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Contents

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Editorial

The Cocoa Market

Six years ago the cocoa industry passed through a period of low prices arising out of a rapid increase in production of over 20 per cent. Such a large increase in supplies was bound to have a drastic influence on prices and they were below £150 a ton for eight months of 1965 dipping below £100 briefly during July. These price movements had a profound effect on the confidence of governments and growers so that interest in long term efforts to increase production has since been lukewarm. Some people may be wondering whether a similar situation faces the cocoa industry now.

As this is written prices are under £200 a ton, a level not seen since 1966 since when the pound has been devalued and inflation has eroded the value of money. These prices reflect current expectations of a rise in production and a possible surplus of about 150,000 tons, as indicated by the Gill & Duffus figures quoted on page 3. This is a smaller rise in production than that of 1965 and at this moment it remains to be seen whether these forecasts are fulfilled. Even if the rise in production is as large as these figures suggest, manufacturers may extend their cover at current attractive prices and extension by only 4-6 weeks would absorb the expected surplus. This would help manufacturers to prevent prices of finished goods from rising – but with other commodities and labour rising in price by no means a guarantee – and hence consumption will be assisted. A recovery in price will come but it takes time.

So much for the short term; looking further ahead it is unlikely that a long period of low prices lies ahead. This statement is based on two factors. First, on past performance periods of low prices have been as short lived as periods of high prices. Second, there is no reason to believe that production will increase rapidly in the next few years. There are replanting schemes supported by World Bank funds going ahead in Ghana, Nigeria and the Ivory Coast but, large though they are, they will only gradually increase production.

The only safe forecast to make is that there will be fluctuations in crops which will result in large changes in price. These fluctuations cannot be forecast with any confidence which points to the lack of knowledge as to the factors affecting yield. This gap in our knowledge of the cocoa tree is one that ought to be receiving more attention.

A price agreement would control to some extent the swing of prices but after many years of talks such an agreement still seems a long way off. In the meantime it should be remembered that manufacturers tend to buy more when prices fall and to reduce stocks when prices rise and this helps to limit the fluctuation in prices.

G. A. R. Wood

ERRATUM: Bulletin No. 16

The editor wishes to draw attention to a mistake in the legend to the map on page 16 of issue No. 16 March 1971. This map showed the distribution of capsids in Nigeria; the shaded area described as showing "resistant D. theobroma" should have been described "D theobroma". Resistance has not been found in D. theobroma in Nigeria.

The editor regrets this mistake and apologises to any who may have been misled by it.

Review of Production and Consumption

December 1971

A. P. Williamson, Cadbury Schweppes Limited

1970–71 Production and 1971 Consumption

Last season's world production has been written down by almost 40,000 tons, principally because of an announcement by the Ghana Cocoa Marketing Board that the main crop had been heavily overdeclared. The actual outturn appears to have been some 15,000 tons less than the official purchases and some 25,000 tons less than the tonnage expected at the time of our last report. The position has been further aggravated by the mid crops in both Ghana and the Ivory Coast being smaller than expected.

1971 consumption is now expected to be 1,395,000 tons, an increase of 4·5 per cent over 1970.

1971–72 Production

Gill & Duffus expect the current main crop production in West Africa to be greatly in excess of last year. Large increases are looked for in Ghana and the Ivory Coast and in Nigeria last year's record level is expected to be maintained. Overall West African production is forecast at 100,000 tons up on last year. In Brazil, where there is an intensive extension programme, they are predicting an increase of 34,000 tons. World wide they are predicting a total of 1,625,000 tons, an increase of 146,000 tons or 10 per cent on last year.

It should be pointed out, however, that not everyone is as optimistic. The F.A.O. has only forecast a world total of 1,478,000 long tons. The final figure will almost certainly be somewhere between these two extremes and this illustrates the difficulties involved in production forecasting.

1972 Consumption

Consumption is expected to increase further in 1972 under the stimulation of lower prices, with world grindings forecast at 1,463,000 tons, or 5 per cent up on 1971. The increase is spread evenly across all consuming areas.

Stocks

The nominal surplus in 1971 is now thought to be 84,000 tons and after allowing for the usual 1 per cent losses this is equivalent to an effective surplus of only 69,000 tons. The carryover of old crop cocoa into 1972 (see our June review) is now reduced to 314,000 tons.

In the face of the conflicting 1971/72 production forecasts it is impossible to make a forecast of the likely surplus in 1972. On the basis of the Gill & Duffus forecast there would be a nominal surplus of 162,000 tons, or 146,000 tons after allowing for the usual 1 per cent losses. This would give an old crop carryover into 1973 of 460,000 tons, which would be similar to the levels ruling during the early 1960's although still below the 1965 level when prices fell to £100/ton. On the basis of the F.A.O. figures, however, there would be no surplus and the carryover would be similar to the carryover in 1972, itself lower than in all but four of the last twelve years.

WORLD COCOA PRODUCTION AND GRINDING DATA

Reproduced from Gill & Duffus Market Report Dated November 1971

(Thousand long tons)

Production

	1969/70	1970/71 (Estimate)	1971/72 (Forecast)
Africa	999	1,078	1,172
America	325	315	356
West Indies	59	42	47
Asia and Oceania	36	44	50
World Total	1,419	1,479	1,625
Principal Countries			
Ghana	409	386	445
Nigeria	219	299	300
Ivory Coast	178	177	220
Cameroon	108	110	116
Guinea (Spanish)	25	30	32
Brazil	197	179	213
Ecuador...	54	60	60
Dominican Republic	42	25	32
Venezuela	19	18	19
Colombia	19	22	25
Mexico	26	27	29
New Guinea	22	29	34

Grindings

	1970	1971 (Estimate)	1972 (Forecast)
Western Europe	509	520	537
Eastern Europe and U.S.S.R. ...	189	203	215
North America	276	286	302
Australia and New Zealand ...	17	17	17
Central and South America ...	158	167	178
Asia	50	56	62
Africa	137	146	152
World Total	1,336	1,395	1,463
Principal Countries			
United States	261	270	285
Germany (Federal Republic) ...	124	129	133
Netherlands	113	115	118
United Kingdom	81	80	86
U.S.S.R.	100	105	112
France	39	41	41
NOMINAL BALANCE	+83	+84	+162

Prices

Month end prices for nearby Ghana shipment cocoa have been:

July	£247·0/ton
August...	£247·0/ton
September	£214·0/ton
October	£206·0/ton
November	£197·5/ton
December (mid)	£187·5/ton

The rally referred to in our last report continued until early July with prices reaching £245·0/ton. There was then a minor reaction before prices peaked at just over £260·0/ton early in August. Since then, with an increasing number of good crop reports circulating, the market has declined steadily reaching £187·5 by the middle of December.

Cocoa in Nigeria

This article describes the cocoa industry in Western and Eastern Nigeria. The first section on Western Nigeria has been written by R. A. Lass, Cadbury Schweppes Limited, while the second on Eastern Nigeria has been prepared from a paper provided by N. E. Egbe of the Cocoa Research Institute of Nigeria.

HISTORICAL

The cocoa industry in Nigeria originated from imports of seeds from Fernando Po during the last three decades of the 19th century. Chief Ibaningo is said to have established a plantation near Bonny in Eastern Nigeria in 1847, five years earlier than Tetteh Quashie's introduction of cocoa into Ghana (4). It is also suggested that there may have been other plantings in Eastern Nigeria about that time (3). Cocoa also moved into the Western Region, the early plantings being in the Agege area; from there cocoa spread over a large area of South-Western Nigeria in the early part of the 20th century (3). A remarkable combination of Christian mission and agriculture based on large farms around Agege developed by the Coker family and other members of the African Church was an important factor in the spread of cocoa growing (7).

These early plantings were on relatively infertile soils north of Lagos. Cocoa has largely died out around Agege and the major area of cocoa has moved northwards to Abeokuta and Ibadan and more recently eastwards to Ondo Province. The development of cocoa growing in Nigeria started a decade or more later than in Ghana and its rate of development was less dramatic. It is estimated that there were 10,000 acres in 1912 and this increased to over 300,000 acres by 1930 (1). Planting continued at a heavy rate from 1930–45 by which time nearly 1 m acres had been planted.

In 1920 production was around 20,000 tons and had increased to 100,000 tons by 1940. It remained at that level until the late fifties when further plantings and the control of black pod and capsids lead to further and rapid increases. This rising trend of production has continued until the present time and since 1960 Nigeria has ranked as the second largest cocoa producer in the world with the 1970-71 crop at an estimated 300,000 tons. (Table 1). An estimated 95 per cent of the total production is produced within the Western State.

Western Nigeria

The Cocoa Industry

The cocoa area of Western Nigeria is shaped like a kidney bean, the main axis lying east-west. In this area there are approximately 1·5 m acres of cocoa, but this is a rough estimate as planting records since 1960 are incomplete.

Most of the trees are Amelonado planted at random with little or no permanent shade. The farms are small, over half the farmers having holdings of less than 2·5 acres (2). Farmers in Nigeria tend to live on or near their farms in contrast with Ghana where the majority of farmers are absentee landlords.

Since the war Government controlled agencies have developed plantations on three of which cocoa has been planted, and in 1963 there were 6,500 acres of cocoa on the three estates.

Judging by recent levels of production and estimated acreage, yields average nearly 450 lb. per acre in favourable years. Obviously yields vary widely from farm to farm and may range from 100 to 1,000 lb. per acre, but the potential yield for mature Amelonado is considered to be 800 lb. per acre, provided black pod and capsid control measures are carried out. The major part of the crop is produced between September and January with a peak in November but the crop continues until April–May.

All cocoa is purchased from farmers by buying agents licenced by the Western Nigeria Marketing Board, which fixes farmers' prices from year to year. The 1970/71 farmers' price was £180/ton for Grade I beans and £162/ton for Grade 2. The grades are based on the International Cocoa Standards with the added categories of main and light crop cocoa designated according to bean size. Light crop cocoa, which amounts to 5–10 per cent of the total crop, is sold at a discount on main crop. Main crop Nigerian beans have a slightly lower butter content than main crop Ghana beans and are sold at a small discount to Ghana cocoa.

The consumption of chocolate products within Nigeria is negligible and effectively the whole crop is exported as raw cocoa beans or cocoa products. There is a processing factory in Lagos which used about 25,000 tons of cocoa in 1970 for the manufacture of cocoa products which were subsequently exported. The major shareholder in this factory is the Western Nigeria Marketing Board. Some 70 per cent of Nigeria's annual cocoa exports are to Europe with a further 10 per cent to the United States and up to 15 per cent to Eastern Europe. In terms of total value cocoa ranks high amongst Nigeria's agricultural export products and the total export value of cocoa was of the order of £66 m in 1970.

Climate and Soils

The mean annual rainfall of the cocoa belt of Western Nigeria lies between 45 and 60 inches. Cocoa will of course grow in areas with higher rainfall, but in Western Nigeria these areas tend to have soils unsuitable for cocoa. This is in marked contrast to the cocoa areas of Ghana where the rainfall is generally in excess of 60 inches per annum. The rainfall is unevenly distributed over the year and during the dry season from November to March the rainfall is less than 10 inches. There is a small dry season in August which on average has less rain than the other months of the wet season. The break in the rains is invaluable as it prevents the spread of black pod at a time when the main crop is developing.

If this short dry season is unduly long or dry the cocoa crop will suffer severe moisture stress; if, on the other hand, the rains between July and October are unduly heavy, this will inevitably cause a high percentage of black pod damage. At this time of year the relative humidity is at its maximum level and may achieve 100 per cent for considerable periods. The mean maximum daily temperature ranges from 78° to 92°F and the mean daily minimum temperature from 68° to 73°F. The low temperatures occur during the short dry season and correspond to the periods of high humidity. The sunshine hours are again at their minimum during August and September when they barely reach 80 hours per month as compared to almost 200 hours per month for the rest of the year.

The first plantings of cocoa around Agege were on sedimentary soils of poor nutritional status, but this has largely died out and cocoa is now grown on soils developed over metamorphic igneous rocks showing an irregular catenary sequence from hilltop to valley bottom with cocoa being grown on the clayey soils on the upper slopes. The moisture retaining capacity of a soil is often the limiting factor as to its suitability for cocoa cultivation. As might be expected cocoa grows better on clayey soils than on sandy soils due to their higher moisture retaining capacity. It is suggested that most of the soils cannot store enough water to supply both the cocoa and large forest trees during the long dry season (8). This absence of shade is in marked contrast to Ghana where all cocoa is shaded and the dry season is generally not as severe in the cocoa areas.

Chemically these soils are characterised by low cation exchange capacity in keeping with the kaolinitic nature of the clay fraction. A careful study of the Western Nigerian cocoa soils (8) concludes that there is little available phosphorous at depths greater than six inches in these soils and the reserves of phosphorous are largely in the organic fraction of the topsoil. Most of this available phosphorous is then leached to depths below those reached by the cocoa roots. Fertilizer trials carried out to examine the requirements for phosphorous on these soils have shown that yields are limited by a lack of phosphate. The requirement for nitrogen is closely related to the absence of shade and studies in many parts of the world have shown that full light requires additional nitrogen for highest yields. It appears that in general there is little need for application of potassium on the igneous soils. Wessel's study concludes by recommending the use of an NP compound (20 per cent N and 20 per cent P_2O_5) for cocoa on these soils and suggests that yield increases of the order of 30 per cent could be expected on physically suitable soils provided pest and disease control is carried out properly.

Establishment

The typical farmer of the Western Nigeria cocoa belt combines cocoa cultivation with the growing of food crops. A method of establishment was developed in the early 1900's which fitted in well with the existing system of farming by shifting cultivation. Cocoa seeds are planted in between food crops, usually cassava and plantains, at a variable spacing of 4–5 feet. As food crop cultivation is discontinued, the cocoa is left to compete with the regenerating bush, the latter being chopped down at intervals. This produces a dense stand of cocoa with 400-700 trees per acre as an average mature stand (8). Seedlings are provided by the Ministry of Agriculture and Natural Resources at cost to farmers from nursery sites distributed through the cocoa belt. Much of the material now being distributed is of the higher yielding Upper Amazon type while nearly all the mature cocoa is of the less vigorous and more disease susceptible Amelonado type. Establishment of cocoa in Western Nigeria is thought to be more difficult nowadays because the adverse effects of droughts

A farmer spraying his farm with carbide Bordeaux mixture.

are more severe due to the clearing of the forest and hence the disappearance of its buffering effect (8).

Cultivation

It is usual for the cocoa farms to be pruned regularly and kept well weeded. Mistletoe does not seem to be a serious problem and many farmers practice regular black pod and capsid control.

The control of black pod by the use of copper fungicides was demonstrated in 1953, a carbide – Bordeaux mixture, in which calcium carbide replaces lime, being used. In the following six years over 80,000 farmers were trained in the use of spray pumps and fungicides. These materials have been sold to farmers at subsidised prices and sales of copper fungicides rose to 2,850 tons in 1968/69 sufficient to spray at least 300,000 acres. It is recommended that spraying should be carried out at three weekly intervals through the rainy season.

Capsids are a severe pest of cocoa in Nigeria with *Sahlbergella singularis* being the most important species (5). The normal recommended application for capsid control in Nigeria is to spray three times per annum, in August, September and October at the rate of 4 ozs γ – BHC per 10 gallons per acre. As for black pod, farmers have been trained in capsid control and insecticides have been sold at subsidised prices. Sales rose to more than 300,000 gallons in 1968/69 sufficient to spray 859,000 acres at recommended doses.

Resistance of *S. singularis* to BHC is on the increase and to date no alternative insecticide has been approved (9). *Distantiella theobroma* is a less significant pest of cocoa in Nigeria with a more restricted distribution than *S. singularis* and is at the moment not showing resistance to BHC insecticides.

Swollen shoot virus was first noticed in Nigeria in 1944. The Nigerian strains are less virulent than the Ghanaian ones and merely weaken the tree, which predisposes it for attack by the other parasites which may cause the eventual death of the tree. The only effective method of controlling spread of the virus is still the cutting out of infected trees and any contact trees.

A survey of the incidence of Swollen Shoot Virus in Western Nigeria was carried out from 1944. This indicated two areas of cocoa of some 125,000 acres where the disease had such a hold as to make cutting out no longer profitable, and these were described as "Areas of Mass Infection". The cocoa on the fringe of this areas was inspected at six month intervals from 1951. The regular re-inspection with subsequent cutting out resulted in the reduction and control of the disease in many localities outside the "Areas of Mass Infection" (6). Within these areas cocoa planting is not encouraged.

Research

A sub-station of the West African Cocoa Research Institute was established at Moor Plantation, Ibadan in 1953. It became an autonomous institute in 1963 and was re-named the Cocoa Research Institute of Nigeria. The Institute has recently moved from its site at Moor Plantation to Gambari, a few miles from Ibadan where a considerable acreage of cocoa is available for research purposes. Much useful information on all aspects of cocoa husbandry has been published by the staff of this station.

The Future

As was seen from Table 1 the production of cocoa in Nigeria has been increasing steadily and with farmer interest provided by a realistic price, and continued subsidies and extension advice, this trend should continue. Much of the cocoa of Nigeria has passed its plateau of production, but there is evidence to suggest that new plantings are more than compensating for this decline. A World Bank project in conjunction with the Ministry of Agriculture was prepared in 1964 and offered two schemes – one for replanting of old unproductive farms and one for planting of new areas. These projects were shelved at the start of the civil war, though re-approval for a World Bank loan of £2·6 m for expansion and improvement of cocoa production in the Western State was announced in May 1971. The first stage of this loan is scheduled for the planting of 16,500 acres and replanting of 27,000 acres of unproductive cocoa.

Eastern Nigeria

The introduction of cocoa from Fernando Po has already been described. The Royal Niger Company planted cocoa at Onitsha in 1899 and at other places in Eastern Nigeria about that time. Since then cocoa has been grown in isolated spots, all over Eastern Nigeria. Most of the cocoa exported from the former Eastern Nigeria was produced in Ikom, Obubra and Bende Divisions; other Divisions contributed to a limited extent and all are now in East Central, South Eastern and Rivers States.

Climate

The annual rainfall in the main areas of production is between 75–120 inches. Most of the rain falls between March and October and there is a marked dry period from December to February, when less than four inches of rainfall is recorded (Table 2).

The temperature range is between 80°F and 90°F. The relative humidity at 15.00 hours is high throughout the year, varying between 80 and 85 per cent.

Soils

In Eastern Nigeria the soils are derived from a variety of parent rocks. In the areas of intensive cocoa cultivation, the parent rock is mainly tertiary basalts (Ikom and Obubra areas) and tertiary Imo-Shale group formation (Umuahia area).

The soils over basalts are deep, well drained and highly acidic. The profiles are homogeneous, dark reddish brown in colour and clayey in texture. There are usually no gravels, iron concretions or stones. The calcium content of the soils is low as a result of the heavy leaching. The topography is generally flat, interrupted in a few places by V-shaped narrow valleys.

The soils over shale have a clayey texture – very plastic clays, which crack on drying and are poorly drained, especially in the low lying areas. These soils are shallow, the slaty-shale being met at a depth of four feet or less.

Production

Eastern Nigeria is unique in that it has a considerable acreage of plantation cocoa, 19,735 acres compared with 6,500 acres on plantations in Western Nigeria (2). There are eight estates established by the former Eastern Nigeria Development Corporation (ENDC) between 1954 and 1966 and they are concentrated in the areas of intensive cocoa production mentioned above. There are four estates in the Ikom area, with a total of 10,210 acres planted up to

1966, two estates with 4,753 acres in the Obubra area and two estates in the Umuahia area with 4,774 acres. One of the estates at Ikom (Obokum) was the first to be established in 1954 with a mixture of planting materials, mostly Amelonado and F4 Amazon. The other seven estates were established between 1960 and 1966 with Amazon cocoa.

The usual method of establishment, in nearly all the estates is selective thinning of the original forest and planting of the cocoa under the shade of the remaining trees. The spacing of Amazon cocoa in these estates is ten feet square while that of Amelonado is 12 feet square. When the canopy closes, about the fourth year, the remaining trees are poisoned off. In the last of the estates established in 1965, in the Ikom area, the site was clearfelled of all trees. Amazon cocoa was then planted at the above spacing, under the shade of economic species of forest trees, spaced at 20 feet square. The economic forest trees used are *Nauclea diderichii*, *Oldfieldia africana* (African Teak), *Terminalia ivorensis*, *Triplochiton scleroxylon* (Obeche) and *Khaya ivorensis* (Mahogany).

Harvesting in the estates begins in the fourth year and it is assumed that the plantations come to maturity in the eleventh year after planting. Up to 1966 only one of the estates (Obokum near Ikom) can be said to have been in optimal production. The yields under good management are much higher than the regional average but production declined during the civil war in Nigeria, when the plots were not properly managed.

It is estimated that up to September 1965, there were 75,000 acres of cocoa of different ages, ranging from one to thirty years, in the three Eastern States.

The quantity of dry beans graded in the three Eastern States has increased from 2,000 tons in 1957/58 to 7,000 tons in 1966, so there has been a sharp increase in production since 1960. Yield per acre is estimated at 300 pounds dry beans (Eme, Pers, Comm.) as against 360 pounds dry beans in Western Nigeria (2).

One interesting aspect of production in Eastern Nigeria, is that in the Bende area, most of the farmers sell their cocoa in the pod, or in the form of wet beans, to middlemen who do the fermenting. Fermentation is done mostly in baskets lined with banana or plantain leaves and takes 4–6 days and drying is done on raised platform made of slatted bamboo.

Most of the crop is grown under shade of the original forest. On the whole the shade is much heavier in Eastern Nigeria than in Western Nigeria.

Pests and Diseases

Most of the diseases and pests common to cocoa in Western Nigeria are also found in the East with the exception of swollen virus disease which has not been recorded anywhere in Eastern Nigeria. Damage by capsids is common and black pod disease is particularly serious in Eastern Nigeria resulting in heavy crop losses sometimes as high as 90 per cent.

The Ministries of Agriculture in the three Eastern States are aware of these limitations and have introduced a Cocoa Improvement Scheme, the object of which is to educate and assist farmers in the use of chemicals against pests and diseases. Subsidies are given to the farmers in cash and kind amounting to £15·00/acre, for buying chemicals, spraying pumps, supply of Amazon cocoa pods, polythene bags and for clearing the site. It is hoped to develop and improve 20,000 acres by this means in the next five years, and to produce 10 per cent of the total cocoa exported out of Nigeria by 1975.

Research

In 1966 the Cocoa Research Institute of Nigeria (CRIN) acquired some land in the Ikom area for a substation, for investigations in the ecological zone of Ikom. Plots have been established with Amazon, Amelonado and some new introductions from Trinidad. It is too early to judge the performance of these varieties under Ikom conditions, but indications are that growth is fairly rapid compared with growth of the same varieties at Gambari near Ibadan.

Fertilisers are not yet used by the farmers but fertilising has to be considered seriously as the soils are very low in nutrients. The soil chemists of the Cocoa Research Institute of Nigeria have started some fertiliser trials at Ikom. It is still too early to draw definite conclusions, but generally the fertilised plots yield higher than the unfertilised ones, particularly plots treated with potassium, calcium and magnesium combined.

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Table 1

Nigerian Cocoa Production 1915–1970

YEAR	5 YEAR AVERAGE (thousand long tons)
1915	10·7
1920	25·2
1925	41·6
1930	56·8
1935	90·2
1940	106·8
1945	99·2
1950	107·0
1955	103·2
1960	151·2
1965	238·0
1970 (estimate)	250·0

Source: Cocoa Statistics 1971: Gill & Duffus, London.

Table 2

Mean Monthly and Mean Annual Rainfall at Selected Stations of the Cocoa Growing Areas in Southern Nigeria

Area	Station	No. Years Recorded	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year Total
Western Nigeria	Ilaro	6	1·28	1·50	6·44	4·06	6·54	8·79	4·19	1·13	6·40	6·85	2·03	·49	49·70
	Ibadan	52	·38	·96	3·54	5·31	5·81	7·39	6·08	3·26	6·97	6·18	1·74	·37	47·99
	Oshogbo	28	·31	1·11	3·20	4·26	5·53	5·89	4·99	3·76	7·70	7·65	1·52	·40	46·32
	Ondo	48	·41	1·38	4·26	6·14	6·70	8·33	9·15	5·13	9·14	7·58	2·87	·67	61·76
Eastern Nigeria	Umuahia	10	·84	2·10	5·11	6·58	10·93	11·67	13·48	10·73	12·54	8·81	2·42	·35	85·56
	Ikom	10	·48	2·12	6·86	11·68	14·14	16·19	13·69	11·71	17·87	18·90	4·44	1·80	113·02

Source:– Wessel, M. (1969) Cacao Soils of Nigeria. **II Int. Cacao Res. Conf. Brazil 1967. 417.**

Mistletoes on West African Cocoa

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Introduction

There is a lot of circumstantial evidence suggesting that mistletoe infestation of cocoa in Ghana and Nigeria is increasing. In the same way as capsids, mealybugs, virus and other organisms indigenous to West Africa have developed strains capable of using cocoa as a host, so too have mistletoes evolved the ability to exploit cocoa. The reproductive rates of mistletoes are low compared with those of the well established cocoa pests, and this probably explains why mistletoes have taken that much longer to adapt to, and become numerous on, the new host. Now that mistletoes are established on the crop in West Africa, they may well become as important as the mistletoes described by Kuijt (3) as major pests of cocoa in Costa Rica.

At least six species of mistletoe have been found on cocoa in West Africa. About 70 per cent of all individuals are *Tapinanthus bangwensis* which is characterised by red flowers, red berries, and a globular haustorium; a further 20 per cent are *Phragmanthera incana* which has yellow flowers, blue fruit and an elongate haustorium; and the remaining 10 per cent is accounted for by four or more 'rare' species. All of these mistletoes differ from the European 'Yuletide' mistletoe by having 'ordinary' non-fleshy ovate leaves although their attachment organs or haustoria are basically quite similar to that of their European relative.

The general morphology and taxonomy of all West Africa mistletoes have been studied by Balle and Halle (1), but the biology and ecology of only one species, *T. bangwensis* have been investigated in any detail (7). It is to this species that the remainder of this article applies.

Life Cycle

There are two annual flowering peaks, one in March/April and the other in July/August, when almost all plants bear masses of bright red flowers which are very conspicuous in the cocoa canopy. Pollination is by sunbirds, bees and possibly certain species of flies. The bright red berries take about a month to ripen, and they are eaten by a number of species of birds. Seeds pass through the gut of a bird very quickly, often in under a minute, and retain an adhesive coating which ensures that the bird has to wipe them from the circum-anal feathers onto a suitable twig (4). In this way pockets of mistletoes tend to develop from seeds dispersed around a single parent plant. Experiments have shown that germination and establishment are only successful in unshaded conditions, and that the germinating seedling can only penetrate the relatively thin bark of young cocoa branches. These results explain why mistletoes are only found in the top of the canopy of unshaded cocoa, or on twigs lower down which are exposed at the side of a road or clearing.

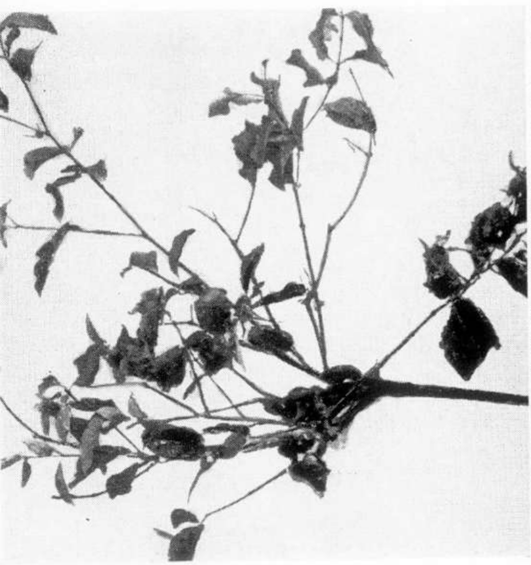
As soon as a seedling has penetrated a cocoa branch it develops a disc between, and in contact with, both the phloem and xylem of its host. This disc gradually expands across the full cross-section of the branch as it grows into a roughly spherical mature haustorium. As the xylem vessels of the host branch become occluded by the haustorium, the part of the branch distal to the mistletoe gradually dies and rots away.

Young mistletoes can flower about nine months after germination, and it has been estimated that the maximum life span is about 18 years.

Direct effects on cocoa

In addition to damaging the canopy by killing cocoa branches distal to themselves, mistletoes have been shown to act as sinks for the products of photosynthesis manufactured by cocoa (6). No photosynthates produced by mistletoes have been detected to pass into cocoa, even in the case of a mistletoe with leaves growing on a leafless cocoa seedling. From this it appears that some sort of active transport mechanism is involved.

Mistletoes, having no normal roots, rely entirely on their hosts for water and mineral salts. Because of the nature of translocation in plants, it is doubtful if this aspect of mistletoe parasitism materially reduces the physiological efficiency of its hosts, and some interesting observations even suggest that the association is beneficial under certain circumstances. When equal numbers of cocoa seedlings with and without mistletoe infestation were subjected to severe water stress, those with mistletoes retained more leaves and generally survived better than those without. This sort of phenomenon has been reported for other mistletoe/host relationships (2) and suggests that mistletoes are relatively refined parasites which help keep their hosts (and thereby themselves) alive over periods of adversity.



A typical specimen of "T. bangwensis" about 2 ft. across. The host cocoa branch (entering from the right) has rotted away distal to the mistletoe.

A four month old mistletoe growing on a cocoa seedling. The upper part of the seedling will soon die as the mistletoe cuts off its water supply.

Insects associated with the Mistletoe

The organisation of the mistletoe fauna is very complex and only an outline of the more important features can be given here.

All mistletoes are attacked at an early age by wood-borers, which make extensive cavities in the haustorium. Death of mistletoes rarely seems to result from the activities of these insects before the plants are old and senescent. None of these borers crosses the interface into the cocoa tissues. Empty bore-holes are taken over by a mealybug specific to mistletoes, *Cataenococcus loranthi*, which often attains populations of up to 4,000 individuals per plant. It is possibly this insect, and not the mistletoes, which is responsible for the active transport of photosynthates from cocoa to mistletoe. Screening experiments have shown that *C. loranthi* is not implicated in the transmission of cocoa swollen shoot virus. This mealybug is tended by several species of ant, all belonging to the genus *Crematogaster* and it has been shown experimentally that these ants protect the mistletoe from leaf damage. Thus, mistletoes, wood-borers and ants are all involved in a complex multiple mutualistic relationship.

Indirect Effects on Cocoa

Mistletoe grows on unshaded cocoa and damages the canopy. Capsid pockets tend to form in damaged parts of unshaded canopy (10) and so it is possible that mistletoes can encourage capsid pocket formation.

Mistletoes provide food, through a mealybug, for Crematogaster ants. These ants are mutually exclusive with *Oecophylla longinoda* (8) and appear to be less effective capsid predators than Oecophylla (5). Here again mistletoes would seem to be indirectly conducive to capsid survival.

The Crematogaster ants provided with food by the mistletoe are the same species which have been implicated in the transmission of swollen shoot virus by tending and possibly carrying the vector mealybugs (8). In this way, the mistletoe is conducive to the spread of swollen shoot virus.

If all the above direct and indirect effects are considered together, it can be seen that the mistletoe fits well into Tinsley's (9) cocoa degeneration syndrome concept, (Fig. 1) and must be considered as an established pest of cocoa.

Control

Accurate quantifications of the pest status of mistletoe would be extremely difficult because of the complexity of its ecological role. Nevertheless, the damaging effect of a heavy infestation (up to 100 mistletoes per tree have been counted in several old farms in Ghana) solely by killing the ends of all young branches must be appreciable, and control would seem desirable.

The maintenance of top shade to prevent mistletoe germination is one obvious long term measure, and it is possible that useful specific herbicides may be developed in the future.

Meanwhile, for more immediate results, manual cutting out is still the best method. A long handled cocoa pruning knife is ideal for the job, and branches should be severed some three inches proximal to a mistletoe to remove completely all traces of the parasite. In Ghana the best time of the year to carry out this work is during the August flowering peak when the plants are easily seen in the canopy and farmers are not involved in harvesting.

T. bangwensis has a very wide range of wild hosts (1) and outside sources of infestations are numerous. Even so, the reproductive rate of the mistletoe is

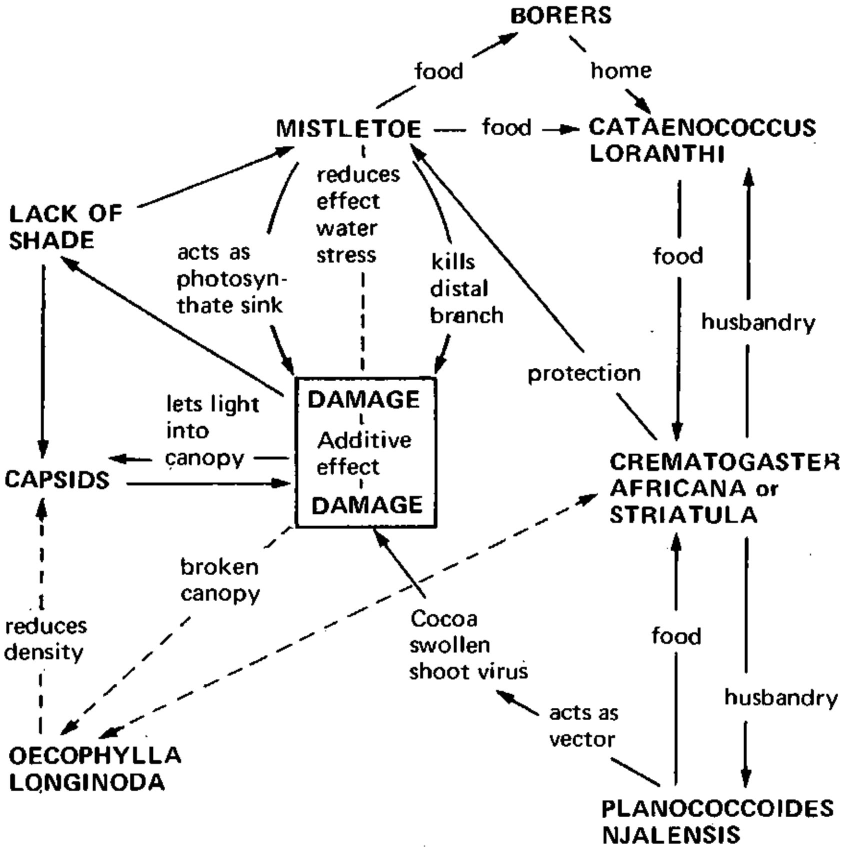


Fig. 1 Suggested role T. bangwensis in cocoa canopy degeneration.

———————> conducive to, – – – – – – – –> antagonistic to.

sufficiently low that cutting out once every two years should give acceptable control.

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Slimy Fermentations

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In a normal fermentation the pulp that surrounds the beans is degraded and eventually reduced to an insignificant remnant on the testa of the dried bean. This degradation of the pulp promotes the growth of acetic acid bacteria by allowing oxygen to penetrate the mass more easily and it facilitates the process of drying at the end of fermentation. It is therefore an important part of fermentation. Sometimes, however, fermentation of the pulp is abnormal; the mass becomes excessively slimy and "waterlogged" and the temperature does not rise in the normal way. Beans from such a fermentation are difficult to dry and have a high proportion with a cheesy texture and purple cotyledons.

My first acquaintance with such fermentations came in 1963 when I visited Jamaica at the request of the then manager of the Cocoa Industry Board to investigate an unusual type of fermentation characterised by low maximum temperatures. Since then similar fermentations have caused concern at two estates in Trinidad, one at Guaico and one at Gran Couva. However, slimy fermentations had been observed by earlier workers and these observations will be discussed later. Bridgland in New Guinea (3) has referred to "dead" fermentations without describing them as excessively slimy. However, P. N. Byrne (pers. comm.) has recently confirmed the fact that dead ferments in New Guinea are slimy. It is thus possible that this defect is much more widespread than present reports indicate.

Description of the Defect

The principal characteristic of the defective fermentation discussed in this paper is its excessive sliminess. This may be noticed as early as the second day and may persist throughout the whole period of fermentation. If the mass is stirred by hand and the spread fingers are moved through the beans, long streamers of slime are left in their wake in a manner quite unlike that of normally fermenting cocoa. With the sliminess is associated a "waterlogging" effect; juice collects in any depression made in the cocoa. In Jamaica (7) there was also a dirty blue-grey discolouration of the beans in the surface layers and in all cases there has been an unpleasant "doggy" odour unlike the normal, vinegar-like odour. Fermentations showing these characteristics in the early stages seldom develop temperatures as high as 45°C and the slime makes drying a time-consuming process. Implements used to move the beans during drying become coated with masses of slimy pulp and require frequent cleaning. Thus the defect increases the time and cost of processing.

The origin of the slime is unknown. Two possibilities can be suggested (a) the slime is mucilage from the beans themselves, (b) the slime is produced by micro-organisms. A priori the second is a very real possibility as some of the micro-organisms involved are known to produce slime (2). However, recent observations suggest that the slime is not bacterial but originates in the cocoa seed.

The testa of a cocoa seed consists of two integuments grown together, outside of which is the pulp. The outer integument contains large mucilage cells near the epidermis (Fig. 1). When the pulp is washed off the seeds in a washing machine the outer epidermis and one or two layers of cells are washed away too, the mucilage cells are broken, and the wash water becomes extremely slimy from the released mucilage. "Skin rigidity varies greatly with different clones. The seed coat is stretched by the growing embryo and sometimes the thickened epidermis of the inner integument is torn locally. The whole seed coat may even be split open at the edge of the seed" (8). The splits in the testas are easily seen in washed beans and my impression is that they are more frequent at some times of the year than at others but no attempt has yet been made to relate these splits to seasonal effects, degree of maturity or variety. At any rate the points to note here are that mucilage from the testa is slimy and that the splits in the testa could allow egress of mucilage cells even in unwashed beans. Further, beans from slimy fermentations seem to have numerous splits over and above these "natural" ones and the impression created is that the excessive sliminess is due to mucilage pouring out from the ruptured mucilage cells. Therefore what little evidence there is favours the interpretation that the slime is cocoa slime not bacterial slime.

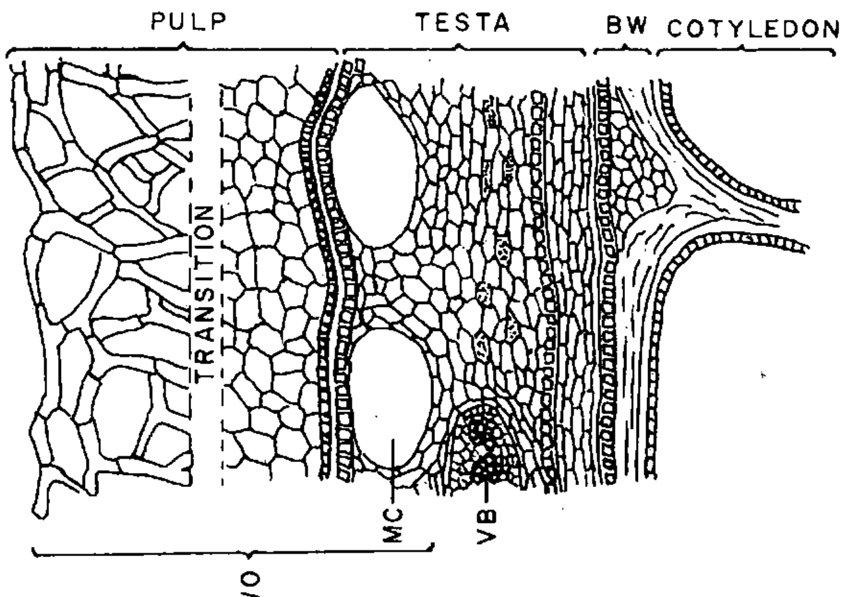

Fig. 1. Transverse section through the cocoa seed to show location of mucilage cells. BW="beeswing", MC=mucilage cells, VB=vascular bundle, WO=portion washed off in a washing machine.

Causes of the Defect

In both Jamaica and Trinidad the defect has occurred mainly in the wet season with some carry over into the early part of the dry season so that there is some association between it and rainfall. When the defect was first encountered in Jamaica several possible causes were considered. In Jamaica, cocoa is grown by small farmers and fermented in central fermentaries. Trucks from the fermentary collect the beans twice a week from collecting stations throughout the country, the pods having usually been picked and opened the day before. Sometimes, the beans may be carried to the collecting station and left overnight in uncovered metal kerosene tins instead of boxes or baskets. It is thus exposed to rain and rust from the metal containers and these were considered as possible causes. Apparently too, green pods were sometimes picked, "force-ripened" and mixed with ripe cocoa. Since unripe cocoa can be easily recognised and is rejected by the collectors, the force-ripening process is resorted to. In this process the pods are stored for several days in heaps covered with banana leaves and earth. Usually the ends are cut off the pods.

In Trinidad there were no obvious malpractices associated with the defect. Beans may come in contact with metal for short periods if transported to the fermentary by tractor but there was no evidence of unripe cocoa and seemingly no possibility of damage by rain.

Experiment soon showed that contamination with metal was not a cause of the defect. In two experiments ferrous sulphate (500 mg) added to fermenting cocoa (30 lb) on the first day failed to produce the sliminess so characteristic of the defective fermentations described above. In another experiment ferric ammonium chloride added at the rate of 0·2 g per kg did not induce sliminess. However, there is little doubt that iron is the cause of the blue-grey discolouration seen in Jamaica since iron reacts with phenols to form coloured compounds and since both ferric chloride and rusty containers have induced dirty blue-grey or green-grey discolourations in fresh seeds. Additions of stannous chloride to fermenting cocoa did not induce sliminess.

On the other hand, rain-soaked cocoa can become slimy. In one experiment beans were allowed to stand out in the rain for about three hours. Compared with the control, which was normal, this lot became extremely slimy, even more so perhaps than the defective commercial fermentations. In two subsequent experiments in which lots were soaked under a sprinkler for 30 minutes no excessive slime developed, probably because the period of soaking was too short. In a further experiment in which the period of soaking was two hours the soaked batch was divided into two lots of 15 lb each. Both became slimy. Sugar (180g), added to one of these after the appearance of slime, did not cause its disappearance but allowed the formation of more normal amounts of alcohol and acetic acid and a much better product was eventually obtained. In a repetition of the experiment in which sugar was added about one hour after the soaking, slime production seems to have been lessened but the added sugar did not entirely compensate for the sugar removed by leaching as shown by the more rapid drift of the pH of the pulp to neutrality.

In view of the foregoing it would not be surprising if unripe cocoa failed to ferment properly because it contains less sugar than ripe cocoa (10). It was gratifying to rediscover that Knapp did the experiment in 1926 when he fermented 600 lb of unripe beans and found that "there was insufficient sugar to maintain the fermentation longer than twenty-four hours and the temperatures reached were much below normal. The product was thus insufficiently fermented. Further, the beans became gummy and slimy" (6). He repeated the experiment with unripe cocoa in muslin bags embedded in a sweat-box of normal cocoa. "The pulp became gummy or ropy and the oxidation of the cocoa-purple proceeded more slowly".

Roelofsen and Giesberger (9) report similar observations. In Java at the end of the season all the pods, including green ones, are harvested for the control of the Java cocoa moth. The "rampasan" cocoa is fermented but the fermentation is distinctly abnormal. The temperature reaches 42°C within 24 hr. but then declines and drops to about 35°C after the first turn at 40 hr. At this time the mass becomes a porridge and aeration is completely disturbed. The so-called second grade plantation cocoa which also contains a high percentage of unripe beans also ferments with unusual sliminess and much pulp remains on the beans after fermentation.

My recent experiments confirm these observations. Cocoa that was harvested when just ripe fermented more or less normally with a slightly increased sliminess but unripe cocoa, which was left in the broken pods until it could be easily removed, fermented with excessive slime.

In Jamaica, it was suggested that beans from pods infested with *Phytophthora* cause the sliminess. Since the fungus in the pod will metabolise sugar in the pulp, beans from infested pods will almost certainly have less sugar in the pulp than normal beans. The pulp also frequently appears excessively watery. Such beans would probably not ferment normally and infected beans within a mass of normal beans frequently appear excessively slimy but a small percentage of such beans in normal cocoa has no effect on the behaviour of the mass.

In the experiments discussed above, additions of iron or tin produced no abnormal sliminess but treatments which resulted in a lower sugar content of the pulp lead to sliminess. This gives a possible clue to the association between slimy fermentations and rainfall. In citrus the sugar content of the ripe fruit is higher in the dry season than in the wet season (5). If cocoa behaves like citrus, pods ripening in the wet season could have pulp with a sufficiently low sugar content to be intolerant of malpractices, such as the addition of green, rain-soaked *Phytophthora*-infected beans, that in the dry season would not lead to slimy fermentations.

Normally fermenting cocoa is extremely attractive to fruit flies (*Drosophila* spp.) but slimy fermentations are completely unattractive. Fruit flies harbour micro-organisms on their bodies and these micro-organisms on transfer to the cocoa are active in fermentation. It was considered possible that in the absence of inoculation from fruit flies slimy fermentations proceed along their abnormal course because of the absence or relative scarcity of the micro-organisms that degrade the pulp. This seemed to be the case on the two estates in Trinidad where slimy fermentations were abnormal. In one, fermentations returned to normal when fifty pounds of well fermenting beans from another estate were introduced into a fermenting batch and on the other when fruit flies were attracted to sweat-boxes with over-ripe bananas.

Yet a third possibility exists. It was mentioned earlier that there are variations in the rigidity of the seed coat from variety to variety and that splits in the seed coat occur naturally. It is possible that these splits occur more frequently in the rainy season when cell turgidity would be expected to be maximal. If this is so the pulp may be naturally somewhat more slimy during the wet season than during the dry and this may predispose the cocoa to defective fermentation from other contributory causes. In fact there is no reason to believe that in any individual slimy fermentation there is only one cause. It is more likely that several causes may be operative at the same time: split testas, low sugar content of the pulp and unbalanced microflora.

Remedies

The immediate remedy for a particular batch of fermenting cocoa which is slimy is an increase in aeration by an increase in the number of turns or even, if necessary, by partial drying. Preventive measures should be aimed at securing an adequate supply of air to the beans. Where fermentation takes place in boxes air must be free to enter through holes or between slats in the floor of the box and its egress must not be impeded by the use of polythene sheet or similarly impervious material as a cover. Turning should be regulated with reference to the other factors influencing aeration.

Since slimy fermentations may be caused by harvesting unripe pods or exposing the beans to rain only ripe pods must be harvested and the beans must be protected from soaking by rain. If these precautions are observed and slimy fermentations still occur, the remedy must be sought in the addition of sugar or molasses as has sometimes been done in Trinidad (4) or in the attraction of fruit flies to the fermenting cocoa. Molasses is about 50 per cent fermentable sugar (1) and should be added at the rate of 50–100 g per kg beans; sugar should be added at half this rate. Fruit flies are important in inoculating the beans with favourable micro-organisms. If they are absent they may be attracted to the fermentary by hanging stems of over-ripe bananas in it.

Acknowledgments

I thank the Manager and staff of the Jamaican Cocoa Industry Board for their co-operation at the time of my visit to Jamaica and the ready acceptance of my proposal to publish here the results of those investigations, the owners of the two estates in Trinidad for their interest and help during the investigations in Trinidad, Mr. D. B. Murray for critical comment on the manuscript, and Mr. I. Sewrajsingh for the translation of the relevant passages from the publication of Roelofsen and Giesberger (9).

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Ikiliwindi: Cadbury Schweppes Plantation in Cameroon

3. Fermentation and Drying

G. A. R. Wood

Crop Pattern

The situation of Ikiliwindi and the pattern of rainfall, temperature and sunshine were described in an earlier article (2). There is a single wet season starting in April and lasting until early November and this results in a crop with one peak period. Flowering and pod setting takes place in April–May and this leads to a peak in November. There is some crop harvested every month but the main crop period starts in August and lasts until January. As the main crop starts before the end of the wet season it is essential to dry the crop on an artificial dryer. Apart from that, the space and labour involved in sun drying would be excessive even if the weather allowed sun drying to be completed in reasonable time.

The proportion of the crop harvested in the peak month can be over 30 per cent. It is clearly important to know this proportion as the drying equipment must be adequate to cope with the peak month's harvest. A crop pattern of this type involves a heavy demand on equipment and labour for 4–6 weeks; a more uniform flow of crop is obviously easier to handle. There is not a great deal that can be done to mitigate this situation. The crop can be spread out to a limited extent by increasing the interval between harvests but this would be dangerous if pod disease is prevalent at the peak month. At Ikiliwindi black pod is usually diminishing rapidly in November so that it is possible to extend the harvesting period to a limited extent when the pressure of the crop demands.

Harvesting

The crop is harvested at two weekly intervals during the wet season but this may be extended to three weeks during the peak month as already explained. During the months of light cropping the interval is two or three weeks according to the amount of crop ripening.

The harvesters gather the pods, cutting the stalks with a hand knife or a knife on a harvesting pole. As the height of the trees is restricted to the first jorquette most of the pods can be reduced with a hand knife. The pods are carried to the roadside in baskets slung on the harvesters' backs. At that point the pods are sorted into good, black and rodent damaged; a fourth category, pods damaged by Bathycoelia, was added after the devastating attack by this bug in 1969.

The symptoms of Bathycoelia attack were described in an earlier note (3). The pods damaged by rodents and Bathycoelia which total about three per cent of the crop now that Bathycoelia is under control, are discarded. Black pods and healthy pods are collected and taken to the factory where they are opened separately, as it is more difficult to open the black pods and extract the beans from them. A proportion of them have to be discarded. It is the incidence of black pod that makes it necessary to move all the pods to a central point for opening, as this allows closer supervision of the quality of the beans. The pods are opened by women using a block of wood or cement on which to crack the pods. They place the wet beans in baskets and from these the beans are transferred to a large fermenting box. The purpose of this box is to hold the beans

The pod – opening scene. The husk hoppers on the left are emptied direct into trailers.

temporarily prior to filling the trays used for fermentation. The box is used partly for convenience but during the hour or two that the beans remain in the box much of the sweatings runs off and the beans ferment more readily as a result. During the cooler wet season the beans do not ferment so readily; this is countered by leaving the beans in the box for a longer period, up to six hours.

Fermentation

The tray method of fermentation was adopted from the start as it occupies less space and uses less labour than traditional box fermentation. The trays, constructed on the estate, are 3′ × 2′ × 5″ deep; three or four battens are fixed across the bottom of the tray and on these a piece of bamboo matting is laid. The depth of the layer of beans is 4″ and each tray holds about 100 lb beans. The advantages of the tray method have been mentioned; it has the disadvantage that the trays and mats require regular maintenance. The trays are stacked 12 high and the stack of trays is raised a few inches off the floor to allow sweatings to drain away and air to circulate; it also allows the use of a pallet truck to move the stacks to the dryers after fermentation. After 24 hours the stacks are covered with sacking to retain the heat and fermentation continues for a further four days. Initially the duration of fermentation was four days, the period recommended following trials at Tafo. This produced samples which were rather under-fermented and trials showed that five days produced a better sample under Ikiliwindi conditions.

Drying

The beans are dried on a platform dryer fitted with a fan and oil-fired heat exchanger. This was adopted following experiments with this type of equipment (1).

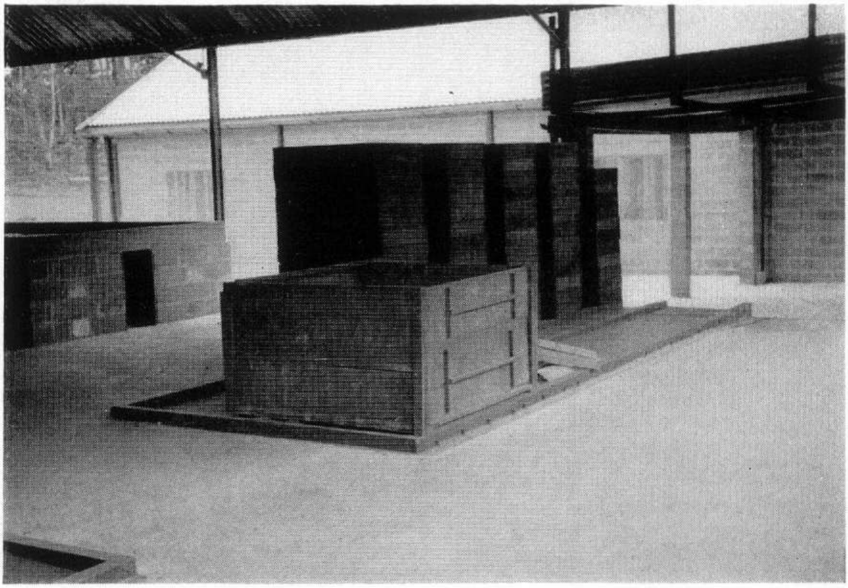
The original equipment proved to be inadequate in its heat output and some changes were made in the additional equipment which had to be bought as the crops increased. Six dryers are now installed and the last three have drying platforms 32′ × 8′; the drying beds are 30″ above the floor which makes loading, mixing and unloading a relatively easy task. The bed itself is made of nylon-covered expanded metal in panels 8′ × 2′ which rest on an angle iron frame.

The hot air is provided by a fan with an output of 4,000 c.f.m. against a static pressure of 0·8″ WG and a heat exchanger with a maximum output of 460,000 BTU's per hour.

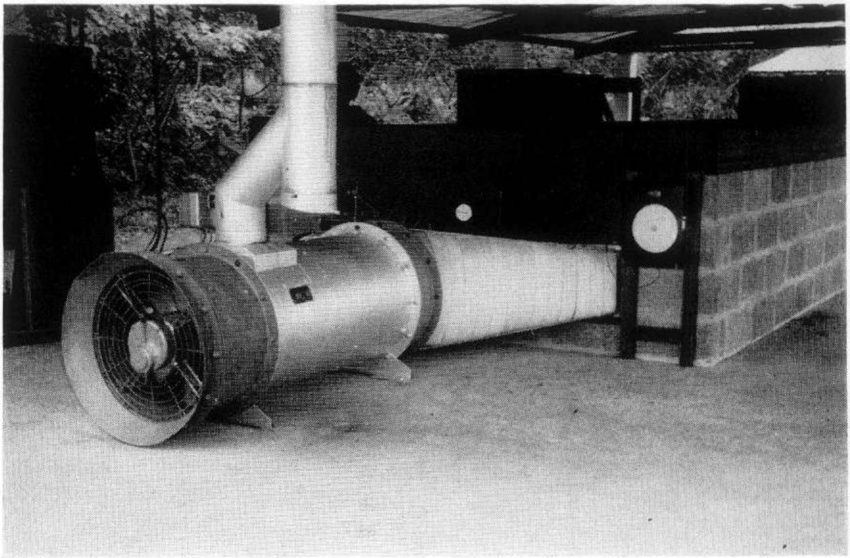
A damper is fitted to control the volume of air and the temperature of the hot air is controlled by a thermostat. At maximum airflow this unit provides an airflow of 15–20 ft/min per sq ft of drying platform and a temperature rise of 75°F can be obtained.

The technique adopted initially was to load the drying platform to a depth of 6″ and to set the fan and damper to provide maximum airflow. The beans are stirred at regular intervals while they are externally wet in order to prevent the beans from sticking together and to ensure uniformity. Wet beans offer greater resistance to airflow than dry beans and if the beans are not stirred during the initial stages the hot air will tend to funnel through a few "dry" patches. When the beans are externally dry, they need not be stirred so frequently and the airflow is reduced to about half the maximum rate by partially closing the damper.

The first trials showed that the original equipment could produce one ton of dry beans in 36 hours at a fuel consumption of 39 gallons. In practice it is



The fermentary and drying shed showing the box used for fresh beans, the stacks of trays and a drying platform; the cocoa store is in the background.



The first drying unit.

difficult to achieve these results consistently, but fuel consumption can be reduced by increasing the depth of beans. The current practice is to load the dryers to 10″ deep with the equivalent of two tons of dry beans; after 24 hours the beans are externally dry and at this stage the loads of two or three dryers are combined. By this means over six tons of beans can be produced in 60 hours at a fuel consumption of 35 gallons per ton. While an individual batch can be produced at this level of fuel consumption, the average over a season is appreciably higher at 45–50 gallons per ton. It has been found that beans from black pods take longer to dry than those from healthy pods and this factor also raises fuel consumption.

Bagging

The beans are bagged and allowed to cool. They are then passed through a grader in order to remove flat beans. From the grader the beans are bagged using a polythene liner (usually 150 gauge) during the wet season; this prevents any possibility of mould development through moisture uptake in the exceptionally humid conditions that occur in West Cameroon.

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Cocoa Abstracts

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Krise in Ghanas Kakaoindustrie. Ein Bericht der Weltbank. (Crisis in Ghana's cocoa industry. World bank communication). Afrika Heute 2, pp. 25-6 (1971). Cocoa supplies 65 per cent of the export of Ghana, the largest producer in the world. Yet, its share in the world production has dropped in recent years from 37 to 30 per cent. In the 1964/65 season, a record of 542,000 tons were produced, against only 320,000 tons in 1968/69. Apart from less favourable weather conditions this setback was mainly caused by lack of money of the smallholders. Now with help from the World Bank the cocoa area will be extended by planting high-yielding new varieties. At the same time the yielding capacity of existing trees and the market value of their product will be increased by improved agrotechnical measures, infrastructure and marketing organisation.

Ashiru, G. A. Viability of cacao beans. Exp. Agriculture 6, 4, pp. 341-4 (1970).

At the Cocoa Research Institute of Nigeria, fresh cocoa beans slowly dried in a flow of air at room temperature were found to lose their viability within four weeks, whereas drying in a flow of CO_2 greatly prolonged their life; drying in N_2 was intermediate in effect. Drying to 25 per cent moisture (in 60 hrs) was much more harmful than drying to 50 per cent moisture (in 12 hrs); storage in polythene bags after drying was better than storage in air-tight bottles. The combination of the best drying and storage methods resulted in about 50 per cent germination after 45 days and about 30 per cent after 60 days, so that the method allows seed to be safely shipped abroad. Tables. 7 refs.

Kanapathy, K. and Thamboo, S. West Malaysian soils in relation to cocoa. In: Crop diversification in Malaysia; ed. by E. K. and J. W. Blencowe, pp. 267-74, 1970.

Trial plantings of cocoa on various soils of W. Malaysia have shown severe die-back a few years after planting. Soil and leaf analysis, and a comparison of the data with those of cocoa soils in Ghana, suggested that poor growth and die-back were mainly due to lack of Ca in the Malayan soils. A trial on Jerangau soil showed responses of the cocoa to liming associated with a considerable rise in the pH and exchangeable Ca content of the soil. On the basis of these findings, many Malayan soils must be judged unsuitable for cocoa; soils derived from basalt, andesite and limestone promise better results than those derived from granite and granodiorite. Tables. 6 refs.

Foster, L. J., and Lim Hong Kee. Some aspects of the management of young cocoa. Planter 46, 533, pp. 261-5 (1970).

Results of investigations conducted at a cocoa estate in Sabah, Malaysia, on aspects of nursery management and cocoa establishment, are summarised. The use of polybags of 15 × 22·5 cm (lay flat size) proved to be satisfactory in producing 3-month-old seedlings; basaltic topsoil from virgin forest and from abaca fields gave similar results which could be somewhat improved by addition of P fertiliser; good control of leaf-eating insects was obtained by endosulfan, bidrin, dimethoate or lead arsenate. Weeds (other than nut-grass) in newly established plantings could be effectively and economically controlled for a period of over 15 weeks by initial handweeding followed by simazine application at the rate of 4·48 kg/ha. 4 refs.

Blencowe, J. W., and Templeton, J. K. Establishing cocoa under rubber. In: Crop diversification in Malaysia; ed. by E. K. and J. W. Blencowe, pp. 286-96, 1970.

Although interplanting of rubber at commonly used spacings with cocoa has not been successful, cocoa may be established under avenue-planted or thinned rubber stands nearing the end of their useful life. Alternatively, the cocoa could be planted first and a limited number of big rubber stumps introduced after some time. A detailed description is presented of a four ha trial field in W. Malaysia where Upper Amazon hybrid seedlings were interplanted at 3 × 1·8 m between rows of an old rubber seed garden which were 18 m apart. Growth of the cocoa during the first 20 months has been fairly vigorous. Tables. 14 refs.

Firman, I. D., and Sundaram, S. Reaction of cocoa cultivars to canker, caused by Phytophthora palmivora, in Fiji. Plant Disease Reporter, U.S. Dep. Agriculture 54, 12, pp. 1035-7 (1970).

Cocoa canker can cause serious damage in Fiji and is common in the south-west Pacific area. The susceptibility of cocoa cultivars was assessed by stem inoculations with *Phytophthora palmivora* and field observations of natural infection. In general, susceptibility as judged by lesion length following inoculation was related to severity of natural infection, although some clones were anomalous in this respect. Methods of assessing canker susceptibility are discussed. From authors' summary. Table. 3 refs.

Evans, R. C. Preparation and maintenance weeding in immature/mature cocoa using herbicides. Planter 46, 536, pp. 369-72 (1970).

With the increased area of cocoa planted, either as a monoculture or interplanted under coconuts in W. Malaysia, efficient methods of weed control had to be evolved, if larger areas were annually to be planted and maintained. The most efficient herbicide combination selected for initial spraying was a tank mixture of MSMA, 2,4-D amine and sodium chlorate. After the 3rd round of spraying (herbicides applied at monthly intervals), sodium chlorate was replaced by DCPA (Monopon). The main weeds controlled are listed; among these are: *Paspalum conjugatum*, *Ischaemum muticum*, *Axonopus compressus*, *Digitaria marginata*, and *Mikania cordata*. The grasses *Cynodon dactylon*, *Zoysia* spp., and *Panicum repens* are susceptible to the MSMA-2,4-D-Monopon combination.

Lordello, L. G. E. Plantas hospedeiras do nematóide Meloidagyne thamesi na Bahia. (Host plants of the nematode *Meloidogyne thamesi* in Bahia). Solo. Centro Acad. "Luiz de Queiroz", Brasil 62, 1, pp. 19 (1970).

The nematode *Meloidogyne thamesi* which was recently found to infest cocoa plants in Bahia, Brazil was shown to have the following host plants: *Lycopersicon* spp. among which *L. esculentum*, *Leonurus sibiricus*, *Spondias lutea*, *Momordica charantia*, *Petiveria hexaglochin*, and *Rivina humilis*. Papaya (*Carica papaya*) roots were found infested by an unidentified *Meloidogyne* sp. English summary. 2 refs.

Dunsmore, J. R., and Ngui, T. S. T. Prospects for cocoa in Sarawak, Malaysia. In: Crop diversification in Malaysia; ed. by E. K. and J. W. Blencowe, pp. 275-85. 1970.

After a long period of neglect, interest in cocoa as a prospective crop for Sarawak was revived, when two plots of amelonado cocoa planted in 1950 were found to have given average yields of 1,870 and 2,150 kg/ha over 1959-64. Since then a number of varietal and fertiliser trials were established on various soil types, and observations made on suitable shade trees and the incidence of diseases and pests. Upper Amazon crosses appear more promising than amelonado progenies. The most immediate prospects lie in parts of the saline gley soils in the mouths of the Sarawak and Rejang rivers which were reclaimed 30–40 years ago and largely planted with coconut palms. Establishment of cocoa under coconuts has given encouraging results. Tables. 21 refs.

Extra Issue 1971

Shaw, D. E., and Burnett, W. M. Galls of cocoa in Papua and New Guinea. Papua and New Guinea Agr. J. 21, 2, pp. 25-48 (1969).

An extensive study has been made of the fan and knob galls on cocoa occurring in Australian New Guinea, although not of economic importance. No significant differences were found in auxin activity and in gibberellin levels between galled and normal samples. Also no virus-like particles have been detected under the electron microscope. The presence of knob galls could neither by correlated with any nutritive state of the tree (including deficiency of boron), nor with any isolated fungus. Not a single bacterium was isolated. Tables. Figs. Photos. 14 refs.

Okaisabor, E. K. The influence of leaf litter on outbreaks of Phytophthora pod rot disease. Cocoa Res. Inst. Nigeria Half-Yearly Prog. Rep., 9, pp. 15-6 (1969).

In Nigeria, field experiments were conducted to study the effect of thick leaf litter in cocoa plantings on the initiation of *Phytophthora* pod rot, the results showed that thick leaf litter delayed the onset of disease and largely reduced severity of infection during the early stages of the epiphytotics. Table.

Okaisabor, E. K. The spread of Phytophthora – pod rot disease. Cocoa Res. Inst. Nigeria Half-Yearly Prog. Rep., 9, pp. 17-9 (1969).

In Nigeria, crawling hymenopterous insects were collected on the ground to test their ability to transfer cocoa pod rot inoculum. The results show that the insects more readily infected healthy pods after crawling on sporulating *Phytophthora* lesions of infected pods, than after crawling on moistened *Phytophthora*-infested top soils. Therefore, it is suggested that these insects play an important role in disease build-up, and that they probably are responsible for the spread of inoculum from primary lesions on basal pods to those in the canopy. This factor probably accounts for the higher level of control of the disease achieved with mixtures of fungicides and insecticides. Table.

Rao, M. R. N. Cocoa has a bright future in Andamans. Indian Farming 20, 1, pp. 15-7 (1970).

Exploratory trials on the Andaman and Nicobar islands, and India, started in 1963, offer encouragement for cocoa cultivation. Discussed are: nursery practices, planting and establishment, soils and cover crops. Seeds of Amelonado and Amazon types were imported from Malaysia, and used for plantings. Only some minor pests and diseases have been noticed so far. Photo.

July 1971

Stejskal, M. Nectar y aroma de las flores del cacao. (Nectar and odour of cocoa flowers). Oriente Agropec., Venezuela 1, 2, pp.75-92 (1969).

The unicellular hairs and multicellular glandular hairs on various parts of the cocoa flower, and the unicellular glandular hairs on the ridges of the petals and the staminodes, are described in detail from material collected in Venezuela, and compared with similar appendages of other plants. Because the excretions of the two types of glands were found to contain sugar these hairs are regarded as nectaries. The author assumes that pollinating midges feed on the secretion and that, therefore, the flower must emit an odour detectable only by insects. English summary. Figs. 16 refs.

Ng Siew Kee, et al. Soil and leaf nutritional status of cocoa plantings on the east and west coasts of Malaysia. Malaysian Agr. J. 47, 4, pp. 390-408 (1970).

In W. Malaysia, cocoa on granitic soils on the east coast shows severe die-back, whereas cocoa under coconut palms on marine clays along the west coast grows much better. Both soil types have a pH of 4·5-5·0; cation exchangeable capacity, base saturation, and exchangeable Ca and Mg contents are much higher in the marine clays. Die-back on the granitic soils is tentatively ascribed to a complex of soil factors involving high acidity, low base saturation and exchangeable Ca levels, inhibition of Ca and water uptake by Al, and moisture stress in the dry season. A trial showed that these unfavourable factors could to some extent be improved by liming. Tables. Photos. 30 refs.

Bartley, B. G. D. First generation inbreds as parents in hybrids of Theobroma cacao L. Trop. Agriculture, Trinidad 48, 1, pp. 79-84 (1971).

In Trinidad, cocoa hybrids obtained by crossing trees derived by selfing the clones ICS1 and ICS45 for 1 generation were observed. It appeared, although the trial was terminated prematurely, that some of the $S_1 \times S_1$ hybrids gave relatively higher yields than the $S_0 \times S_0$ hybrid. Development is therefore suggested of superior parents by inbreeding heterozygous individuals with promising characteristics. A technique is described for obtaining improved single crosses by selection for yield components and other desirable characteristics in the early inbred generations combined with variety testing. Tables. 12 refs.

August 1971

Phillips, P. H. Marketing of cocoa. Planter 47, 538, pp.15-22 (1971).

This article discusses the different aspects of cocoa marketing and outlines the many difficulties met at finding practical systems to regulate prices within reasonably narrow limits. In major producing countries, national marketing boards have been established with absolute control over the internal buying and the external selling of their country's produce. An international controlling body is suggested to carry out a "sales quota" system backed by a buffer stock. Great difficulties are experienced in carrying out all these plans. 2 refs.

Verlière, G. Influence de l'humidité du sol sur le développement du cacaoyer. (The influence of soil humidity on the development of the cocoa tree). Café Cacao Thé, 14, 4, pp. 265-74 (1970).

In the Ivory Coast, cocoa seedlings were raised up to the age of three years in 1 m high concrete containers under four water regimes: a fixed water table 45, 60 or 75 cm beneath the soil surface, and free drainage. Growth periodicity was studied in relation to solar radiation. Amelonado, Upper Amazon, and Trinitario cocoa were found to differ considerably in their rate of growth and their daily water consumption per tree. Trinitario seedlings grew best under a regime imitating natural conditions of rainfall and drainage through the soil, whereas the other two types showed maximum growth when the water table was kept at 75 cm beneath the surface. English, German, and Spanish summaries. Tables. Graphs. Photo.

Ravisé, A. Modalités du parasitisme de souches de Phytophthora De Bary sur jeunes cacaoyers. (Modes of parasitism of *Phytophthora* strains in young cocoa plants). Café Cacao Thé, 14, 4, pp. 295-302 (1970).

In Congo-Brazza, 171 young cocoa seedlings representing 10 progenies of various types were inoculated at the root collar with 20 *Phytophthora* strains, covering to eight species which were isolated from various host plants. All progenies were more or less susceptible to all strains of the fungus irrespective of species or source, but not all strains were equally virulent. Relative susceptibility to collar infection in some progenies was greater or smaller than their known relative susceptibility to *Phytophthora* pod-rot. Reaction to the infection appeared to depend on properties of the cocoa progeny and of the fungal strain. The pathogen could be isolated from some of the 17 inoculated plants that did not develop symptoms. English, German and Spanish summaries. Tables. 14 refs.

Vincent, J. C. Influence de différents traitements technologiques sur la fermentation du cacao et le goût du chocolat. (Influence of different technological treatments on the fermentation of cocoa and the taste of chocolate). Café Cacao Thé, 14, 4, pp. 303-22 (1970).

Fermentation trials with 250 kg lots of fresh cocoa beans, conducted in bins in the Cameroon Rep., showed that washing the beans under a jet of water during 10 minutes, and addition of up to 10 per cent by weight of pod and rachis debris to the beans, had no important effect on the fermentation process, the commercial quality of the product, or the eating quality of chocolate. The above implies that there is no objection to mechanical pod breaking; it is not necessary to separate completely the beans from pod debris. The best quality chocolate was obtained by fermentation during seven days, stirring the mass after one, two, four and six days. English, German, and Spanish summaries. Tables. Photo. 6 refs.

Chok, D. K. K. Shade – its cultivation, management and problems at BAL Cocoa Estate. Planter 47, 539, pp. 47-53 (1971).

Field trials conducted in a cocoa estate in Sabah, Malaysia, in the early 60's showed the superiority of *Leucaena glauca* (= *L. leucocephala*) as primary shade to planting in thinned forest. Its large-scale application, however, was not a success; overshading due to labour shortage made the cocoa trees susceptible to the fungus *Botryodiplodia theobromae*. A trial started in 1965 showed that *Gliricidia maculata* had certain practical advantages over *L. glauca*. Notwithstanding certain drawbacks, it is used for primary shade. The introduction and experience obtained with the permanent shade trees *Albizzia falcata*, *A. chinensis*, *Parkia javanica* and other species and the present and future shade policy of the estate are outlined. New cocoa hybrids may be better adapted to less shade than Amelonado cocoa. Table. 6 refs.

Wyrley-Birch, E. A. Shade for cocoa. Cocoa Planter 47, 539, pp. 54-62 (1971).

Shade experiment results obtained at the Cocoa Research Station in Sabah, Malaysia, are presented and the possibility of growing cocoa under shade of perennial tree crops, viz. coconut palm, rubber, oil palm, durian (*Durio zibethinus*) is considered. Choice of species as temporary shade is limited to *Gliricidia maculata, Erythrina subumbrans, Albizzia falcata* and possibly *Lannea grandis*. For permanent shade *A. falcata* and *A. chinensis* and *Parkia javanica* are indicated, whereas durian and species of the fam. of *Dipterocarpacea* are considered to be promising. Tables. 8 refs.

Gouveia, A. J. Soares de, and Sousa, M. E. da Silva e. Aspectos da defesa fitossanitária do cacau armazenado em S. Tomé. (Aspects of the protection of stored cocoa beans in the isl. of S. Tomé). Garcia de Orta 16, 3, pp. 309-66 (1968; received 1971).

An evaluation was made in the isl. of S. Tomé of the degree of infestation of stored cocoa beans by insect pests and fungi. The climatical factors favouring the development of the pests, such as humidity and temperature have been studied. Lists are presented of the insects and fungi found. Recommendations are given on the storage in warehouses and on the prevention of the infestation by pests. German, English, and French summaries. Tables. Graphs. Map. 35 refs.

Owusu, G. K. Cocoa necrosis virus in Ghana. Trop. Agriculture, Trinidad 48, 2 pp. 133-9 (1971).

During a survey of cocoa viruses in the northwestern cocoa growing areas of Ghana, a small outbreak of cocoa necrosis virus was inspected in a locality at the northern most limit of cocoa cultivation in Ghana. The virus is easily graft-transmissible and readily transmitted mechanically using partially purified preparations from infected cocoa leaves. Unlike some other viruses, however, it is not transmitted by mealy bugs. Natural infection appeared to have little effect on the growth of the infected trees, whereas artificially inoculated seedlings were severely affected and frequently died. The natural vector and original source of the virus are unknown. Control by eradication appears to be effective. Tables. Photos. 14 refs.

Chee, K. H., and Phillips, T. A. Phytophthora stem canker of cocoa. Planter 47, 539, pp. 43-6 (1971).

A new disease for Malaysia, stem canker die-back in cocoa trees (*Phytophthora palmivora*), was found to occur in 6-year-old trees growing under oil palm stands at two different localities in Johore. Occurrence and symptoms observed are described. Trees which had been killed had almost ring-barking cankers on the main trunk. A number of trees of the infested plantings had black pods. Concern is expressed on the possible consequences the disease may have now the country is developing a cocoa industry. Precautionary measures, mainly based on experience gained in other countries, are indicated. Photo. 5 refs.

Gonzalez, V. R. Observaciones de una asociación de insectos daninos al fruto del cacao (Theobroma cacao L.). (Observations on an association of insects harmful to cocoa fruits). Cacao, Bol. Inform. 6, 2, pp. 1-6 (1969).

Observations were conducted in Costa Rica concerning the association between two harmful cocoa insects, viz., the ant *Pheidole biconstricta* and the cochineal *Horiola picta.* Both insects were found to live in symbiotic association. Cochineals are protected by the ants by covering colonies on fruits, flower cushions and chupons with a saw-dust-soil mixture. The ants partly feed on sugars given off by the cochineals. Cherelles once attacked by cochineals did not recover. Of economic importance is flower cushion damage due to cochineals. Pod rot (*Phytophthora palmivora*) incidence tended to be more severe on fruits previously attacked by the cochineals. 7 refs.

October 1971

Tarjot, M. Nouvelle contribution a l'étude de la pourriture des cabosses du cacaoyer due au Phytophthora palmivora (Butl.) Butl. en Côte d'Ivoire. (New contribution to the study of cocoa pod-rot due to *Phytophthora palmivora* in the Ivory Coast). Café Cacao Thé 15, 1, pp. 31-48 (1971).

The soil of a cocoa field in the Ivory Coast and the flower cushions were found to contain *Phytophthora* inoculum throughout the year, but were found to infect pods only in the rainy season. Susceptibility to infection of pods of the same tree was highly and positively correlated with water content of the pericarp, which showed seasonal fluctuations; when pods of different trees were examined, this correlation was weak or non-existent. Losses from pod-rot were positively correlated with the degree in which external fluctuations in humidity were reduced within a cocoa plot. English, German, and Spanish summaries. Tables. Graphs. Figs. 9 refs.

Muller, R. A. Quelques aspects de la cacaoculture au Brésil. (Some aspects of cocoa growing in Brazil). Café Cacao Thé 15, 1, pp. 3-12 (1971).

The author outlines the situation of the cocoa industry in Brazil and particularly in the State of Bahia which accounts for 96 per cent of the total production. Special attention is paid to the activities of the various organisations created to improve existing plantations and to expand the area under cocoa including research on many subjects (among which pest and disease control are highly important), large-scale production of improved seed, soil analyses as a basis for fertiliser recommendations, and training of personnel. English, German and Spanish summaries. Tables. Photos. Maps.

Programa de cacao. Informe anual. Junio 1969 – Mayo 1970. (Cocoa programme. Annual report. June 1969 – May 1970). Cacao Inst. Interamer. Cienc., Agr. 15, 3 pp. 1-13 (1970).

Cocoa research activities and progress made at the "Instituto Interamericano de Ciencias Agricolas", Turrialba, Costa Rica, during the period June '69 to May '70 are reported. Results are presented covering the following fields: (1) breeding and selection including hybridisation, genetical research, heritability of resistance to *Phytophthora palmivora* and (2) cultivation practices mainly including studies on the effects of planting density and of artificial pollination in combination with fertilising. Tables.

Alencar, M. H. Aspectos da concentraçao da produção de cacau e da estrutura fundiária na região cacaueira do Estado de Bahia. (Aspects of cocoa production concentration and land tenure structure in the cocoa growing region of Bahia State). Comun. Técn., CEPLAC 37, pp. 1-27 (1970).

To provide a basis for an adequate policy for cocoa production increase in Bahia, Brazil, a socio-economic study was conducted. It revealed, among others that the bulk of the cocoa in the region is produced by a relatively low number of medium-sized farms (with an average area of 140-270 ha) belonging to relatively few municipalities. Different policies to develop the region are considered. Efforts could be concentrated either to improve cocoa production of a certain most promising zone, or to promote cocoa production or other activities in other less developed and more densely populated areas. Appendixes. Tables. Graphs. 8 refs.

Wyrley-Birch, E. A., and Shao, Y. T. The cocoa industry in Sabah. Planter 47, 541, pp. 144-52 (1971).

History and present situation of the cocoa industry in the State of Sabah (Malaysia) are described. The government plans to encourage cocoa planting in the State so that the crop will rank third in importance after rubber and oil palm. At the end of 1969, more than 3,000 ha were planted to cocoa and the target at present is 10,000 ha by the end of 1975. Distribution of present acreage and production in the various districts in the State are presented in one table. Each district is discussed separately. Tables. Map. 9 refs.

The present position in developing cocoa varieties. J. Agr. Soc. Trinidad Tobago 70, 3, pp. 307-21 (1970).

During a monthly general meeting of the Agricultural Society of Trinidad and Tobago in August 1970 a specialist of the Cocoa Research Unit discussed the main concerns of a cocoa breeder. Selection of varieties for commercial planting involves a good deal of concern, most of which is related to the need for more thorough local, extensive farmers fields and long-term testing. Current breeding-work being conducted in Trinidad is discussed. Some of the other topics dealt with were, variety release criteria, parent choice in hybridisation, breeding for special characteristics, breeding for resistance to witches broom disease, current and planned breeding programme, effect of plant density, seed size in hybrids, variability of dry to wet weight conversion factors, and incompatibility and pollination efficiency in single-variety commercial plantings.

Case study – the Western Nigeria cocoa project, 1969. Agr. Planning Stud., FAO 13, pp. 49-69 (1970).

This project aims at replanting and at new planting of cocoa in W. Nigeria. The present situation and the project are described. Cost estimates are made and financing sources proposed. Detailed calculation of the internal rate of return of the project over the assumed duration of 30 years are presented at two different cocoa prices, at two levels of investment cost and two yields. Some work sheets on financial implications, costs and revenues are also added. Appendix. Tables.

Are, L. A. Cacao rehabilitation in Nigeria. Ann. Rep. Cocoa Res. Inst. Nigeria 1968-69, pp. 20-9 (1970).

Results of former research on cocoa rehabilitation conducted in Nigeria and on farmer practices, in particular those recommended for swollen shoot virus areas are summarised. Execution of the W. Nigeria Government Replanting Scheme, of which the main rules are indicated, is largely hampered by lack of funds. Suggestions are given for successful rehabilitation. These mainly refer to soil surveys to determine fertiliser needs, control of increased insect attack due to exposure of areas to be rehabilitated, provision of loans (partly in kind) as an incentive to farmers and to compensate for temporary income breakdown and timely provision of sufficient, improved planting material. Improved management is considered to be an integral part of rehabilitation schemes. Tables. Photo. 14 refs.

Kenten, R. H., and Legg, J. T. Varietal resistance of cocoa to swollen shoot disease in West Africa. FAO Plant Prot. Bull. 19, 1, pp. 1-11 (1971).

The cocoa swollen shoot disease is a virus disease transmitted by mealybugs. Various control methods and difficulties encountered in their application are discussed. Because of the difficulty of controlling the mealybug vectors, the latent infection in cocoa and in certain forest trees, and the high cost of control by cutting-out diseased trees, it appears that the use of tolerant and/or resistant cocoa varieties is the most practical method of reducing the disease incidence. Studies on resistance and tolerance to the virus disease are outlined. Tables. Graphs. 61 refs.

Youdeowei, A. The seasonal abundance of the cacao thrips Selenothrips rubrocintus Giard (Thysanoptera) in a cacao rehabilitation trial in Nigeria. Cacao Inst. Interamer. Ciencias Agr. 15, 3, pp. 14-5 (1970).

The occurrence and population fluctuation of the red-banded cocoa thrips (*Selenothrips rubrocinctus*) was studied in a cocoa rehabilitation trial in Nigeria from March 1968 to Sept. 1969. The results, as assessed by weekly countings of both larvae and adults on at random sampled leaves, showed that the thrips were more abundant during the dry season than in the wet season (June-Nov.). There was no direct relation between amount of rainfall and number of thrips. The humid and cool wet season conditions possibly are unsuitable for the development of the thrips. The results also showed that thrips population can be very high in rehabilitation plantings; leaf browning followed by leaf fall during the dry season was found to be largely due to thrips damage rather than to drought. Spanish summary. Graph. 8 refs.

Owusu-Manu, E. Bathycoelia thalassina – another serious pest of cocoa in Ghana. Cocoa Marketing Board Newsletter 47, pp. 12-4 (1971).

The shield bug *Bathycoelia thalassina* (*Pentatomidae*) previously considered as a minor cocoa pest, is of growing importance in all cocoa growing areas of Ghana. The bugs feed on immature pods which then cease development. The main morphological characteristics, habitat, biology, the large number of natural enemies and alternative hosts of the insects, their occurrence in cocoa plantings including the typical vertical distribution within individual trees are described. Estimated average percentages of damaged pods vary from 20 to 40 per cent. Insecticides used in capsid control are not effective enough against *Bathycoelia* and most probably upset control by natural enemies. Research on biological control has therefore been undertaken. Table.

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