanting. Tables. 10 refs.

Morais, F. I. de Oliveira, and Rosand, F. P. Cabala. Efeitos dos equilibrios entre cálcio, magnesio e potássio no crescimento do cacaueiro. (Effects of the balance between Ca, Mg, and K on the growth of cocoa). Rev. Theobroma 1, 3, pp. 21-32 (1971).

In Bahia, Brazil, cocoa seedlings were grown for 9 months in plastic bags containing 10 kg of an infertile soil; N, P, K and minor nutrients were applied uniformly. When sufficient $CaCO_3$ was applied to neutralize the exchangeable Al, the dry matter production of the cocoa plants increased with Mg dosages of up to 1.87 me/100 g soil, independent of the Mg/K ratio. When uniform amounts of Mg were applied, dry matter production increased with the dosage of Ca and, consequently, with the (Ca + Mg)/K ratio. In this case the maximum Ca dosage was 5.48 me/100 g soil yielding an exchangeable (Ca + Mg)/K ratio of 24.5 at the start and one of 71.4 at the end of the trial, English summary. Tables. Graph. 23 refs.

Miranda, E. R. de, and Dias, A. C. da Costa Pinto. Efeito da saturação de aluminio no crescimento de plântulas de cacau. (Effect of Al saturation on the growth of cocoa seedlings). Rev. Theobroma 1, 3, pp. 33-42 (1971).

Effects of additions of Al sulphate NPK fertilizers, and lime on the chemical properties of a poor acid soil from the Bahia, Brazil, cocoa belt were studied in the laboratory. When cocoa seedlings were grown in this soil to which 10 g Al sulphate and 1-5 g of lime per kg had been applied, their growth was not appreciably impaired by Al saturation values of up to 32%, however, they were very poor at higher saturation percentages (Al saturation = the ratio of exchangeable Al to exchangeable (Al + Ca + Mg + K) contents). This indicates that soils rich in Al need no liming, unless Al saturation is very high. English summary. Tables. Graph. Photo. 14 refs.

Adebayo, A. A. (Cocoa Res. Inst. Nigeria, Moor Plantation, P.M.B. 5244, Ibadan, Nigeria). **A technique of inoculation of fixed cocoa pods with Phytophthora palmivora (Butl.) Butl.** Turrialba Rev. Interamer. Ciencias Agr. 21, 3, pp. 280-2 (1971).

A standardized technique for field inoculation of cocoa pods with *P. palmivora* is described. A test experiment, with cocoa clones of known field susceptibility, which confirm the usefulness of the technique is reported. Author's summary. Spanish summary. Table. Photo. 12 refs.

Wood, G. A. R. Cocoa drying. Planter 47, 547, pp. 449-58 (1971).

The various methods of drying cocoa beans currently in use are described and their merits and demerits discussed. Artificial dryers can be divided into non-mechanical dryers depending on conduction or convection to convey heat from a solid fuel fire to the wet beans, and mechanical dryers using fans and heaters to blow hot air through a layer of wet beans. There are 2 sorts of mechanical dryers: rotary dryers and platform dryers. The article also discusses the effects of drying methods on flavour and quality of the product. Table. 14 refs.

Purr, A., and Helfenberger, A. (Inst. Food Technol. Packaging, Munich, Germany). **Effect on the curing of fresh cocoa beans by vacuum infiltration of certain substances.** Gordian 10, 1656, pp. 298-304 (1971).

On the basis of available knowledge on the chemistry of chocolate flavour development during fermentation of cocoa beans, a preliminary experiment was conducted in Costa Rica on the possible quality improving effect of vacuum infiltration of certain substances in fresh beans followed by different curing procedures. Definite results will be presented later. Tables. Graphs. 7 refs.

Quesnel, V. C. Slimy fermentation. Ann. Rep. Cocoa Res. 1970, pp. 47-8 (1970).

From time to time cocoa fermentations have been observed in the W. Indies in which the pulp became extraordinarily slimy; the phenomenon appears to be restricted to the wet season and to be associated with low fermentation temperatures. In 2 cases occurring in Trinidad, fermentation could be restored to normal by adding properly fermenting cocoa to the mass and by attracting *Drosophila* flies with rotting bananas, respectively. This suggests that sliminess results from the absence of pectinase-producing yeast strains.

Delaporte, G. La commercialisation du cacao et du café au Cameroun et l'action des caisses de stabilisation. (The marketing of cocoa and coffee in the Cameroon Rep. and the operation of the stabilization funds). Marches Trop. Medit. 28, 1368, pp. 288-92 (1972).

In the Cameroon Rep., 3 separate stabilization funds (caisses des stabilisation) are in operation: 1 for cocoa, 1 for robusta coffee and 1 for *arabica* coffee. The different methods, used in each of these funds, to achieve price stabilization, are discussed in detail. The cocoa fund is by far the largest. Information is also given on production. Estimates for 1971-72 are 110,000 tons cocoa, 60,000 tons robusta and 19,000 tons *arabica* coffee. Tables.

Vasconcelos Fulho, A. P. Renovação de cacauais. (Rejuvenation of cocoa fields). Cacau Atualidades 8, 2, pp. 16-26 (1971).

In the State of Bahia, Brazil, cocoa in the coastal area around Ilhéus, where soils and climate are near-optimum for the crop, is less productive than cocoa in the less favourable inland zone, because the plantations are older and nearing the end of their economic life. It is envisaged to rejuvenate 150,000 ha in the coastal zone within 10-12 years. Replanting in existing fields is preferred to clearing because the former method, though technically more difficult, is more readily adopted by the farmers. Seed gardens have been established and a credit system has become operational. It is hoped that the relative importance of Brazil as a cocoa-producing country will be restored to its former level. Tables. Graph. Photo. Maps.

Okaisabor, E. K. (Cocoa Res. Inst. Nigeria, Ibadan, Nigeria). **The survival of Phytophthora palmivora (Butl.) Butl. through the dry season.** Nigerian Agr. J. 6, 2, pp. 85-9 (1969).

Investigations conducted in Nigeria showed that the survival of *Phytophthora palmivora* (the pathogen of black pod disease of cocoa) in infected leaves, chupons, undetached pods and flower cushions of cocoa varied from 2 weeks to 3 months. The fungus could not survive in these tissues through the dry months from November to March. The occurrence of hyperparasites and secondary invading micro-organisms and the adverse effects of the dry season are considered to be mainly responsible for the short survival. The fungus remained viable in buried black pod tissues for at least 12 months, and these are considered to be the sources of fresh outbreaks of black pod disease epidemics. Tables. 19 refs.

Sharma, R. D. Nematódios associados com o cacaueiro e seringueira na Bahia. (Nematodes associated with cocoa and rubber in Bahia). Rev. Theobroma 1, 3, pp. 43-5 (1971).

A survey was conducted of nematodes occurring in the rhizosphere of cocoa and rubber plants in Bahia, Brazil. Diseased nursery plants of cocoa were found to suffer severe damage to the roots caused by *Dolichodorus* sp., which was not known to parasitize cocoa and by *Xiphinema* sp. Roots of diseased nursery plants of rubber showed lesions due to the presence of *Pratylenchus* sp. Text also in English. 2 refs.

Ghosh, B. N. Nôvo sistema para secagem de cacau. (A new drying system for cocoa beans). Rev. Theobroma 1, 3, pp. 45-7 (1971).

A new type of cocoa dryer designed in Bahia, Brazil, essentially consists of a series of drying platforms covered by an overhanging glass roof; adjustable shutters and an exhaust chimney allow controlled ventilation. An air chamber below the platforms can be heated by infra-red heaters using commercial gas. After 1 day of exposure to the sun, cocoa beans can be dried at a temp. of 70°C to a moisture content below 7% in 16-18 hrs without any risk of becoming smoky. Text also in English.

August 1972

Boyer, J. Étude des principales composantes du microclimat d'une cacaoyère au Cameroun. Importance écologique des variations spatiales et saisonnières. (Study of the main microclimatic components of a cocoa plantation in the Cameroon Rep. Ecological importance of spatial and seasonal variations). Café Cacao Thé 15, 4, pp. 275-300 (1971).

Microclimatic measurements were conducted in a smallholder's cocoa planting near Yaoundé, the Cameroon Rep., during 3 years. It became apparent that seasonal rainfall pattern and intensity of solar radiation markedly affected the behaviour of the plantation. Measurements on light distribution, leaf temperature and atmospheric humidity show a remarkable degree of resemblance with that of different types of forest cover. English, German, and Spanish summaries. Tables. Graphs. 26 refs.

Guers, J. (Fac. Sci. Yaoundé, Yaoundé, Cameroun). **Influence de l'éclairement sur la morphologie et la physiologie des feuilles de cacaoyer. (Theobroma cacao L.).** (Effect of illumination on the morphology and physiology of cocoa tree leaves). Café Cacao Thé 15, 3 pp. 191-201 (1971).

Leaves from 25-year-old Amelonado trees exposed to different illumination intensities were sampled in a plantation near Yaoundé, the Cameroon Rep., and analysed for leaf surface, dry weight, thickness of main rib and veins, nitrogen and chlorophyll contents. The preliminary observations indicate that in an unshaded area, leaves exposed to direct sunlight are much smaller and thicker, and have a lower water content than leaves in shaded areas; their nitrogen content and especially their chlorophyll content is also much lower. English, German, and Spanish summaries. Tables, Graphs. Photos. 13 refs.

Shearing, C. H., and Lim Hong Kee. Cocoa progeny trials on BAL estates. Planter 47, 545, pp. 351-63 (1971).

Results are reported obtained so far from 2 progeny trials, one including 4 Amelonado × Upper Amazon (UA) crosses and the other 5 UA × UA families, established in Sabah, Malaysia in 1964 and 1965. Growth and yield performance of all the hybrids tested showed to be greatly superior to that of Amelonado cocoa seedlings. Recent findings have largely removed concern about profuse flowering observed in some of the best crosses. Tables. Graphs. 4 refs.

Chee Yau Fah. Cocoa breeding in Sabah. Planter 47, 545, pp. 364-73 (1971).

Cocoa breeding and selection was taken up in Sabah, Malaysia, in 1958/59 to provide for improved planting material. Background information for the present breeding programme and its goals are discussed. Results obtained so far with progeny trials are presented, and compared for 3 different localities. A wide range of mixed hybrids is now available from a seed garden. Arguments in support of the recommended planting of mixed hybrids rather than one type, concern flavour, cross-compatibility, disease resistance and adaptability. Discussion. Tables. 5 refs.

Tarjot, M. Quelques précisions sur le rôle de l'environnement dans le comportement des cabosses de cacaoyer envers le Phytophthora palmivora (Bult.) Butl. en Côte d'Ivoire. (Some details concerning the role of the environment on the behaviour of cocoa pods towards *Phytophthora palmivora* in the Ivory Coast). Café Cacao Thé 15, 3, pp. 235-40 (1971).

The effect of rainfall, temperature and relative humidity on the sensitivity of cocoa pods to black pod fungus *Phytophthora palmivora* was studied in the Ivory Coast. Rainfall does not influence either the behaviour of the pod or the water content in the pericarp tissue. Infection percentage seemed not to be influenced by temperature. However, pod sensitivity increased with increasing relative humidity. English, German, and Spanish summaries. Tables. 2 refs.

Braudeau, J., and Muller, R. A. Des possibilités d'emploi des composés organostanniques contre la pourriture brune des cabosses du cacaoyer due au Phytophthora palmivora (Butl.) Butl. au Cameroun Oriental. (Possibilities of using organotin compounds against cocoa black pod disease due to *Phytophthora palmivora* in E. Cameroon). Café Cacao Thé 15, 3, pp. 211-20 (1971).

Preliminary investigations in the Cameroon Rep. on the use of organotin compounds in the control of black pod disease demonstrated that Triphenyltin-chloride (45%) and -hydroxide (20%) are more effective than the standard Cu-fungicide treatment. However, the economics of using these compounds have still to be studied. Fermentation and organoleptic characteristics of chocolate were not adversely affected by the compounds. Their application is not risky for the user provided precautions are taken. Toxic residue levels in beans were very low. English, German, and Spanish summaries. Table. 3 refs.

Massaux, F. Etude des résidus de chlorure de triphénylétain (Brestanol ^{113}Sn) sur féves de cacao. (Study of Triphenyltin-chloride residues (Brestanol ^{113}Sn) in cocoa beans). Café Cacao Thé 15, 3, pp. 221-34 (1971).

Experiments conducted in the Cameroon Rep. showed, that Triphenyltin-chloride used in the control of pod rot disease (*Phytophthora palmivora*), had no systemic action, through the leaves, roots or pod exocarp, on the beans. Organic tin content of commercial cocoa beans is of the order of 0.005 ppm. English, German, and Spanish summaries. Tables. Graphs. 13 refs.

Shenk, M. D. (Int. Plant Prot. Center, Corvallis, Oregon, U.S.A.). **Weed control in cacao.** World Farming 13, 9, pp. 12-3 (1971).

Experiments in Ecuador showed that when weeds were controlled by selective herbicides, cocoa seedlings developed greater trunk diameter and plant height than cocoa which received 7 manual weedings. Cocoa yields in the 6th, 7th and 8th years are highly correlated with trunk diameter and plant height at $3\frac{1}{2}$ years of age. For cocoa less than 4 years old, it is advisable to use only dalapon, ametryne, prometryne, linuron, and contact herbicides, such as MSMA, DSMA, paraquat, diquat, PCP, and cacodylic acid. Cocoa trees more than 4 years old are less sensitive to certain organic herbicides than younger trees. A wide range of weeds was controlled, among others, by a mixture of diuron (at 4 kg/ha) and paraquat (at $\frac{1}{2}$-$\frac{3}{4}$ kg/ha). Photo.

September, 1972

Olatunbosun, D., and Olayide, S. O. Output-income effects on agricultural export pricing strategy in Nigeria: the case of cocoa. Developing Econ. 9, 1, pp. 65-82 (1971).

The present export-pricing strategy of the W. Nigerian Marketing Board for cocoa is quantitatively analysed and criticized. The strategy was a disincentive to farmers; it is shown that a system of price incentives would have increased farm incomes without diminishing government income. A new price-incentive strategy is proposed, as well as feasibility studies on commodity processing and by-product manufacturing from cocoa. Expansion of export markets should be actively pursued. Tables. 15 refs.

Montoya Maquin, J. M., and Quiroga, V. (Inst. Interamer. Ciencias Agr. OEA, Turrialba, Costa Rica). **Relaciones entre clones de los principales complejos genéticos de Theobroma cacao determinados mediante propiedades hidricas de limbos foliares.** (Relations between clones of the main genetic groups of *Theobroma cacao* determined by moisture conditions of the leaf blades). Rev. Theobroma 1, 4, pp. 10-20 (1971).

At Turrialba, Costa Rica, the relations between leaf size, fresh weight, and dry weight were determined in leaf blades of 3-month-old seedlings of 3 Criollo, 3 Amazon and 3 Trinitario clones, treated so as to obtain maximum water absorption. The results indicated that the Criollo type has a slightly more hygrophytic character than the Amazon type; the Trinitario type is intermediate in this respect, but approaches the Criollo type rather than the Amazon type. English summary. Tables. Graph. 13 refs.

Are, L. A., and Atanda, O. A. (Njala Univ. College, Freetown, Sierra Leone). **Seasonal influences on some yield factors in four varieties of Theobroma cacao L.** Trop. Agr., Trinidad 49, 2, pp. 161-70 (1972).

In Nigeria, field trials with 4 cocoa varieties showed that the percentage conversion rate for wet bean weight to fermented dry ones, mean cured bean weight and number of beans per 100 pods were usually, but not invariably, higher in the dry season than in the wet season. Amelonado varieties had the highest mean conversion rate (44.35%), number of beans per 100 pods (3,530.6), and mean weight of dry beans per pod (39.54 g). In the dry season, 10.60 pods of Amelonado and 11.34 pods of F_3 Amazon, the varieties most commonly cultivated, gave 454 g dry beans. The corresponding figures in the wet season were 13.54 and 18.55. A conversion rate of 43.3% (instead of 40%) is suggested. Tables. Graphs. 7 refs.

Ram, C., and Figueiredo, J. M. de. (CEPEC, Itabuna, Brazil). **Comparative studies of different Phytophthora palmivora isolates.** Rev. Theobroma 1, 4, pp. 3-9 (1971).

The white-seeded Catongo var. of cocoa grown in Babia, Brazil, has been considered to be fairly resistant to *Phytophthora*, but in 1969 showed a rather high incidence of black pod disease. Three isolates of *Ph. palmivora* from the Catongo cv. were compared with 8 isolates from existing collections. The isolates showed important morphological differences in several characters, but those from Catongo differed as much among each other as from the remaining isolates. Portuguese summary. Tables. Fig. 12 refs.

October 1972

Vello, F., and Magalhães, W. S. (Div. Genética CEPEC, Itabuna, Brazil). **Estudos sôbre a participação da formiga caçarema (Azteca chartifex spiriti Forel) na polinização do cacaueiro na Bahia.** (Studies on the role of the ant *Azteca chartifex* in the pollination of cocoa in Bahia). Rev. Theobroma 1, 4, pp. 29-42 (1971).

Trials conducted in southern Bahia, Brazil, demonstrated that colonization of cocoa trees by the ant *Azteca chartifex* results in an increase of the percentage of flowers pollinated and of the yield, although the ant itself is not able to pollinate the flowers. The effect of the ants is greatest when their mobility is increased by disturbing the nests. Since pollination is also improved by spraying the trees with a suspension of ground-up ants, it appears that the ants excrete a substance which attracts pollinating midges. English summary. Tables. Photos. 20 refs.

Pereira, R. J. de Carvalho, and Alvim, P. de T. (CEPEC, Itabuna, Brazil). **Emprêgo de arboricidas no raleamento de sombra em cacauais.** (The use of arboricides for shade-tree thinning in cocoa fields). Rev. Theobroma 1, 4, pp. 21-8 (1971).

Shade thinning trials in cocoa fields in southern Bahia, Brazil, compared: (1) injections of 1 ml 50% Tordon 101 (picloram plus 2,4-D) at distances of 5, 10 or 20 cm around the circumference of the trees at a height of 30 cm, and (2) application of 500 ml 20% sodium arsenite per m of girth into grooves made with a cutlass. Application of Tordon was more effective and much cheaper than application of arsenite; the medium dosage was hardly less effective than the highest one. Considerable differences in resistance to the arboricides were observed among the 9 tree species treated. English summary. Tables. Graph. 14 refs.

Cabala, R., F. P., et al. (Div. Solos CEPEC, Itabuna, Brazil). **Efeito da remoção de sombra e da aplicação de fertilizantes sôbre a produção do cacaueiro na Bahia.** (Effect of shade removal and fertilizer application on the yield of cocoa in Bahia). Rev. Theobroma 1, 4, pp. 43-57 (1971).

Identical unreplicated shade removal × NPK fertilizer trials were initiated in 21 cocoa fields in Bahia, southern Brazil, in 1964. The mean yields of the 21 control plots were about 1,240 kg of dry beans per ha in 1965 and about 1,060 kg/ha in 1966. Plots with fertilizer alone yielded 6 and 14% more, respectively; the corresponding percentages were 20 and 40 for plots in which all shade was removed, 39 and 80 for plots in which both measures were combined. Where fertilizer applications were continued, yields up to 1970 showed similar differences; where they were discontinued the fertilizer showed an appreciable residual effect. English summary. Table. Graphs. 38 refs.

Legg, J. T. (Cocoa Res. Inst. (C.S.I.R.), Tafo, Ghana). **Measures to control spread of cocoa swollen shoot disease in Ghana.** PANS 18, 1, pp. 57-60 (1972).

This virus disease, spread by mealybugs, was first recognized in Ghana in 1936. It probably originated from alternative hosts among forest trees. The mealybugs cannot yet be eliminated. The disease was first controlled by destroying infected trees, and this was followed by what must be one of the longest, most complicated and expensive efforts to control a plant virus disease. Over 140 million diseased and contact trees were cut-out. Now the production of resistant cocoa progenies has come to the forefront. They are being tested, and it is expected that cocoa varieties with a high level of resistance to virus infection will be produced. Fig. 15 refs.

Bigger, M. (Cocoa Res. Inst., Tafo, Ghana). **Recent work on the mealybug vectors of cocoa swollen shoot disease in Ghana.** PANS 18, 1, pp. 61-70 (1972).

After nearly 30 years of research, the transmission of cocoa swollen shoot disease is still not under control in W. Africa. Different species of mealybugs, all belonging to the family *Pseudococcidae*, act as vectors. Use of insecticides against them was not effective, and increased other minor pests. Biological control measures neither reduced the mealybugs noticeably. Swollen shoot disease, like the other 2 main scourges of cocoa, capsids and black pod disease, are ecologically linked, with ants playing a role in each case. It is considered that further study of the interaction of these different factors will be required in order to find a final solution of the problem. Tables. Graph. Photos. 36 refs.

Collingwood, C. A. (Minist. Agr., Fisheries Food, Agr. Development Advisory Serv., Government Buildings, Lawnswood, Leeds LS16 5PY, U.K.). **The international capsid research team in West Africa.** PANS 18, 1, pp. 46-55 (1972).

The above team was set up by the Research Committee of the International Office of Cocoa and Chocolate. With financial aid from several countries, the team worked at stations in Ghana and Nigeria. The 2 main capsid pest species are *Distantiella theobroma* and *Sahlbergella singularis*. The cocoa capsid problem was studied from many aspects for several years. A list of publications of the team members is given, and the results are summarized together. This account deals only with some of the more interesting aspects of the work. Graph. Many refs.

Majer, J. D. (Dep. Zool., Univ. Ghana, Legon, Ghana). **The ant mosaic and its influence on cocoa.** Cocoa Marketing Board Newsletter 49, pp. 25-6 (1971).

Ants are distributed as a patchwork in a cocoa plantation in Ghana. They are associated with pests and diseases either positively or negatively. So the layout of the ant mosaic present in the field effects the distribution of the cocoa pests and diseases. Blanket spraying of cocoa against capsids, which are also controlled by ants, alters or destroys the ant mosaic. Mechanical removal of ant species from the field is now carried out to investigate its influence on the cocoa. Different ant species react differently towards shade. Their presence can thus be regulated by cultural methods affecting the amount of shade. A list of ant species with nesting habits and their effect on cocoa and its pests is given. Table.

November 1972

Taysum, D. H. Cocoa and coconuts — a survey of failure and success in deployment. Planter 47, 549, pp. 534-9 (1971).

Production of cocoa (*Theobroma* spp.) and coconut (*Cocos* spp) in the Br. Solomon Isl. Protectorate is briefly reviewed. Attention is paid to aspects of cultural practice and pest and disease control. The author concludes that: (1) planting of sophisticated crops such as cocoa ahead of adequate research is an unwise policy; (2) effective cash crop production at village level depends on the actual presence of efficient trade and marketing infrastructure, and due incentives; (3) there is little point in development of new cash crops, if poor handling and storage facilities inhibit acceptability of the product overseas; (4) smallholder development frequently follows successful estate development as a nucleus; and (5) dispersive planting is unlikely to be successful for any cash crop which has to compete for international markets. 4 refs.

Cabala R., P., and Fassbender, H. W. Formas de fósforo em solos da região cacaueira da Bahia. (Forms of P in soils from the Bahia cocoa belts). Cacau Atualidades 8, 3, pp. 5-7 (1971).

The total P content and its distribution in various groups of compounds in the different horizons of 3 soil types from the Bahia, Brazil, cocoa belt were determined at Turrialba, Costa Rica. The total P content was high in 2 soils showing means around 4,000 and 1,700 ppm, respectively, but low (400-150 ppm) in the 5 remaining soils. Moreover, in these 5 soils a high proportion of the P was present in relatively insoluble compounds; which explains the widespread need of P fertilizers in the region. Table.

Soria, V., J. (Inter-Amer. Inst. Agr. Sci. OAS, Turrialba, Costa Rica). **The present status and perspectives for cacao cultivars in Latin America.** Proc. Trop. Region Amer. Soc. Horticult. Sci. 14, pp. 53-65 (1970; received 1972).

Three main kinds of cultivars are being used at present as planting material of cocoa: varieties, clones and F_1 hybrids. The most important cultivars in each one of these categories, grown at present in tropical Latin America are described and mention is made of their resistance to some important cocoa diseases, such as witches broom, black pod and *Ceratocystis fimbriata*. Tables. 21 refs.

Mainstone, B. J. (Dunlop Res. Centre, Batang Melaka, W. Malaysia). **Environmental influences and the importance of covers and shade for cocoa. Part II. Work in relation to the level of permanent top shade for cocoa.** Planter 47, 548, pp. 479-85 (1971).

Trials conducted to study the effects of varying intensities of top shade on the yield of cocoa are reviewed. The mechanism of response to shade reduction appears to be intricate; besides the intensity of daylight, other factors are also involved, e.g., the build-up of pests after shade removal. The complex shade-soil cover is further discussed in detail. Factors of soil quality, availability of water and nutrients, wind, sunlight, drought, pests, and the age of the cocoa plants, are taken into account. Tables. Graph. 15 refs.

Ng Siew Kee. A review of factors influencing the fertiliser requirements of cocoa plantings in Malaysia. Planter 47, 549, pp. 514-33 (1971).

The mineral nutrition of cocoa (*Theobroma* spp.) is comprehensively reviewed. Detailed attention is paid to quantitative requirements for growth and production, shade effects, soil conditions, cover crops, leaf analysis and rainfall distribution. Demands for N and P during immaturity should be complemented with K and Mg when pod production begins. Mulching of immature plants provides the best yield results as compared to bare soil and vegetative cover, but promising effects have been obtained with bushy legumes, such as *Tephrosia*, *Flemingia* and *Sesbania* spp. Tentative recommendations on N, P, K, Ca and Mg are given for mature and immature trees under coconuts in W. Malaysia and for monocropping on volcanic-ash soils in Sabah to support current commercial yields of 2,250 kg/ha. Tables. Graphs. 37 refs.

Gregory, P. H. Cocoa: the importance of black pod disease. Span 15, 1, pp. 30-1 (1972).

Black pod, caused by the fungus *Phytophthora palmivora*, is believed to be responsible for severe annual losses of cocoa beans, and is a factor in the fluctuation of cocoa prices. Although control is chiefly by the use of fungicides (mostly copper) and hygiene measures, much effort is being devoted to breeding resistant varieties of cocoa. This article reviews the present state of knowledge of the disease itself, its economic importance, and methods of controlling it. Two difficulties prevent the breeding of resistant cocoa cultivars forming the ideal solution to the black pod problem. First, replacing the world's existing cocoa trees with improved hybrid material, which inevitably will take many years. Second, a difficulty arising from the fact that the pathogen is itself an assemblage of strains differing genetically and liable to variation. Photo.

Marchart, H. (Cocoa Res. Inst., Tafo, Ghana). **Evaluation of insecticides for the control of cocoa capsids in Ghana.** FAO Plant Prot. Bull. 19, 5, pp. 97-109 (1971).

Forty insecticides were screened under simulated field conditions, and selected compounds were tested for contact toxicity and fumigant, residual and ovicidal effects. In extensive trials, the performance of the carbamate Propoxur (arprocarb) was compared with lindane, DDT and fenitrothion. Arprocarb and lindane at 840 g/ha resulted in more than 100% increase of crop setting in the year after treatment. Monocrotophos appeared promising for the protection of small-holdings of young cocoa. From author's summary. Tables. Graphs. 30 refs.

Printed in England by Haines Clark & Co. Ltd., 176, Gooch Street, Birmingham B5 7HE