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Cadbury Limited
Bournville

Editorial

Research and Extension in Brazil

The importance of viable extension services has often been stressed and is indeed vital to the long term future of any cocoa producing country. This issue contains two articles on the cocoa industry of Brazil and we hope the articles show the close relationship between cocoa research, cocoa extension and the farmer which seems to offer an encouraging future for cocoa cultivation in Brazil.

Poor harvests in the early fifties and low prices in 1956 put many Brazilian cocoa farmers into bankruptcy and caused the Brazilian Treasury Department to set up a debt-relief organisation called Commissao Executivo de Plano de Recuperacao Economica do Lavoura Cacaueira (CEPLAC) in 1957 funded by a 15 per cent levy on exports of cocoa beans and products. The debts were duly lifted, but were then replaced by a new round of debts incurred in similar circumstances in 1962. It became obvious that repeated debt-relief exercises would not provide a long term solution and that other measures were necessary. In 1963 a cocoa research station (CEPEC) was established by CEPLAC. This was followed in 1964 by the establishment of an extension service (DEPEX) which at once established offices in the cocoa zone with a quota of trained agronomists. Soon afterwards the old Urucuca experimental station was absorbed by CEPLAC and transformed into a School of Agriculture (EMARC) for training agricultural officers, managers and farmers.

In 1969 studies at CEPEC on the use of fertilizer showed dramatic responses from fertilizer applications on many soil types. These results were immediately passed on to farmers by DEPEX and have resulted in impressive yield responses under farm conditions. A hybrid breeding programme was already in hand at CEPEC and the distribution of hybrid seed to farmers has gained momentum since 1966. During 1974 over 26 million hybrid seeds were distributed to farmers by CEPLAC. The laboratories of the research station (CEPEC) and the headquarters of the farm advisory service (DEPEX) are located in the same building just outside Itabuna and the extension effort is controlled by eight regional and 45 local offices throughout the cocoa zone. This close liaison between extension and research has produced an impressive increase in the application of CEPLAC recommended methods in recent years.

Since the formation of CEPLAC the levy has been reduced from 15 per cent to 10 per cent ad valorem. The name was changed in 1974 to Commissao Executiva do Plano de Lavoura Cacaueira though the initials remain as CEPLAC and the responsibility for CEPLAC was moved from the Treasury Department to the Ministry of Agriculture. The estimated budget for CEPLAC in 1975 is expected to be in excess of £15 million (or CR$ 275 millon). This unified body with adequate funds controlling extension, credit, research and agricultural education must have contributed to the considerable progress made in the improvement of the Brazilian cocoa industry in the last few years.

R. A. LASS

Review of Production and Consumption

August 1975

A. B. Cook, Cadbury Schweppes Limited

Production

The latest Gill & Duffus forecast of 1974/75 world production is 1,477,000 tons, which is 44,000 tons more than the forecast made last February.

The principal gain has been in Brazil, where the record Temporao crop of an estimated 2·35 million bags means that total production for the year should now exceed last year's record level. The outturns in Ivory Coast, Ecuador and Nigeria have also been better than originally anticipated.

Consumption

The grinding figures announced by the major Western consuming countries for the first and second quarter of 1975 have underlined how severely consumption has been affected by the high prices of the last two years. Total consumption in 1975 is now expected to be only 1,366,000 tons, a decrease of 71,000 tons from the estimated final 1974 figure which was itself 105,000 tons below the final 1973 figure.

World consumption will have fallen by over 11 per cent in two years. It seems clear that a period of substantially lower prices will be needed to re-establish the long term rising trend in consumption.

Stocks

The net surplus for the 1974/75 season is now predicted by Gill & Duffus as 96,000 tons, more than twice the figure they forecast in February. This would make the end of season stocks 381,000 tons (3·3 months usage) compared with 285,000 tons (2·4 months usage) at the end of the 1973/74 season. The supply situation will have significantly improved, although historically a stock of 3·3 months usage is still comparatively low.

Prices

Month end prices for nearby Ghana shipment cocoa have been:

1975	January	£755/metric ton
	February	£773/metric ton
	March	£813/metric ton
	April	£575/metric ton
	May	£605/metric ton
	June	£620/metric ton
	July	£730/metric ton

The improved supply situation has brought about a decline in prices. However the decline has not been as great as might have been expected, as the market has been fully aware that the bulk of this year's projected surplus still lies in the producing countries, with large tonnages still held in Nigeria due to shipping congestion and much of the Brazilian Temporao crop only just being harvested.

WORLD COCOA PRODUCTION AND GRINDING DATA

Reproduced from Gill & Duffus Market Report
Dated 27th June 1975

(Thousand Long Tons)

Production

	1972/73	1973/74 (Estimate)	1974/75 (Forecast)
Africa	1,014	937	984
America	283	390	403
West Indies	41	43	38
Asia and Oceania	38	49	52
World Total	1,376	1,419	1,477
Principal Countries			
Ghana	411	344	380
Nigeria	237	212	205
Ivory Coast	178	206	226
Cameroon	105	107	108
Equatorial Guinea	10	12	12
Brazil	159	242	252
Ecuador	42	70	68
Dominican Republic	28	30	25
Venezuela	19	15	16
Colombia	23	23	25
Mexico	30	28	30
New Guinea	22	27	30

Grindings

	1973	1974 (Estimate)	1975 (Forecast)
Western Europe	584	524	497
Eastern Europe and U.S.S.R. ..	244	248	245
North America	292	241	198
Central and South America ..	196	206	200
Australia and New Zealand ..	19	20	19
Asia	68	55	48
Africa	139	143	159
World Total	1,542	1,437	1,366
Principal Countries			
United States	274	226	185
Germany (Federal Republic) ..	150	136	134
Netherlands	121	113	110
United Kingdom	105	92	82
U.S.S.R.	132	141	136
France	47	36	34
NOMINAL BALANCE .. .. (after allowing for 1% loss in weight)	—180	— 32	+96

Cocoa in Brazil

W. M. Aitken and R. A. Lass

1. Formerly CEPLAC, Itabuna, Bahia

2. Cadbury Schweppes Limited

Historical

The first exports of cocoa from Brazil were from the Amazon basin, but now almost all cocoa in Brazil is growing in the State of Bahia. There are no official records to show when Brazil, then a Portuguese colony, started exports of cocoa. However the Spanish trade regulations of 1717 and 1722 prohibited the import of cocoa from Portuguese colonies in an attempt to protect exports from the Spanish colonies of Mexico and Venezuela and this suggests that there were significant exports from Brazil at that time. Exports until 1890 came principally from the wild trees of the Amazon basin, even though cocoa had been transported to the Bahia region of Brazil and planted as a curiosity as early as 1746 (6). A shipment of 800 kilos from Bahia in 1778 was recorded, but regular annual exports probably did not start until 1834 when a shipment of 26 tonnes was made.

In 1890, habitation in Bahia was still limited to villages along the main rivers and exports of cocoa from Bahia totalled 3,502 tonnes—only marginally more than exports from the Amazon (5). The abolition of slavery in 1888 and frequent droughts in the north east of Brazil brought many people into the region. Cocoa planting expanded and the news that fortunes could be made caused a large influx of people resembling a 'gold rush'. The Bahia production for the year 1900–1 was 11,592 tonnes but by 1920–1 had risen to 59,616 tonnes (2). The world cocoa prices remained high in the early part of the century reaching a peak in 1927 of 17 US cents per pound and considerable acreages were planted in those years.

The depression in the early thirties caused many bankruptcies and amalgamation of a number of smaller farms. Farmers demanded government intervention and in June 1931 the 'Instituto da Cacau da Bahia' was formed. The ICB provided mortgage loans, improved the road network and encouraged the formation of purchasing co-operatives. It also actively promoted additional cocoa plantings in an attempt to maintain the farmers incomes so that by 1937–8 production was 135,536 tonnes. Brazil did not experience a surge of plantings during the fifties as was seen in West Africa especially Ghana, (4), and in fact very little cocoa was planted in Brazil at that time. Dry weather conditions in Brazil can cause dramatic fluctuations in the production which is well illustrated by the production in 1951-2 of 56,000 while that in 1952–3 was 142,000 tonnes. The price received by the Brazilian farmer has always been closely related to the world market price with no government support price and unfortunately the good crops have often coincided with very low world market prices. In 1957 in the middle of one such crisis CEPLAC was created, while the research station (CEPEC) was established in 1963. In the following year the existing farm advisory service was expanded to form DEPEX in an attempt to improve the productivity of the farms by introducing modern agricultural techniques. The close liaison between research and extension has considerably improved both yields and returns to the farmer and the recent increases in the application of the approved techniques are shown in Table 1. (See page 16)

Cocoa Areas of Brazil

Cocoa is grown in various States of Brazil (figure 1), but in fact only 5 per cent of the national production is now grown outside the State of Bahia. The cocoa zone of Bahia extends from latitude 14°—16° South with the most concentrated plantings between the towns of Ubaitaba and Camacan (figure 2). Cocoa is very rarely planted at a distance greater than 70 kilometres from the coast with the cocoa zone itself only being about 200 kilometres by 70 kilometres. The actual area planted with cocoa in Bahia is thought to be 380–400,000 hectares, but the area may in fact be less. A detailed land resources survey is in preparation by CEPLAC which will give a more accurate figure.

It is generally considered that there are approximately 16,000 holdings and that 70 per cent of the cocoa is grown by 30 per cent of the farmers. The average area of cocoa on each holding is therefore 25 hectares (60 acres) a much greater area than is normal for West Africa. It is likely that the majority of the owners of the smaller holdings will live on the farms, but many live in the small towns near the properties. All cocoa farms in Bahia have a permanent labour force who live on the farms and are generally not related to the owner. The State of

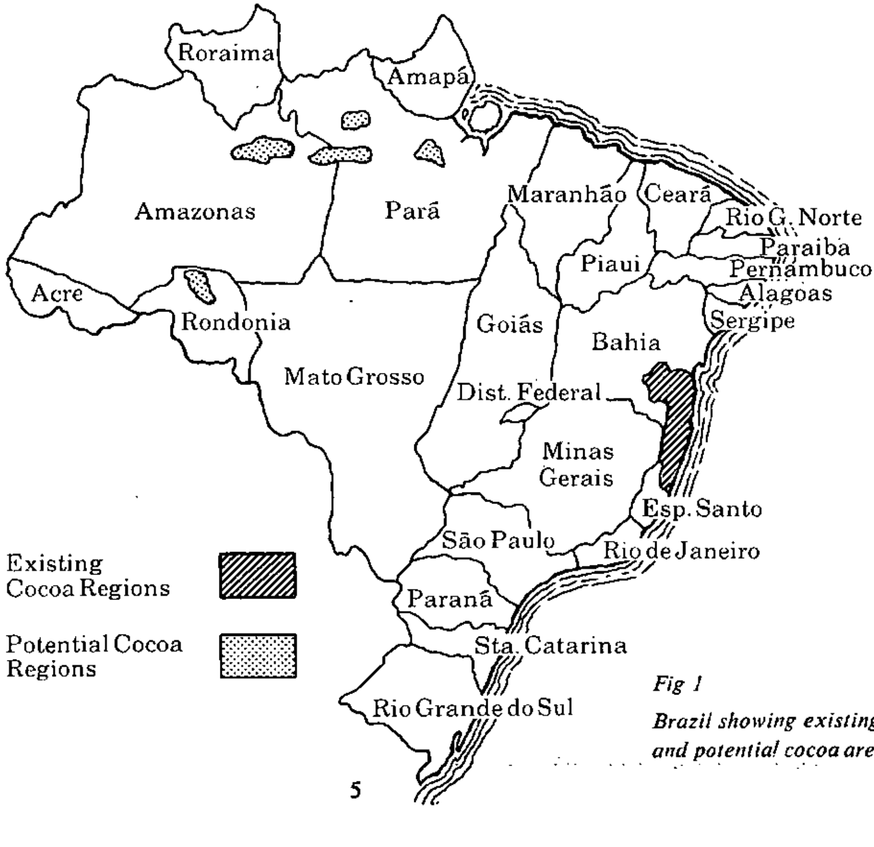

Fig 1

Brazil showing existing and potential cocoa areas

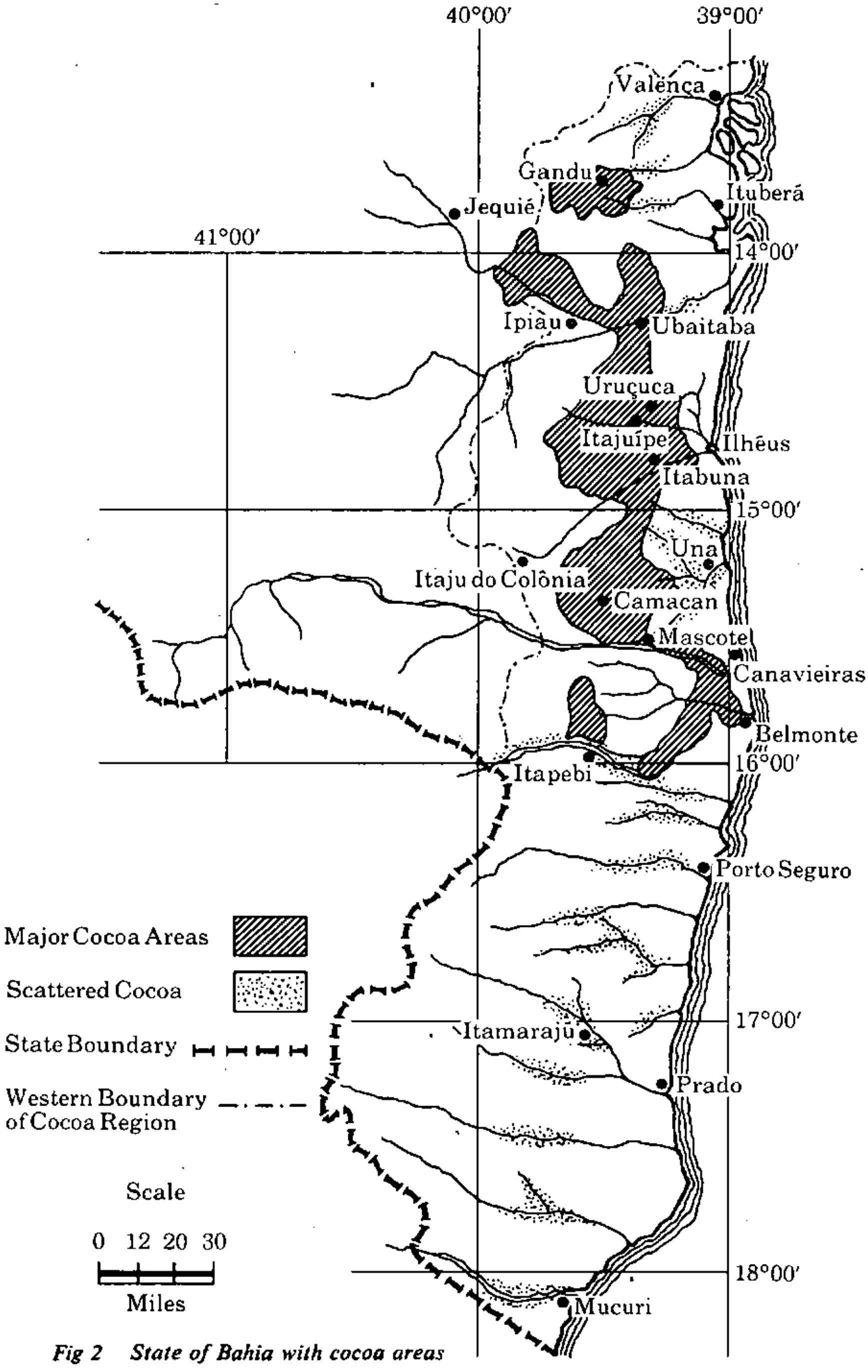

Fig 2 State of Bahia with cocoa areas

Espirito Santo to the south of Bahia contributes 4 per cent to the national cocoa production and is estimated to have 22,000 hectares under cocoa. These cocoa plantings stem from the early thirties and were planted by farmers who had moved from South Bahia.

In the cocoa zone of Bahia there are three major age groups of cocoa. The first was planted before 1900 in the rich soils in the valleys of the major rivers. The second was planted between 1900 and 1930 on the gently to strongly undulating hillsides immediately around the towns of Itabuna, Ilheus, Lomanto Junior, Coaraci, Itajuipe and Urucuca. The third group followed the stimulus given by ICB in the early thirties resulting in the planting of steep hillsides throughout the zone. From that time until 1970 there has been some infilling but no significant cocoa plantings. This lack of new plantings contributed to the poor production in the early sixties. Considerable new plantings have been made in all parts of the cocoa zone since 1970 under the auspices of the CEPLAC programme.

There are considerable areas of land in States other than Bahia which are suitable for cocoa cultivation. However, one would not expect substantial production from the Federal Territory of Rondonia in north-western Brazil in the immediate future. This is an area of good soils which could support significant plantings of cocoa, but the difficulty of access and shortage of labour in Rondonia means that development will be a fairly long-term project. CEPLAC is actively promoting a programme for planting 25,000 hectares in Rondonia by 1980. It should be noted that the soils of Rondonia are similiar to the good cocoa soils of Bahia and current surveys of Rondonia conservatively indicate that there exists over 4,000 square kilometres of land which could be planted with cocoa and would not need fertilizers (10).

Cocoa Varieties

The cocoa of Bahia is of the Amelonado group of bulk or Forastero cocoas. The botanical variety is usually termed 'Comum', though there were in fact originally three specific types which have become thoroughly intercrossed through the years. The cocoa brought from the State of Para in the Amazon in 1746 was the true 'Comum'. It was well adapted to the rich alluvial soils, but did not grow well on the upland soils. In 1874 Baron Steiger, a trader and large landowner near Ilheus, introduced two new varieties 'Maranhao' and 'Para'. It had been thought that Para was a natural hybrid between the existing Comum and Maranhao, but genetical studies suggest Para was a specific introduction (12). Both the Maranhao and Para varieties were imported from the State of Para, but Maranhao had in fact been previously transported by Baron Steiger from the Putumayo river of the Upper Amazon Valley (13). Its shape is very similar to the Criollo types of cocoa with a bottle neck and deep furrowed pods but it belongs to the Forastero group of cocoas. There were no significant plantings of Maranhao further south than Itajuipe, probably because it is susceptible to black pod and the southern part of the zone has a higher infection rate (11). The Para variety adapted well to the strongly sloping and steep upland soils and was very popular with farmers because of its seemingly high yield. Although these trees bore a large number of fruits the actual weight of beans per tree was low as the pods are small and round. This factor accounts for much of the variation in bean weights noted with cocoa from Bahia.

The seeds currently being distributed to farmers are hybrids between Upper Amazon types and Bahia selections. In most cases the Bahia selection is of 'Catongo', a white seeded mutant of the 'Comum' type discovered in 1939 on the Catongo farm near Itajuipe (9).

Climate

Over 90 per cent of the cocoa in Bahia is grown within 70 kilometres of the coast and though the climate is still typical of the humid tropics, the average rainfall varies between 1,500 and 2,000 mm per annum depending on the distance from the coast (7). There is no distinct dry season and monthly rainfall in the cocoa zone rarely falls below 60 mm, though the months of January, February and March are often the driest. Dry conditions during the early part of the year have in the past severely reduced the temporao crop and dry weather can always be a limiting factor. Mean maximum monthly temperatures range from 32°C for the hot months of January, February and March in the north of the zone to 16°C minimum for the colder months of July and August in the south of the zone (Table 2). Absolute maximum and minimum temperatures can exceed these levels by several degrees. The absence of a well defined dry season at harvesting makes the drying of cocoa a problem in Brazil.

There are two distinct cocoa crops in Brazil either of which can be the largest. This is in marked contrast to the situation in West Africa where the summer (mid or light) crops are a very small percentage of the main crop. The 'safra' or main crop runs from October to January and the 'temporao' runs from May to September. The Brazilian cocoa year for statistical purposes starts in May and

A typical cocoa farm in Bahia. The building in the middle includes sundrying platforms and an 'estufa'.

runs through to April whereas the crop year in all other major cocoa producing countries starts in September.

Cocoa Soils of Bahia

The soils of the cocoa zone are in general old. Many are Oxisols and in consequence low in nutrients being derived from tertiary sediments and other materials of the pre-Cambrian era. There are also relatively young soils rich in exchangeable bases which have been derived from intermediate or basic rocks. It is in these latter soils that most of the cocoa is grown, but as the topography is undulating or steep the farmers often have difficulty in cultivating these soils. The zone is well served by rivers and there are also some rich riverine alluvial soils. It has been suggested there may be a further 80,000 hectares of good fertile soils in climatically suitable parts of the cocoa zone, which could be planted with cocoa and would give adequate yields without the addition of fertilizers. For many years fertilizer costs have been sufficiently low to warrant planting of the poor, but structurally good soils (such as Oxisols to the south of the existing zone), but the recent dramatic increase in fertilizer prices will render these areas less profitable for cocoa.

Cultivation Practices

Historically cocoa was planted under a contract system whereby a worker was given a plot of land to plant with the owner purchasing the trees at a fixed price at maturity. Farms were therefore rarely planted to a specific pattern though the average number of trees per hectare is probably about 750 in such plantings. The worker would have harvested and eaten, or sold, the food crops grown during the years before the cocoa trees came into bearing. These old plantings now have a poor stand per hectare, but nevertheless application of fertilizers to these trees has given some dramatic yield responses. Whereas in 1965 only 190 hectares of cocoa received fertilizers, by 1969 this figure had risen to 22,769 hectares and in 1973 to 133,679 hectares. The recent substantial increase in world fertilizer prices has meant an increase in the farmer's price of fertilizer of over 300% since 1973. This has lead to a reduction in fertilizer usage. The recent excellent crops are due to a combination of fertilizer application, good weather conditions and improved farm maintenance but it would be a great error to attribute these record crops and recent improvements in yields to application of fertilizer alone.

A soil analysis is carried out at the CEPLAC laboratories before the farmer is allowed to purchase any fertilizer and on the basis of this analysis, recommendations would be given to the farmer using one of five different formulations of four basic ingredients (urea; diammonium phosphate; triple super phosphate and muriate of potash). The most common recommendation is the application of 400 grammes of an 11 : 31 : 14 mixture to every tree with the second most common 400 grammes of a mixture 9 : 24 : 24. Application of fertilizer could take place any time between August and the following March and would be carried out by scattering fertilizer in a one and a half metre circle round the tree, often after weeding. In addition to fertilizer the analysis may call for lime applications in areas with a high aluminium level. When necessary dolomitic limestone would be applied in a split application two months apart. Some cocoa farms have as many as 200 shade trees per hectare and it is recommended that these should be progressively reduced to about 30 prior to fertilizer application.

Poisoning using Tordon 101 is the recommended method of shade reduction.

The farm is usually weeded once per annum in March/April though if necessary a second round would be made in September. There is an annual pruning beginning in December with the purpose of cleaning the tree rather than achieving any specific shape and at this time chupons would also be removed. Cocoa trees in Bahia are not as tall as is normal in West Africa and are rarely more than 5 metres in height. Stakes are widely used to support trees and branches and these would be put into position during pruning. Mules are almost universally used to carry wet beans out of the farms, so some tree shaping is required to permit the free passage of mules through the plantations.

The Bahian farmer is in a privileged position as regards pest and disease problems in comparison to his West African counterpart. The total loss from pests and diseases in Bahia is minimal in comparison to the losses from either swollen shoot, or capsid or black pod in West Africa. It maybe that combined total losses from pest and diseases could be as low as 20 per cent total crop, though Gregory (8) states that loss from black pod alone could be as high as 20 per cent. In Bahia there is tremendous variation in incidence of black pod from zero in the north of the cocoa zone to over 50 per cent in the south. Witches broom disease is endemic throughout the Amazon Valley, but so far has not been noted in Bahia. Thrips damage can also be serious in specific areas in particular years. It is always difficult to estimate crop losses and estimation of the loss of cocoa from pests and diseases in Brazil is no exception.

Black pod occurs during the wetter cooler months of June and July especially in the low lying or over-shaded areas and more especially in the southern part of the cocoa zone where rainfall and humidity is higher. Recommended control for black pod disease is spraying 2–4 times per annum (depending on area) at 30 day intervals from May with Cobre Sandoz at 4 per cent or Kocide 101 at 4 per cent. Trials are nearing completion using low volume mixture of 31·5 per cent Kocide 101 in 18·5 litres of mixture with an oil-base. Shade thinning, drainage and liming of pod husk heaps is also recommended.

Thrips can be a problem in dry areas which are more marginal for cocoa cultivation or in areas where excessive shade thinning has occurred. Insecticides are currently applied as a prophylactic over some 150,000 hectares using a BHC 1·5 per cent at the rate of 12–15 kg per hectare per application. Whether widespread application of insecticides is desirable in view of the possible build up of resistance is open to question and it would seem more economical and beneficial to use insecticides for the control of specific problems not as a prophylactic. The use of BHC in this way is being examined in current research at CEPEC.

New Plantings

For the establishment of new plantings, CEPLAC recommend clearfelling and burning with the planting of temporary shade of bananas or cassava. Bananas would be planted in the inter-rows at 3 x 3 metres, with gradual thinning and complete removal in the fifth year. New plantings of hybrids funded by Banco do Brasil in liaison with CEPLAC are planted at 3m x 3m spacing (1,111 plants per hectare). Distribution of hybrid seeds to the farmer is free with a nominal charge for the plastic bag used in the farm nursery. Permanent shade is usually provided by the legume *Erythrina fusca* planted at 24 metres square. It is

Removing fermented beans from a sweat box.

Beans drying on a barcaca—sliding roof dryer.

recommended that cocoa is planted in the field between May and August due to the better rainfall pattern, but in practice farmers plant at any time in the year. Temporary shade and clearing is carried out at any time labour is available. Planting under thinned forest is gaining popularity as the cost of establishment is considerably lower than clearfelling.

Very little replanting of old cocoa areas has so far occurred under the CEPLAC programme due to the dramatic results obtained by fertilizer application to older plantings.

Harvesting, Fermentation and Drying

Pods are opened in the fields using a sharp cutlass and wet beans are loaded onto mules to be carried to the farm buildings. Unopened pods are often left in the field for 24 hours before opening. Fermentation is in a wooden sweat-box about 120 cm wide, but of variable length with removable partitions at about one metre intervals. It is recommended that cocoa is loaded into the individual sections to a depth of about one metre and covered with sacking or banana leaves. The beans should ideally be mixed after 48 hours and then at 24 hour intervals by moving the partition and transferring to the adjoining section. The whole fermentation process should take four to six days. It is certain that many farms have inadequate fermentation or drying facilities due to the dramatic yield improvements recently achieved and many farmers do not allow fermentation to continue long enough with the result that beans tend to be underfermented. Some farms do not always ensure that drainage holes are unblocked or cover fermenting beans to retain the heat. The beans would either be sun-dried on dryers with sliding roofs called 'barcacas' or artificially dried on wood-fired dryers called 'estufas'. Sun-drying may take from 3 to 10 days for complete drying depending on the weather conditions. It is widespread practice to allow beans to sun-dry for 1-2 days before drying artificially for a further 1-2 days. This short period of sun-drying permits the continuation of fermentation which can partially compensate for the shortened time in the fermentation boxes.

Insufficient care in the construction, location and maintenance of artificial dryers causes smoke contamination. This is an important defect of Brazilian cocoa, although the incidence of smoky beans has been reduced in recent years. Many barcacas were constructed with living quarters below which caused smoke from kitchens to pass through the drying beans. Many farms have now changed this due to efforts by CEPLAC. There is no differential for delivery to the exporter of well-fermented and well-dried cocoa as opposed to poorly fermented or damp cocoa, so farmers lack a price incentive to encourage them to ferment and dry the beans effectively. The introduction of a price penalty for delivery of poor quality cocoa would rapidly improve the quality of Brazilian cocoa. Such an improvement could mean that Brazilian cocoa would no longer sell at a discount to Ghana cocoa on the world market (3).

'Dancing' by way of a final polishing of the beans was once a normal event in Brazil, but this activity is now dying out. The procedure was the same as used in Trinidad where water is sprinkled over the beans and workers execute 'dancelike' movements over the beans to polish and remove surface mould. There is no premium for 'danced' cocoa, even though there is a measurable weight loss during 'dancing'.

Internal Marketing

Brazil is the only major cocoa producing country where the farmers' price follows the prices on the New York and London terminal markets. The farmer does not have a guaranteed price. The holding size in Brazil is much larger than other major producing countries and this means that the farmer is better able to withstand adverse price fluctuations, and thus to survive periods of uncertainty or of low prices. CEPLAC consider that the Brazilian farmer will receive approximately 70 per cent of the export value of his produce. This is a much higher percentage than cocoa farmers normally receive in other producing countries. With a hypothetical world market price of 100 U.S. cents per pound CEPLAC estimates the following deductions totalling 30 cents (30 per cent) would be made:

Buffer stock levy (I.C.C.O.)	1·0 cent
Buyers costs—bag, transport and handling	2·0 cents
Interest charges and margin to exporter	3·0 cents
State tax	13·0 cents
Export tax (CEPLAC retention)	10·0 cents
Cocoa Institute of Bahia subscription	0·72 cents
Commission for export broker	0·375 cents
TOTAL	30·1 cents

There are a considerable number of cocoa exporters who maintain cocoa buying agencies in the interior, and the local processing industries also operate buying stations. The smaller farmers probably bring cocoa to the exporter by mule for immediate cash payment, but the medium and larger farmers would often negotiate a price with the exporters for future and prompt delivery. Cash advances against contracts for future delivery are often negotiated by exporters with an appropriate price adjustment. The internal market for cocoa is highly competitive due to the large number of exporters and local manufacturers. The majority of exporters offer the same price on any one day, but there is almost always one buyer offering a slightly higher price than the majority to satisfy commitments or because he has taken a view of the market. The farmer may deliver cocoa to the buyer's store in his own transport or hired transport or buyers can also send their own transport to the farm.

The exporter will weigh beans and make a brief visual quality examination of the cocoa on delivery for gross quality problems, but the farmer will usually receive the quoted price regardless of quality unless beans are excessively wet or mouldy. If one exporter tries to penalise a farmer by a deduction for quality or rejects a parcel then the farmer tends to take his cocoa to another exporter. CEPLAC have recently introduced a grading service and it is planned to station grading officers throughout the cocoa zone attached to the local extension offices. The grading standards are in line with International Cocoa Standards (1) with an additional examination for smokiness.

External Marketing

The activities of bean and product exporters are supervised by the 'Bahia Cocoa Trade Commission' (B.C.T.C.) which meets daily to discuss the export business recorded during the previous day's trading. All sales are reviewed by this body and forwarded to the Foreign Trade Department of the Banco do Brazil (CACEX) for Government approval. Full details of all new business must be lodged with B.C.T.C. within ten minutes of the completion of the business, and price, quality and destination would be announced at the next daily meeting. Any unusual contracts are subject to discussion and veto. There are a number of seats on the Trade Commission divided amongst the exporters and the meetings include a representative of CACEX.

Until the mid 1950's the small number of exporters of cocoa in Bahia made sales through their own agents in New York, London, Amsterdam and Hamburg. In the early 1960's the number of exporters and the number of overseas buyers increased substantially and local brokers began to play an important role in the Bahia cocoa market. The number of brokers has varied over the years from seven to three at present. Exporters and product manufacturers are now obtaining telex machines and starting direct communication with customers, but brokers nevertheless still have an important part to play in the Bahia Cocoa Market.

Extensive new port facilities have just been constructed at Ilheus with a substantial contribution of funds from CEPLAC. This port is at the moment largely to be used for bean export with the export of cocoa products continuing from Salvador and Ilheus. Fumigation of cocoa has historically only been carried out at the written request of and for the account of the final buyer. Recent shipments have however had hygiene problems at port of entry and routine fumigation funded by CEPLAC was introduced in May 1975.

About half the total exports from Brazil arise from the agricultural sector either as raw materials or as partly processed products. In 1968 cocoa beans and products together were the fourth most important export of value, but by 1973 had dropped to seventh position. This change of importance is in spite of the dramatic increase in the world market price of cocoa and is due to diversification of exports. Cocoa as an export is of relatively small importance to Brazil, even though it is of enormous importance as an export and source of employment to the State of Bahia. The major market for exports of beans and products was historically U.S.A. with the next most important markets being the EEC and the Eastern Bloc with much smaller totals. However the total exports of beans and products to U.S.A. and Eastern Bloc were similar during 1974/75.

Local Processing Industry

The cocoa processing industry in Brazil is well established and the first factory started operations in 1927. There are currently four companies (Barretto de Araujo Produtos de Cacau, Chalder da Bahia, Joanes Industrial and Bernardo Kaufman) exporting cocoa products as butter, cake, powder and unsweetened chocolate liquor. There is considerable discussion and rumour of further local processing units, but at this moment the only new factory under construction is the plant of Barretto de Araujo at Ilheus which is due to start operations during 1976. This factory is expected to increase the local consumption of beans (including local chocolate industry) from about 95,000 tonnes in 1974 to 130,000 tonnes when fully operational. The long-term objective of the Federal Government is that the Brazilian cocoa crop should be 100 per cent industrialised in Brazil and that at some date in the future only exports of cocoa products would be allowed. This is in line with the Federal Government policy to increase processing of all primary agricultural products in Brazil and in fact castor oil production is already almost entirely processed within Brazil.

There is an active Brazilian chocolate industry which probably utilises in excess of 20,000 tonnes of Brazilian beans purchased either as raw bean from exporters, or as partly processed cocoa products from the local factories. A percentage of these beans would be the production of the State of Bahia, but an appreciable quantity would originate in the State of Espirito Santo. The majority of the confectionery manufacturers are based in Sao Paulo and Rio de Janeiro. A number of large international food companies are involved in both the Confectionery and cocoa processing industries in Brazil.

Future

There is a well established cocoa research and extension service in Brazil with substantial funds available for advising farmers and supplying them with the necessary inputs. In 1957 the cocoa trees existing in Bahia were in the most part old and in need of rehabilitation. This rehabilitation has made considerable progress since that date, but theoretically there is still a substantial area of cocoa in Bahia in urgent need of rehabilitation and there is also a significant area of land which is suitable for, and could be economically planted with cocoa. Yields on many farms have been increased dramatically by the use of fertilizer, better management and improved agronomic techniques. There is still considerable scope for improvement though the recent very high prices have spurred many farmers in Bahia to plant hybrids in new land and to intensify cultivation.

There are huge areas suitable for cocoa cultivation in Brazil in States other than Bahia. Resources are being devoted to agricultural development in these regions, but the problems are immense due to the lack of infrastructure and habitation.

Brazil has successfully reversed the downward trend of her cocoa production seen during the 1950's and it seems likely that Brazil can maintain the current annual increases in cocoa production throughout this decade and perhaps beyond. The close relationship between research and extension has contributed substantially to this increased production. The production in any one season will however always be subject to suitable weather conditions.

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Table 1

Agricultural techniques applied to cocoa in States of Bahia and Espirito Santo according to CEPLAC recommendations for the years 1971/74.

	1971	1972	1973	1974
Fertilizer				
Area applied (ha)	85,010	96,120	133,679	144,766
Quantity distributed (tonnes) ..	19,364	31,830	37,105	30,101
Number of farmers	4,488	4,999	6,036	4,614
Price trend CR$/50 kg sack ..	26·00	35·00	39·50	135·00
Insecticides				
Area applied (ha)	104,864	124,116	155,114	157,780
Quantity distributed (tonnes) ..	2,738	3,593	4,186	4,303
Number of farmers	4,436	5,064	6,189	4,981
Price trend CR$/25 kg sack ..	7·50	7·50	12·00	25·00
Fungicides—Black Pod Control				
Area applied (ha)	12,605	8,809	13,998	19,890
Quantity distributed (tonnes) ..	101	116	125	206
Number of farmers	445	426	495	855
Price trend CR$/25 kg sack ..	50·00	120·00	120·00	264·00
Planting				
New planting (ha)	4,068	6,102	8,939	12,506
Seeds distributed (million) ..	15·5	12·2	18·9	28·6
Number of farmers	1,288	1,786	1,552	2,253
Shade Thinning				
Area (ha)	25,382	27,357	33,026	41,945
Arboricide distributed (litres) ..	8,078	9,457	12,564	16,207
Number of farmers	1,646	1,773	1,746	2,351
Price trend CR$/litre	16·00	30·00	30·00	35·00
Pruning				
Area (ha)	45,813	66,602	71,113	110,391
Number of farmers	1,800	2,653	2,842	4,918
Liming				
Area applied (ha)	9,568	9,807	14,455	8,709
Quantity distributed (tonnes) ..	7,047	8,458	9,740	7,271
Number of farmers	1,047	1,000	1,305	1,250
Price trend CR$/50 kg	2·25	2·25	4·00	7·00

TABLE 2

SELECTED CLIMATIC DATA FOR SOME COCOA-GROWING AREAS OF BRAZIL*

	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	Mean Annual	Mean number Rainy Days Annual
Camacan, Bahia														
Rainfall (mm)	107	103	164	107	106	109	127	74	98	157	218	156	1,527	178
Temp: Mean Max (°C)	31·8	31·4	31·1	29·9	28·3	27·2	26·3	26·8	27·5	28·7	29·4	30·6	29·1	
Mean Min (°C)	19·2	19·7	19·8	19·6	18·2	17·4	16·1	15·8	16·9	18·7	19·5	19·6	18·4	
Mean Daily (°C)	25·5	25·5	25·3	24·4	22·8	21·9	21·5	21·8	22·5	23·8	24·5	25·1	23·7	
Absolute Max (°C)	36·1	37·0	26·5	34·0	33·2	32·4	31·7	31·6	31·6	32·9	33·6	35·6		
Absolute Min (°C)	16·7	16·8	16·7	15·0	13·4	10·5	10·2	11·8	12·0	12·8	15·2	16·4		
Gandu, Bahia														
Rainfall (mm)	94	137	187	131	106	156	148	75	65	133	180	127	1,539	176
Temp: Mean Max (°C)	31·2	31·0	31·1	30·2	28·3	27·6	26·6	27·1	27·8	29·1	30·1	31·4	29·3	
Mean Min (°C)	19·9	20·3	20·5	20·0	18·6	17·5	16·4	16·0	17·2	18·8	20·1	20·4	18·8	
Mean Daily (°C)	25·5	25·6	25·8	25·1	23·4	22·5	21·5	21·5	22·5	23·9	25·1	25·9	24·0	
Absolute Max (°C)	35·6	26·2	36·3	35·0	32·6	32·0	31·1	30·6	31·5	33·4	34·8	37·9		
Absolute Min (°C)	16·0	16·5	18·0	14·4	13·4	11·0	10·4	11·0	12·6	12·5	13·5	16·7		
Ipiau, Bahia														
Rainfall (mm)	81	113	146	76	70	100	97	47	59	124	161	159	1,233	204
Temp: Mean Max (°C)	32·3	32·2	31·9	31·4	28·8	27·9	26·8	27·9	28·8	29·9	30·6	31·6	30·0	
Mean Min (°C)	20·4	20·7	20·9	20·6	19·2	18·4	17·3	17·1	18·1	19·8	20·5	20·5	19·5	
Mean Daily (°C)	26·3	26·4	26·4	25·8	24·0	23·1	22·0	22·4	23·4	24·8	25·6	26·1	24·7	
Absolute Max (°C)	36·8	38·6	39·7	36·6	33·6	33·4	31·6	32·8	33·8	34·2	35·2	37·8		
Absolute Min (°C)	16·4	17·6	16·0	14·5	14·0	11·2	12·3	12·0	13·6	10·1	16·6	17·0		
Itabuna, Bahia														
Rainfall (mm)	113	116	150	102	90	137	148	69	94	140	130	176	1,465	218
Temp: Mean Max (°C)	30·5	30·5	30·5	30·0	28·3	27·4	26·5	27·0	27·4	28·3	29·0	29·8	28·8	
Mean Min (°C)	20·4	20·7	20·8	20·6	19·2	18·3	17·0	16·9	17·7	19·5	20·6	20·6	19·4	
Mean Daily (°C)	25·5	25·6	25·6	25·3	23·7	22·8	21·8	21·9	22·5	23·9	24·7	25·2	24·0	
Absolute Max (°C)	33·4	33·2	35·2	33·5	32·3	31·2	30·8	30·3	30·2	31·7	32·4	34·0		
Absolute Min (°C)	17·2	18·0	17·0	16·0	14·6	10·6	10·8	11·2	12·5	14·2	17·0	17·7		
Linhares, Espirito Santo														
Rainfall (mm)	122	102	108	78	26	53	83	64	55	137	163	130	1,121	156
Temp: Mean Max (°C)	31·5	31·5	31·2	29·4	28·2	27·2	25·8	26·3	26·5	27·0	28·3	30·0	28·6	
Mean Min (°C)	22·4	22·4	21·9	20·6	18·2	17·7	16·8	17·2	18·4	19·7	20·9	21·8	19·8	
Mean Daily (°C)	26·8	26·9	26·5	25·0	23·2	21·3	21·3	21·7	22·5	23·3	24·6	25·9	24·1	
Absolute Max (°C)	37·8	35·4	36·4	34·8	33·4	33·2	30·2	31·2	32·6	35·0	33·0	35·6		
Absolute Min (°C)	17·8	17·8	17·2	13·6	13·0	12·6	12·0	13·0	12·4	16·0	16·2	15·0		
Ubaitaba, Bahia														
Rainfall (mm)	113	141	173	114	159	215	218	112	160	204	166	170	1,945	166
Temp: Mean Max (°C)	31·4	31·0	30·9	30·0	28·2	27·5	26·6	27·2	27·7	28·9	29·6	30·7	29·1	
Mean Min (°C)	20·2	20·4	20·5	20·2	18·9	17·9	17·0	16·7	17·7	19·3	20·2	20·2	19·1	
Mean Daily (°C)	25·8	25·7	25·7	25·1	23·5	22·7	21·8	22·0	22·7	24·0	24·9	25·5	24·1	
Absolute Max (°C)	34·8	37·2	37·5	33·4	32·0	32·0	29·8	30·8	30·0	33·6	35·0	36·0		
Absolute Min (°C)	17·4	17·4	16·0	15·6	13·2	11·6	10·9	11·8	13·2	14·6	17·0	16·0		

*Figures refer to means of six year period 1968/1973

Source: CEPLAC—Climatology Division, Cocoa Research Centre (CEPEC) 1974

Cocoa Research in Brazil

P. de T. Alvim, Scientific Director, CEPEC, Itabuna, Bahia.

In June 1963, CEPLAC created its Cocoa Research Centre (CEPEC) which at present employs about 80 university graduates, many with post-graduate training. The main Research Station, situated in the cocoa zone of Bahia between the towns of Ilheus and Itabuna, has a modern laboratory complex which includes library, auditorium and computer facilities. It also has 700 hectares for field experimental purposes, part of which has been set aside for small scale crop diversification studies including animal and poultry husbandry. CEPEC also operates a quarantine station in Salvador for the introduction of plant material from the Amazon valley and from other parts of the world. Many of CEPEC's research projects are located on private farms and sub-stations which, in the state of Bahia, are situated at Urucuca, Jucari, Reconcavo (near Salvador), Belmonte (for crop diversification) and Coaraci (for hybrid seed production). In other states there are sub-stations at Linhares (Espirito Santo), Cameta and Belem (Para), and Manaus (Amazonas). The Extension Department (DEPEX), which has its headquarters at Itabuna and works in close co-operation with CEPEC, employs a further 85 university graduates and 120 agricultural officers trained at EMARC.

CEPEC's research programme is orientated to the search for economic methods of increasing the productivity of cocoa farms and improving the quality of cocoa beans produced in Brazil. Absence of previous research meant that much has to be discovered about the crop and the factors controlling its yield. Basic studies on soils, climate, plant responses to environment, breeding, pests and diseases, fermentation and drying and farm management had to be initiated.

Interdisciplinary research bringing together specialists in biological, physical and socio-economic sciences was recognised from the start as the most rewarding way of approaching most problems. Selected members of the staff were given post-graduate fellowships for further training abroad or at Brazilian Universities and in the last eight years about a third of the present CEPEC staff have completed post-graduate training. Although the results of basic studies are not of immediate interest to farmers, they do contribute to making applied research more efficient and thus help to improve existing cultural practices and develop new methods of crop production.

CEPEC's research activities cover the full range of agricultural scientific disciplines from plant breeding to agricultural engineering and social sciences. The greatest emphasis is currently being placed on plant breeding and soil fertility studies, with research into pests and diseases having less emphasis. The economic losses arising from attacks of pests and diseases in Brazil are not as severe as in other cocoa growing countries.

Plant Breeding

One of CEPEC's most important functions is to produce improved planting materials for replanting low yielding cocoa farms and for new plantings in suitable areas. Previous breeding work carried out in Brazil was only of a preliminary nature and did not reach the point where recommendations for planting material could be made available to farmers. CEPEC initiated a large number of yield competition trials, simultaneously planting seed gardens using a wide range of promising clones, including some imported ones, leaving for the future the decision as to the type of material to be recommended. Even now, lack of improved planting material is a limiting factor for the replanting scheme launched by CEPLAC.

Work on selection began during the early 1940's at Urucuca. After recording individual tree yields for a few years in commercial cocoa plantings, a number of plants were selected and propagated using seeds from self-pollinated flowers. It was unfortunate that vegetative propagation was not used at that time, for the wide variability among the seedling progeny prevented conclusive results being obtained as to the agronomic value of these selections. Crosses between different selections (hybridisation), which later became the most widely recommended technique for breeding, was not explored at that time. However, recent work by CEPEC has demonstrated that some of the original Urucuca selections, especially the white seeded cultivar known as 'Catongo', are good parent material for the production of high yielding hybrids, particularly when crossed with Upper-Amazon clones such as SCA-6, SCA-12 and IMC-67. At Jucari and Linhares between 1954 and 1957 work was started selecting plants for high yield with propagation by rooted cuttings or budgrafts. This resulted in a large number of clones known by the initials SIAL and EEG, respectively. The second and most important phase of the programme, to carry out clonal comparison trials using the selected materials, was delayed for several years because of lack of funds and it was only begun after CEPEC was established.

Inspired by research carried out at other research centres, especially Turrialba and Trinidad, the breeding programme started by CEPEC in 1963 was directed towards the production of high yielding hybrids. A large number of promising imported clones from Trinidad, Costa Rica and Ecuador, were introduced through the U.S.D.A. Quarantine Station in Miami. In 1967 a modern quarantine station was built by CEPLAC in Salvador for the purpose of receiving plant material from other producing areas, including new types collected during expeditions made to the Amazon basin of Brazil. The plants remain here for over 12 months under observation before being incorporated into the CEPEC collection in Itabuna.

At present, CEPEC's germplasm collection includes 130 foreign clones and about 100 Brazilian clones. Over 300 different hybrids are under competitive trials, about 20 per cent of which were planted in 1964. All the hybrids now being distributed to farmers through DEPEX have produced over 1000 kg of dry cocoa per hectare after only 5 years in the field under experimental conditions. They are expected to produce 1,500 to 2,000 kg/ha in the 7th year. When Amazon clones such as SCA-6, SCA-12 and IMC-67 are used as one of the parents, yields of about 1,000 kg/ha are reached in the 3rd year. A few hybrids, such as SIC-952 X SCA-12, SIC-864 X SCA-12 and SIC-831 X SCA-6, reached about 3,000 kg/ha after only 4 years in the field. This last figure corresponds to over 6 times the average yield of Bahian cocoa farms which is around 450 kg/ha. These long term trials are continuing.

Clonal propagation by rooted cuttings or bud grafting was never recommended to farmers, but is used at CEPEC for the establishment of seed gardens. While most of CEPLAC's hybrid seeds come from hand pollinations, an increasing part comes from hybrid seed gardens of which a further 20 hectares were planted in 1974 making an overall total of 70 hectares. These gardens have used various combinations of promising clones both imported and Brazilian.

A special exchange agreement signed between CEPLAC and MARDI (Malaysian Agricultural Research Development Institute) led to seeds from 60 cocoa progenies being sent to Malaysia in exchange for oil palm selections. CEPLAC remains open to similar exchanges between interested institutions, although it must be noted that any request must initially be conducted through diplomatic channels.

Soil Sciences

Only very superficial studies on soils and fertilizers were carried out in Bahia before 1963. As good cocoa soils become more difficult to find, new plantings were gradually reduced and had practically stopped by the time CEPLAC started its programme in 1957. This fact, together with the decline in yield of older plantings partially accounted for the stagnation of Brazilian production from 1935 to about 1955. These soil science studies incorporate studies of pedology and soil fertility.

Systematic soil surveys to identify, describe and map the soil types in the areas, were essential to CEPLAC's programme and soil surveys were started in 1963. An exploratory soil map covering 80,000 sq km was published in 1965. The Bahian cocoa zone has now been completely surveyed, mapped and classified with regard to potential use by aerial photography and radar. It is estimated that the total area presently planted with cocoa covers about 400,000 hectares.

An intensive soil fertility survey of the cocoa regions of Bahia and Espirito Santo was carried out using the maize microplot technique. Over 270 microplot tests were conducted between 1963 and 1964 before laboratory facilities for chemical analysis were available. More than 150,000 soil samples, representing all types of soils of the cocoa region, have been analysed since a laboratory was set up. It has now been established that phosphorous deficiency is commonly found in most cocoa soils in Bahia and Espirito Santo. Deficiencies of nitrogen, potassium and magnesium, although less frequent than phosphorous, also occur in at least 30–40 per cent of the farms. Liming has proved to be beneficial for cocoa in a quarter of the areas surveyed. The quantity is calculated on the basis of exchangeable aluminium in the soil and recommendations vary from 1–2,000 kg/ha of dolomitic limestone, which is commonly found in the region. A large number of experiments carried out by the CEPEC staff at numerous farms and demonstration plots under the supervision of extension officers, have conclusively shown that in Bahia and Espirito Santo the use of fertilizer and lime combined with careful shade control and good farm maintenance is the most effective way of increasing yields.

Applications for fertilizers should be accompanied by a CEPLAC routine soil analysis. Soil samples are collected by the extension officer; soil analysis is carried out at the research centre at Itabuna and results presented by the CEPLAC computer. More than 25,000 soil samples were analysed in 1974 as part of this programme.

Plant Protection

Black pod disease caused by the fungus *Phytophthora palmivora* is by far the most important cocoa disease in Bahia, though in the States of Para and Amazonas which produce only about 2–3,000 tons of cocoa per year, witches' broom is also important. Other diseases of minor importance in Bahia are pink disease (*Corticium salmonicolor*), trunk canker caused by *Phytophthora palmivora* and 'Sudden Death' whose symptoms resemble the malady caused by *Ceratocystis fimbriata*. The causal agent for 'Sudden Death' has yet to be conclusively identified, though a constant association with the fungus *Mycoleptodiscus terrestris* has been noted. This fungus produces a toxin which could be responsible for the disease symptoms.

Black pod in Bahia is typically a seasonal disease in the sense that it only becomes severe during the winter months, particularly from June to August. Diseased pods are rarely found between October to April.

The environmental factor which shows a close negative correlation with black pod incidence, is the vapour pressure deficit of the atmosphere—a function of both temperature and relative humidity. A relatively low vapour pressure deficit seems to be a requirement for high incidence. The winter temperature in the cocoa region of the State of Espirito Santo is lower than in Bahia, but because rainfall and relative humidity are also lower the mean vapour pressure deficit remains above the critical level throughout the year. Black pod disease is practically unknown in Espirito Santo, in spite of the frequent presence of the fungus on the litter under the cocoa trees. It is found that losses due to black pod are usually higher in shaded as opposed to exposed areas, probably as a result of the lower vapour pressure deficit under the shade. Removal or reducing the number of shade trees can lower the disease incidence in such farms. The white seeded cultivar Catongo was found to be much less susceptible to Bahian strains of black pod than many cultivars. Some of the introduced clones (specially SCA-6, SCA-12, TSH-565, TSH-516, TSH-774, TSH-792, CAS-2 and Pa-30) were also found to be highly resistant or tolerant, and a high degree of resistance has also been detected in some of the hybrids now being distributed to farmers.

The usual method for the control of black pod has been the use of cuprous oxide (Copper Sandoz) or cupric hydroxide (Kocide 101) mixed with water. However the major drawback has been the large quantity of water (120 litres per hectare) required to obtain a uniform cover. Experimental use of the fungicide, spray oil and water with emulsifier has been successful and permits the reduction of the quantity applied from 120 to 20 litres. Field experiments have also shown that the most economic results have been when spraying commences when the disease incidence has reached a level of 5 per cent regardless of the month of the year. Further work is in hand to study the economic response further.

In 1973 eleven different fungicides were tested in field trials for the control of black pod and these trials were continued into 1974 with ten fungicides. The best results were obtained with tri-phenyltin acetate (Brestan 20), cuprous hydroxide (Funtox), cupric hydroxide (Kocide 101) and cuprous oxide (Copper Sandoz).

A new line of research is the control of the natural dispersion of the black pod fungus by the use of anti-sporulants. About 70 products have so far been tested and Canavanine and Ethionine, both amino acid analogues, have shown ability to reduce sporulation. The practical aspects of this method of contol are still under study.

There are several insect pests associated with cocoa in Bahia and Espirito Santo, but none of them in any way compares in importance with the West African capsids. Among the more important insect pests are the thrips (*Selenothrips rubrocinctus*), the capsid (*Monalonion bondari*) and several small beetles. The thrips are particularly serious in Espirito Santo and the drier areas of Bahia. The role of the 'gardening' ant (*Azteca paraensisi v. bondari*) in the ecology of the cocoa farm is being studied.

Thrips damage becomes particularly evident, where overhead shade has been excessively reduced especially in the drier zones on the western margin of the main cocoa region. Population studies in 1974 confirm that numbers only reach serious proportions during the drier months of the year. Field studies have been initiated to observe whether the newer cocoa hybrids currently being distributed have any inherent resistance to thrips attack. Preliminary results suggest that thrips have preferences for some of these hybrids, but this work is continuing.

Considerable work has been initiated to observe the possible effects of regular insecticide sprayings on the population of cocoa pollinating midges. The three insecticides tested (BHC 1·5 per cent, methyl parathion 1·5 per cent and carbaryl 7·5 per cent) gave high mortality rates two hours after spraying, but after 24 hours the midge population had already begun to recover. Bearing in mind the wide interval between the two annual insecticide applications, it is not considered that these sprayings have any permanent harmful effect on the midge population.

Phytology (Physiology and Plant-Biochemistry)

Studies on the phenology of the cocoa tree have been intensified following the arrival of the microclimatologist on loan from the British government. The flowering intensity appears to be mainly controlled by rainfall distribution and to a lesser extent by the air temperature, though internal competition with growing fruits for photosynthates reduces the flowering intensity in August/September. Flowering and flushing both appear to be particularly profuse after the first rains following a period of moisture deficiency. It seems that actual leaf-fall only occurs on the rehydration of plant tissues after a period of water stress. Even though many old leaves become permanently wilted during stress, the leaves only fall when soil moisture returns to field capacity. Within 7–8 days of watering the trees would begin to flush.

In 1972 studies to determine the effect of various harvesting and drying techniques on the melting point of cocoa butter indicated that the month of harvest had an important effect. Detailed studies using gas chromatography and differential scanning colorimetry has now shown that the butter's chemical composition and in consequence its physical characteristics (hardness and melting point) are affected by small variations in the ambient temperature during the cocoa pod's development. Cocoa beans from fruits which had developed through the warmer summer months (harvested between March and June) were found to have a butter fat containing 5 per cent saturated fatty acids (oleic and linoleic) than beans from fruits which had developed during the cooler winter months. This resulted in the cocoa butter from the former having a melting point of 33°C or similar to African butters. Comparisons with cocoa beans from the Amazon valley indicated that they had a melting point higher than the African beans at all times of the year.

A more disturbing result has been the finding of residues of gamma BHC in cocoa beans from plantations which had been subjected to twice yearly dusting with BHC (1·5 per cent) over a period of 10 years. These residues, although within the limits set by most importing countries, could in later years build up to unacceptable levels. Such a finding lends weight to the argument that prophylactic dusting should be discontinued, in future only treating trouble spots as and when they arise. Other insecticides are being seriously considered for use.

Technology

A new colorimetric method is being developed for detecting the degree of smoke contamination in cocoa beans. A hundred grammes of whole beans are soaked in 33 ml ethyl alcohol 96 per cent for 5 minutes with constant agitation. The alcohol is poured off, filtered and the resulting colour compared with calibrated standards. Levels as low as 2 per cent smoke can be detected using this simple method which is greatly superior to the smell tests previously carried out at the grading stations. Chocolate tasting panels have been set up to determine the level at which smoke can be detected in chocolate made from the smokey beans.

A new drying system using solar energy by means of a glass-roof drying platform (barcaca) has been developed. Work is proceeding on the possible use of infra-red heaters and commercially available household gas to permit all-weather drying on the barcaca. The economics of gas-drying are unclear due to recent substantial price rises in the cost of gas.

At CEPLAC's request the British Government sent a consultant to review the possibility of a joint project between the Tropical Products Institute and CEPLAC for improving the drying techniques as practised on Bahian cocoa farms. It is expected that a drying engineer will be sent in 1975 to work on this particular problem.

A pilot plant is being constructed at CEPEC for research into industrialisation of cocoa by-products, as well as tropical fruits of the region. This is due for completion during 1975. This development has generated from the current interest in crop diversification in Bahia.

Natural Resources Survey

In 1971 an ambitious programme for a complete land resources and sociological survey of the Bahian cocoa region was begun. The initial stage of the surveying and mapping of the region to cover such topics as soil classification, land use, geology, mineral resources, vegetation and land use potential was mainly carried out by the Soils Division. The second stage consisting of the economic and sociological surveys was started in 1972 and field studies were completed in February 1974. All aspects of credit, marketing, production procedures, work effort, income grouping, and living standards, were studied by interviewing sample populations in both urban and rural communities. The area of this project in the State of Bahia is about 35,000 square miles and covers an area with a population of two million people. The region under study also includes the periphery of the cocoa zone. From the field work carried out, over eleven thousand questionnaires are being currently processed by CEPLAC's computer services. The mineral resources, geological survey and industrial census of the region was completed in 1974. The vegetation and hydrology maps and the socio-economic study await completion and full publication in 1976 seems probable.

Publications

CEPLAC publishes much research and extension literature including the following:

Revista Theobroma—a quarterly publication reporting the results of research. Some of the papers are written in English, all the papers have an English summary.

Cacau Atualidades—an extension bulletin published quarterly. Portuguese only.

Boletim Tecnico—a series of bulletins in which soil surveys and other larger items of research are recorded. Summary in English.

New Books

The literature on cocoa continues to grow. Authoritative works on the crop, its pests and Phytophthora disease have been published recently. To complete the picture C. A. Thorold has written about diseases — "Diseases of Cocoa" C. A. Thorold Oxford University Press 1975 £11, xii and 423pp.

It is hoped to review this book in the next issue.

Cocoa Abstracts

These abstracts are reprinted from 'Abstracts on Tropical Agriculture' published by the Royal Tropical Institute, Amsterdam.

December 1974

Lockwood, G. (Cocoa Res. Inst., P.O. Box 8, Tafo-Akim, Ghana). **Hybrid cocoa varieties in the Eastern Region of Ghana, present and future.** Cocoa Growers' Bull. 21, pp. 13-21 (1974).

Since the release of the Series II hybrid cocoa varieties for use by farmers in Ghana, it has been found that Upper Amazon (UA) × Amelonado crosses are preferable to UA × Trinitario hybrids. The UA parent in biclonal seed gardens is now hand-pollinated with Amelonado pollen exclusively. Experience has shown the superiority of these hybrids over pure Amelonado material; ease of establishment, early bearing, and smaller losses from pod diseases are particularly valuable. The greater tolerance of the UA to swollen shoot virus may lead to the development of UA × UA crosses. Adaptation of growing techniques to the new material is necessary to make the maximum profit from it. Tables. Graphs. 9 refs.

Soenaryo, and Muhadjir. (Balai Penelitian Perkebunan Bogor, Jember, Indonesia). **Hasil sementara pengujian keturunan legitim klon-klon coklat di perkebunan Ngobo.** (Preliminary results of the testing of legitimate progenies of cocoa clones on Ngobo estate). Menara Perkebunan 41, 6, pp. 281-5 (1973).

In Central Java, Indonesia, the legitimate progenies derived from crossings between a number of DRC and GC cocoa clones as the female parents and the clone DR2 as the male parent were screened for yield performance. On the basis of 400% relative yield index as compared with the clone DR2, some 24 new mother trees were selected out of this 1st screening. English summary. Tables. 7 refs.

Soenaryo. (Balai Penelitian Perkebunan Bogor, Jember, Indonesia). **Sebab-sebab terjadinya tanaman abnormal pada kebun coklat berasal dari okulasi.** (The occurrence of abnormal trees in a budded cocoa planting). Menara Perkebunan 41, 4, pp. 161-7 (1973).

In an experiment conducted in E. Java, Indonesia, it was shown that different original lengths of scionstocks produced progenies with significant different lengths of main stem. Dwarf scionstocks produced dwarf budded trees, whereas extra-long scionstocks produced abnormally long-stemmed trees. From author's English summary. Tables. Fig. Photos. 8 refs.

Tan, Y. C., et al. Control of insect pests of young cocoa using systemic insecticides. Planter 50, 574, pp. 18-23 (1974).

Truly systemic activity was demonstrated by application of Orthene as a stem paint against foliage insect pests of cocoa in Malaysia. Taint/residue tests are being undertaken. It is suggested to apply Orthene at 25% concentration on immature cocoa using a 10-15 cm band width located at the base of the tree. Tables. 9 refs.

Bravo, A; McGaw, Dr. (Fac. Eng., Univ. West Indies, St. Augustine, Trinidad). **Fundamental artificial drying characteristics of cocoa beans.** Trop. Agric., Trinidad 51, 3, pp. 395-406 (1974).

Three separate drying periods were identified. In the 1st period the rate of drying was controlled by the rate of heat transfer to the beans from the air stream. In the 2nd and 3rd periods, drying was a function only of air temperature.

Sundaram, S; Hassan, M. (Res. Div., Dep. Agric., Suva, Fiji). **Further notes on the Waimaro cocoa Part 2 Yield.** Fiji Agric., Suva 35, 2, pp. 61-66 (1973).

During 1968-72 individual plots at Waimaro, the first Amelonado cocoa planting in Fiji, yielded between 1,500 and 3,700 kg/ha. Large variations in yield, and in loss of black-pod within the small area of the trial (1.7 ha) show that the growth of cocoa is highly sensitive to small variations in soil, and the incidence of black-pod to variations in micro-climate. The average black-pod loss (25%) is so high as to make it doubtful whether cocoa should be planted in this rainfall zone. Authors' summary.

Dublin, P. (Div. Biol. Cell IFCC Côte d'Ivoire, ORSTOM, Paris, France). **Les haploïdes de Theobroma cacao L. Diploïdisation et obtention d'individus homozygotes.** (Haploids of Theobroma cacao L. Diploidization and production of homozygote individuals). Café Cacao Thé, Paris 18, 2, pp. 83-96 (1974).

Pot trials conducted in the Ivory Coast showed that grafting of haploid cocoa plants on diploid cocoa rootstocks gave superior growth as compared to growth on their own root system. Diploidization was successfully carried out by applying 0·25% colchicine solution in 0·15% agar + 10 ppm gibberellin to buds; 70% of the haploids treated produced a diploid shoot.

Anselmi, J. A; Nam, L. S; Hain, M. C. The barico cocoa dryer. Planter, Kuala Lumpur 50, 578, pp. 144-51 (1974).

Description of a low capital cost and low labour cost cocoa dryer used at an estate in Malaysia. The barico cocoa dryer is built entirely of local materials. A costs calculation is presented of processing with the dryer working at full capacity. However, the system is flexible and will cope with a wide range of daily intakes.

Brandt, S. A; Neto, A. A; Rezende, A. M; Sousa, A. F. de; Rebello, A. de pp. (Univ. Fed. Viçosa, Viçosa, Brazil). **Condições de equilíbrio no mercado internacional do cacau.** (Equilibrium conditions in the international cocoa market). Rev Ceres, Viçosa, Brazil 21, 113, pp. 38-50 (1974).

Large price fluctuations in cocoa bean prices during 1925-71 resulted from considerable fluctuations in supply coupled with a very low price elasticity of demand.

Oyejola, B. O. (Cocoa Res. Inst., Nigeria, Ibadan, Nigeria). **Effect of depth of placement on uptake of radioactive superphosphate by cacao (Theobroma cacao L.)** Turrialba Rev Interam Cienc Agric., Turrialba, Costa Rica 24, 2, pp. 200-4 (1974).

In Nigeria, the specific activity of P^{32} in leaves decreased with increasing depths of labeling sites, with the highest specific activity at a depth of 7·5 cm. Uptake.

Pires, E. do p; Smith Figuerôa, G. E. Custo da implantação de 1 ha de bananal para sombreamento provisório de cacau em Linhares-Espirito Santo. (Cost oj planting 1 ha of banana as temporary shade for cacao in Linhares-Espírito Santo) Cacau Atual, Ilheus, Brazil 10, 2, pp. 8-11 (1973).

An analysis.

February 1975

Knight, P. T. Transforming traditional agriculture: the CEPLAC experience with cocoa in Bahia. In: Contemporary Brazil: issues in economic and political development, Praeger, New York NY (USA) pp. 253-277 (1972).

In 1957, the CEPLAC (Executive Commission of the Plan for the Rural-Economic Recuperation of Cocoa Farms) was formed to restore, improve and rationalize the entire cocoa production process. Accomplishments of CEPLAC in research, extension, education and supervised credit are reviewed. Lessons are drawn from its successes and failures.

Alvim, P. de T. (Centro de Pesquisas do Cacau (CEPEC), Itabina, Bahia, Brazil). **CEPLAC program in Brazil, 1973/1974.** In: Summary of research sponsored by Chocolate Manufacturers Association 1973/74. America Cocoa Research Inst. (ACRI) McLean, Va (USA) A. p. 13 (1974)

The activities of the CEPLAC programme on cocoa is briefly described. Attention is paid to plant breeding, soils, entomology, phytopathology, plant physiology, bio engineering, economics, crop diversification and extension results. Some broad details are presented.

Griffin, M. J; Maddison, A. C. (Cocoa Research Inst., Nigeria (CRIN), Ibadan, Nigeria). **International black pod research project. Second six monthly report — general.** In: Summary of research sponsored by Chocolate Manufacturers Association 1973/74. American Cocoa Research Inst. (ACRI) McLean, Va (USA) D. p. 7 (1974).

In this 6-monthly report attention is paid to techniques for detection of Phytophthora palmivora, and to trials in the field on blocking various routes of infection by Phytophthora, inoculum detection, mapping trials, Phytophthora survival, husk pile infections, and compatibility typing.

Mogrovejo, E. (Tropical Experiment Station, Instituto Nacional de Investigaciones Agropecuarias, Pichilingue, Ecuador). **Phenological studies on clonal and hybrid cocoa (Theobroma cacao L.) in Pichilingue, Advance Report, February 1974.** In: Summary of research sponsored by Chocolate Manufacturers Association 1973/74. American Cocoa Research Inst. (ACRI) McLean, Va (USA) G. p. 13 (1974)

In a field trial with several varieties of cocoa the following records have been taken: monthly mean of flowers and of fallen leaves, flower setting and bearing and the mean number of leaves per branch.

Bixler, R. W. The West African cocoa story. Vantage Press New York, NY (USA) p. 195 (1972).

This is mainly the story of fluctuations and trends in cocoa production in Ghana (formerly Gold Coast) and Nigeria, and how they affected, or were affected by, world market demand and prices, farmers incomes, and attempts by producers, traders, consumers, and governments to get a grip on the cocoa business. Among the subjects treated are the beginnings of the cocoa industry in the 2 countries, the effect of the economic recession in the 1930's, the work of the British Parliamentary Commission of Enquiry in 1938, the origin and history of the Cocoa Marketing Boards, and the unsuccessful attempts to establish an International Cocoa Agreement.

Murray, D. B. (Cocoa Research Unit, University of the West Indies, Trinidad and Tobago). **Annual Report to A.C.R.I. 1st April, 1973 — 31st March, 1974. Cocoa Research Unit — University of the West Indies, Trinidad.** In: Summary of research sponsored by Chocolate Manufacturers Association 1973/74. American Cocoa Research Inst. (ACRI) McLean, Va (USA) C. p. 4 (1974).

Research progress on collection, breeding and screening for yield and disease resistance of cocoa. Attention is paid to the germplasm collection, variety trials, the testing of isolates of Phytophthora palmivora and processing of beans.

Moreira, M. (Tropical Experiment Station, Instituto Nacional de Investigaciones Agropecuarias, Pichilingue, Ecuador). **Progress Report, July 1973 — February 1974.** In: Summary of research sponsored by Chocolate Manufacturers Association 1973/74. American Cocoa Research Inst. (ACRI) McLean, Va (USA) F. p. 4 (1974).

Brief outline of witches' broom research; attention is paid to flushing of shoots and entry of Marasmius perniciosus.

Adomako, D; Owusu, G. K. (Cocoa Research Inst., Tafo, Ghana). **Studies on the mechanical transmission of cocoa swollen virus: some factors affecting virus multiplication and symptom development in cocoa.** Ghana Journal of Agricultural Science (Ghana). v. 7(1), pp. 7-15 (April 1974).

The difference between virus infection by mechanical means and by mealy-bugs (Planococcoides njalensis) was studied.

Asare – Nyako, A. (Cocoa Research Inst., Tafo, Ghana). **Towards an economic chemical control of the black pod disease of cocoa in Ghana.** Ghana Journal of Agricultural Science (Ghana). v. 7(1), pp. 17-23 (April 1974).

Basing the spraying schedule on the known black pod disease incidence curve in a plot yielding about 773·4 kg dry beans/ha, it was found economical to spray 6 times in the year with Kocide (micronized cupric hydroxide) at a concentration of 2·24 kg formulation in 222·4 dm^3 water to the ha. Missing spray applications in periods when the disease was naturally on the decline did not affect the efficiency of the control but resulted in marked financial gains. Regardless of the level of yield, a crop saving of 201·7 kg, 252·2 kg and 369·9 kg dry beans/ha was the minimum required to break even costwise on spraying 5, 6 and 9 times, respectively, during the year with Kocide in the plots studied. Perecol (micronized copper oxychloride) was less persistent than Kocide but both fungicides significantly reduce the incidence of black pod disease. Sprayed plots gave significantly ($P = 0{\cdot}05$) higher yields than unsprayed plots.

Dakwa, J. T. (Cocoa Research Inst., Tafo, Ghana). **The occurrence of Phytophthora palmivora (Butl.) Butl. in soil in Ghana.** Ghana Journal of Agricultural Science (Ghana). v. 7(1), pp. 37-41 (April 1974).

The fungus was frequently found in soils of a forest reserve, an abandoned cocoa farm and in farms still under cocoa cultivation; its activity, however, differed under the 3 soil conditions. Fluctuations in the occurrence of P. palmivora in soil did not depend on atmospheric temperature. At Obomeng, the fungus was isolated more frequently from a cocoa farm than from either an abandoned cocoa farm or a forest area. The isolation of P. palmivora from the uncultivated forest soil indicates that the fungus is indigenous to forest soils.

Adenikinju, S. A. (Gambari Experimental Station, Cocoa Research Inst. of Nigeria, Ibadan, Nigeria). **A rapid non-destructive means of calculating leaf area in cocoa.** Tropical Agriculture (Trinidad and Tobago). v. 51(4), pp. 578-79 (October 1974).

In Nigeria, leaf area (Y) in cocoa seedling could be estimated by using a regression equation of the type $Y = a + bX_1 + cX_2 + dX_3$ in which a, b and c are constants for the particular variety studied and X_1 is seedling height, X_2 leaf number and X_3 seedling age.

March 1975

Gestin, A. J; Roux, G. (Station du Cacaoyer, Institut Français du Café et du Cacao (IFCC), Nkoemvone, Cameroon). **L'utilisation des herbicides pour l'entretien des jeunes cacaoyères.** (The use of herbicides in the maintenance of young cacao plantations). Café, Cacao, Thé (France). v. 18(2), pp. 107-20 (1974).

Field trials in cocoa plantations showed that application of 1·5 l gramoxone (20% a.i.) + 0·1 l Teepol per ha at a frequency of 6 rounds per year is approx. 40% cheaper than manual weeding in controlling graminaceous material. It was further shown that the 3 most efficient treatments are, in decreasing order: 1·8 l MSMA + 2·4 kg diuron per ha; 1·25 l amino-triazole and per ha; and 4·25 kg dalapon + 0·3 l paraquat per ha. It was noted that symptoms of Zn deficiency were induced in cocoa following application of MSMA to weeds.

Situmorang, S. (Balai Penelitian Perkebunan Bogor, Jember, Indonesia). **Ngengat cokelat (Acrocercops cramerella) pada cokelat.** (The cocoa moth (Acrocercops cramerella) in cocoa plantings). Menara Perkebunan (Indonesia). v. 42(4), pp. 195-97 (August 1974).

A literature study on the taxonomic status and biology of the cocoa moth is conducted. Some measures for prevention and control are mentioned.

Nguyen Ban, J. (Laboratoire d'Entomologie, IFCC, Ivory Coast.) **Elevage en laboratoire de trichogrammes en prévision d'une lutte intégrée contre Earias biplaga (Wlk); note préliminaire.** (Laboratory breeding of trichograms in anticipation of an integrated control of Earias biplaga (Wlk) (Preliminary note). Café, Cacao, Thé (France). v. 18(3), pp. 193-97 (July 1974).

Laboratory experiments showing the possibility of breeding Trichogrammatoidae lutea parasites in Aanagasta kuehniella eggs and that the parasites return to their original host, i.e. Earias biplaga eggs, when they are placed in the latter's presence at the 11th generation.

Bruneau de miré, P; Lotodé, R. (Laboratoire d'Entomologie, IFFC, Cameroon). **Comportement de familles hybrides de cacaoyers soumis aux attaques d'homoptères.** (Behaviour of hybrid families of cocoa trees subjected to attacks by Homoptera). Café, Cacao, Thé (France). v. 18(3), pp. 187-192 (July 1974).

A comparative test is described which shows, among other things, that the differences in the vegetative development result from a more or less resistance to attack by Homoptera pests.

Soenarjo. (Bali Penelitian Perkebunan Bogor, Jember, Indonesia). **Jarak tanam sempit dan pertanaman yang rapat pada cokelat.** (Close spacing and high density in cocoa). Menera Perkebunan (Indonesia). v. 42(4), pp. 181-186 (August 1974).

Based on the results of experiments conducted in different cocoa countries, the influence of close spacing and high plant density in cocoa, particularly with respect to growth and yield aspects, is discussed. No negative effects of close spacing (> 1,000 plants/ha) on growth have ever been observed. Closely grown cocoa looked rather more healthy and budding rendered a higher successful percentage yield increase, particularly in the early productive stage and was enhanced by close spacings. Crown thinning, appeared necessary however, to obtain good growth of the young fruits (cherelles).

Guers, J. (Laboratoire de Physiologie Végétale, Faculté des Sciences, Yaoundé, Cameroon). **Influence des conditions d'éclairement et de température sur la teneur en chlorophylles et l'activité photosynthétique des feuilles de cacaoyer.** (Influence of light and temperature conditions on the chlorophyll content and photosynthetic activity of the cocoa tree leaves). Café, Cacao, Thé (France). v. 18(3), pp. 157-166 (July 1974).

An experiment is described showing the remarkable morphological and physiological adaptation of cocoa leaves to various conditions of illumination. Leaves exposed to direct sunlight, which are smaller and thicker, have a higher compensation point and higher photosynthetic yields than the leaves growing under shade, but their chlorophyll content is much lower.

Mossu, G. (Centre de Recherches, IFCC, Cameroon.) **La conservation du pouvoir germinatif des graines de cacaoyer.** (The conservation of the germinative power of cocoa seeds). Café, Cacao, Thé (France). v. 18(3), pp. 179-186 (July 1974).

Methods in use for the conservation of the germinative power of cocoa seeds are reviewed. Tests recently conducted in Cameroon showed that coating of the ripe cocoa pods with a powder consisting of 50% talc and 50% benomyl gives 98% and 95% germination after conservation for 1 month and 1 1/2 month, respectively. Coating with pure talc provides excellent conservation for 35 days only, after which period the germination percentage decreases rapidly.

(Centre de Recherches de Côte d'Ivoire, IFCC, Bingerville, Abidjan, Ivory Coast). **The studies of the inorganic nutrition of coffee and cacao, carried out by the IFCC in the Ivory Coast.** Potash Review (Switzerland). pt. 27(63/2), p. 4 (1974).

Results are presented of experiments with inorganic fertilizing of cocoa and coffee growing on different soils.

Smith, E. S. C. (Department of Agriculture, Stock and Fisheries, Popondetta, Papua New Guinea. **A laboratory rearing method for the cacao mirid Helopeltis clavifer Walker (Hemiptera: Miridae).** Papua and New Guinea Agricultural Journal, (Papua New Guinea). v. 24(2), pp. 42-53 (September 1973).

A method is described for continuous rearing and handling of large numbers of adults and nymphs of Helopeltis clavifer. The egg and nymphal stages last 7-8 days and 11-12 days, respectively, which are very similar to their durations as recorded in the field.

Abreu, J. M; Silva, P. Divisão de Entomologia, Centro de Pesquisas do Cacau (CEPEC), Itabuna, Bahia, Brazil). **Controle das formigas cortadeiras Atta cephalotes e Atta sexdens, na região cacaueira da Bahia.** (Control of the leaf-cutting ants Atta cephalotes and Atta sexdens in the cocoa region of Bahia). Revista Theobroma (Brazil). v. 3(3), pp. 3-11 (July 1973).

Field trials were conducted to compare the baits Mirex and Nitrosin Extra (aldrin), and the dusts aldrin, heptachlor and a mixture of aldrin and PDCB for the control of ants. The results showed that the baits were more efficient in controlling A. sexdens, whereas the dusts were more efficient in controlling A. cephalotes. Methods of application of the insecticides are given.

Silva, L. F. da; Carvalho Filho, R; Melo, A. A. O. de. (Divisão de Solos, Centro de Pesquisas do Cacau (CEPEC), Itabuna, Bahia, Brazil). **Aptidão agrícola dos solos da região cacaueira da Bahia.** (Agricultural potential of the soils of the Bahian cocoa region). Revista Theobroma (Brazil). v. 3(3), pp. 25-40 (July 1973).

A modified system of land classification has been applied to the soils of the Bahian cocoa region. The results provide a basis for better future recommendations on land use and management systems for the region.

Carletto, G. A. (Divisão de Genetica, Centro de Pesquisas do Cacao (CEPEC), Itabuna, Bahia, Brazil). **Expedição internacional à Amazônia equatoriana para coleta de material botânico de cacau.** (An international cocoa collecting expedition to the Ecuadorian Amazon). Revista Theobroma (Brazil). v. 3(3), pp. 41-74 (July 1973).

This 5-day expedition has been made to collect new cocoa plant material of good agronomic characters and genetic diversity for use in new breeding programmes.

O'Sullivan, D. F. (Lowlands Agricultural Experiment Station, Keravat, Papua New Guinea). **Insecticide control of Salina celebensis Schaffer (Collembolla: Entomobryidae), a minor pest of cacao in Papua New Guinea.** Papua and New Guinea Agricultural Journal (Papua New Guinea). v. 24(2), pp. 58-60 (September 1973).

Experiments comparing several chemicals for the control of Salina celebensis. Lindane and parathion at 0·1% a.i. were the best treatments. Addition of 0·1% white oil to the insecticide mixtures enhanced the effectiveness of the treatments. Dieldrin, chlordane, carbaryl, dicrotophos, fenthion, formothion and trichlorphon were also tested.

Ram, C; Ram, A. (Division of Plant Pathology, Centro de Pesquisas do Cacau (CEPEC), Itabuna, Bahia, Brazil). **Virulence of some selected isolates of Phytophthora palmivora in cacao.** Revista Theobroma (Brazil). v. 3(3), pp. 12-16 (July 1973).

Tests were conducted to group 22 isolates of P. palmivora according to their levels of virulence, using 4 different clones of cocoa. Significant differences in virulence and clone resistance were observed.

Sharma, R. D; Sher, S. A. (Division of Entomology, Centro de Pesquisas do Cacau (CEPEC), Itabuna, Bahia, Brazil). **Nematodes of the cocoa region of Bahia, Brazil. II — Occurrence and distribution of plant parastic nematodes associated with cocoa (Theobroma cacao L.)** Revista Theobroma (Brazil). v. 3(3), pp. 17-24 (July 1973).

A survey to identify the genera of nematodes associated with the cocoa tree. Seventeen general and 25 species of nematodes were encountered in 118 samples taken from 24 different localities of the Bahian region cocoa.

Brown, D. A. L. Bibliografia Monilia roreri (Cif. & Par.). (Bibliography, Monilia roreri (Cif. & Par.). Federación Nacional de Cafeteros de Colombia Bogota (Colombia). p. 12 (July 1974).

Monilia cacao pod rot bibliography.

Cocoa Research Institute Annual Report 1970-71. Annual Report—Cocoa Research Institute (Ghana), 227, p. (1973). Research activities on agronomy, plant pathology, entomology, plant physiology, plant breeding and chemistry. Some notes on results and farm management. The numerous projects are described individually, and the results of investigations are often reported in detail, which makes this a particularly useful source document.

May 1975

Dakwa, J. T. (Cocoa Research Inst., Tafo, Ghana). **The availability of Phytophthora palmivora (Butl.) Butl. inoculum for the development of cocoa black pod disease.** Ghana Journal of Agricultural Science (Ghana.) v. 7(2), pp. 117-120 (August 1974).

The sources of supply of inoculum needed for the initial development of black pod epiphytotics are investigated.

Santana, M. B. M; Rosand, P. C; Miranda, E. R. de. (Divisão de Solos, Centro de Pesquisas do Cacau (CEPEC), Itabuna, Brazil). **Toxidez do alumino em plântulas de cacau.** (Aluminium toxicity in cocoa seedlings). Revista Theobroma (Brazil). v. 3(4), pp. 11-21 (October 1973).

Trials with cocoa seedlings growing in hydroponics show that cocoa is tolerant to Al concentrations up to 16 ppm. Higher concentrations inhibit the development of the root system. Concentrations of 128 ppm and higher cause serious disturbances and even the death of the seedlings. Seedlings with one part of their root system growing in a nutritional solution, and the other part in a solution containing only Al, showed translocation of Al and nutritive elements, especially P, from one part of the root system to the other part. Increasing the Al concentration of a nutritional solution caused an increased P content of the roots, and a decreasing phosphorus and calcium content of the aerial portion of the seedlings.

Chan, C. L; Lee, B. S. A preliminary survey of cocoa diseases in West Malaysia. MARDI, Research Bulletin (Malaysia). v. 1(2), pp. 22-31 (December 1973).

The range of diseases in the 5 major cocoa growing areas varies considerably. Vascular streak dieback is wide-spread, while witches broom and cocoa virus diseases are absent. Black pod is generally low, while stem canker is confined to specific areas. It was observed that type of planting material, age, rainfall, soil type and shade trees can affect incidence and distribution of the disease.

Abreu, J. M. (Divisão de Entomologia, Centro de Pesquisas do Cacau (CEPEC). Itabuna, Brazil). **Avaliação de inseticidas no combate ao tripes do cacaueiro Selenothrips rubrocinctus (Giard) na Bahia.** (Evaluation of insecticides to control cocoa thrips Selenothrips rubrocinctus (Giard) in Bahia, Brazil). Revista Theobroma (Brazil). v. 3(4), pp. 3-10 (October 1973).

The results of trials showed that the insecticides lindane, BHC and carbaryl give effective control of S. rubrocinctus. This efficacy remains for 21 days after treatment, although a slight reduction of the efficacy occurs after the 14th day, Malathion fenitrothion and parathion-methyl are highly efficient up till 24 hours after treatment. Phosalone and diazinon were less efficient in controlling the thrips.

Eguagie, W. E. (Cocoa Research Inst. of Nigeria (CRIN), Ibadan, Nigeria). **The concept and practice of integrated control and prospects of their adoption for West African cacao ecosystem.** Revista Theobroma (Brazil). v. 3(4), pp. 35-44 (October 1973).

The use of insecticides may have undesirable side effects as the resurgence in numbers of secondary pests and the development of resistance to certain chemicals. It is suggested that centrally organized 'spot' spray programmes, based on integrated methods involving a careful choice of chemicals and more efficient methods of application, could provide an answer to the present problem. Whenever possible, chosen insecticides should have short residual action, appreciable fumigant properties, and must be selectively toxic to the pest. Such treatments should be combined with good cultural practices, such as regular pruning and weeding.

Carletto, G. A. (Divisão de Genética, Centro de Pesquisas do Cacau (CEPCE), Ilhéus, Bahia, Brazil). **O poder germinativo das sementes do cacaueiro.** (The germinative power of cocoa seeds). Cacau Atualidades (Brazil). v. 11(1), pp. 2-3 (January 1974).

Five hundred seeds each of hybrid cocoa and of the Catongo cocoa variety were kept in plastic bags after removing the pulp and applying fungicides. At intervals of 10 days, 100 seeds of each type were used to test their germination capacity. The percentages of germination of the hybrid and the Catongo seeds were: 100 and 99 after 0 days of storage; 88 and 85 at 10 days; 72 and 28 at 20 days; 63 and 24 at 30 days; and 61 and 7 at 40 days of storage, respectively. It is suggested that the low germination percentage of the Catongo seeds may be the result of the absence of anthocyanic pigments.

Santana, C. J. L. de. (Divisão de Geociências, Centro de Pesquisas do Cacau (CEPEC), Ilhéus, Bahia, Brazil). **Importância dos micronutrientes no cultivo do cacaueiro.** (The importance of micronutrients for cocoa growing). Cacau Atualidades (Brazil). v. 11(1), pp. 7-10 (January 1974).

A discussion on the need of microelements for growing cocoa, especially the vigorously growing high-yielding varieties, and on the different methods of application.

Magalhães, W. S. (Divisão de Genética, Centro de Pesquisas do Cacau (CEPEC), Ilhéus, Bahia, Brazil). **Reprodução assexuada do cacaueiro.** (Vegetative propagation of cocoa). Cacau Atualidades (Brazil). v. 11(1), pp. 21-23 (January 1974).

In practice, 60 to 80% of the budded material of cocoa in the State of Bahia appeared to be satisfactory, while 40% of the cuttings gave good results. Cocoa was budded when the stock material was about 4-5 months old and had a diameter of 1-1·5 cm. The plants were planted out 4 months after budding.

Kaufmann, T. (Cocoa Research Inst., Tafo, Ghana). **Cocoa pollination by males of Forcipomyia squamipennis (Diptera: Ceratopogonidae) in Ghana.** Tropical Agriculture (Trinidad and Tobago). v. 52(1), pp. 71-74 (January 1975).

Cage experiments in the field proved that males of Forcipomyia squamipennis (Diptera: Ceratopogonidae) Ingram & Macfie are pollinators of cocoa flowers (Theobroma cacao) in Ghana, contrary to former claims that this species is a non-pollinator and that only females of certain Forcipomyia species are pollinators. Author's summary.

Soria, S. de J; Silva, P. (Divisão de Fitoparasitologia, Centro de Pesquisas do Cacau (CEPEC), Ilhéus, Bahia, Brazil.) **A polinização do cacaueiro na Bahia e algumas implicações do uso de inseticidas e outras práticas culturais.** (The pollination of cocoa in the State of Bahia and some implications of the use of insecticides and other cultural practices). Cacau Atualidades (Brazil). v. 11(1), pp. 15-20 (January 1974).

Cocoa in Bahia is mainly pollinated by the small fly Forcipomyia (Euforcipomyia). These flies live on decomposing organic material and are favoured by humid conditions. Excessive removal of fallen leaves and pods from the plantation, and the cutting of shade trees may seriously affect the breeding conditions of this insect. Trials with insecticides in cocoa plantations, using BHC 1·5%, parathion 1·5% and carbaryl 7·5% at a rate of 16 kg/ha, showed that the highest mortality of the pollinating flies was caused by BHC. Although the fly population rapidly re-establishes itself after treatment, repeated sprayings might cause a reduction of the population of this fly, and might affect the pollination of the cocoa. The life-cycle of the fly is discussed.

Lee, G. R. (Makanga Agricultural Experiment Station, Chiromo, Malawi.) **Irrigated Upper Amazon cacao in the Lower Shire Valley of Malawi. I — NPK factorial trial.** Tropical Agriculture (Trinidad and Tobago). v. 52(1), pp. 65-69 (January 1975).

In an irrigated NPK fertilizer trial on young Upper Amazon cocoa grown under light shade on rich alluvial fans, there was no significant response to the main effects of N, P and K in terms of weight of wet beans or number of pods per hectare, although N significantly increased the weight of wet beans per pod.

N applied in the absence of other nutrients significantly decreased the weight of wet beans and number of pods per hectare. N and K interacted to increase significantly the weight of wet beans per hectare above that obtained when these nutrients were applied separately. Significant increases in the weight of wet beans per hectare were obtained from P in the absence of K and from K in the absence of P. Author's summary.

Oni, S. A; Olayemi, J. K. (University of Ibadan, Ibadan, Nigeria). **Acreage response in a developing agriculture; a case study of Western Nigerian cocoa farmers.** African Studies Review, (USA). v. 17(2), pp. 381-395 (September 1974).

A review of the pertinent factors affecting the planting of cocoa is followed by a discussion of an acreage-response model which relates area planted to producer prices.

Odegbaro, O. A; Folarin, J. O. (Cocoa Research Inst. of Nigeria (CRIN), Ibadan, Nigeria). **Potential pod production and pod yields of F_3 Amazon cacao budded or grafted on shoots regenerated from coppiced Amelonado trees.** Turrialba (IICA). v. 24(3), pp. 256-646 (July 1974).

During a year, each month a number of old Amelonado cocoa trees were cut back and the regenerated shoots were either budded or grafted with F_3 Amazon scions or left to grow normally. Records of the number of flowers and young fruits as well as all mature pods harvested were taken every month for the first 3 years of productivity. The potential pod production and the actual pod yields are presented. The trees came into production 18 to 24 months after renovation. The budded and grafted F_3 Amazon trees started bearing earlier and yielded more pods than the Amelonado trees. The period of cutting back was found to significantly affect pod production and the results indicate the period October to December as the best time to renovate cocoa trees for best yields. The F_3 Amazon clones reached the pre-renovation level of production in the 2nd year. In the 3rd year the production of all the regenerated trees including Amelonado was higher than the pre-renovation level.

Friend D. (Department of Agriculture, Honiara, British Solomon Islands.) **Aspects of the cocoa weevil borer Pantorhytes biplagiatus Guer in the British Solomon Islands Protectorate.** Papua and New Guinea Agricultural Journal. (Papua New Guinea). v. 24(2), pp. 61-69 (September 1973).

In this treatise, 2 control methods are discussed and suggested as possible methods for the control of the cocoa weevil borer in the British Solomon Islands, viz. (1) the introduction of the ant Oecophylla smaragdina into cocoa farms for biological control; and (2) the planting of less susceptible cocoa varieties. Amelonado and progenies of clone Na 32 were found to be less susceptible to Pantorhytes damage than Trinitario.

Turner, P. D. (Harrisons Fleming Advisory Services, London, UK). **Diseases of oil palm, rubber and cocoa in North Sumatra; second report.** Strengthening Research on Rubber and Oil Palm in North Sumatra (Indonesia) UNDP/FAO Medan (Indonesia) no. 25, 29, pp. (April 1974).

A 2nd consultancy visit for pathology was made during the period 16 February to 16 March 1974 with the purpose to supplement information obtained during the 1st visit and to review developments in the light of recommendations made in the 1st report. Where necessary, this report gives additional recommendations. The report comments on the pathology programmes of the 3 research centres working in the 3 crops, viz. BPPM, MRS and RRC, and also recommends the production and dissemination of simple, well-illustrated technical leaflets giving information on the important diseases of rubber and oil palm.

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