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Editorial

This issue is late going to press so nine months have passed since the last issue was prepared. At that time the forecast of production and consumption for 1972 indicated a possible surplus of 160,000 tons and as a result prices were depressed. Since then the picture has changed dramatically which, incidentally, goes to show how difficult it is to forecast production accurately. Production in Nigeria and Brazil has fallen far short of expectations while the low prices in the latter part of 1971 have stimulated consumption to a greater extent than was anticipated.

It is the growth in consumption that is important for the future. Consumption was static from 1965-70 because production was also static, but when more cocoa became available in 1970 and 1971 consumption rose and there is no reason to believe that it could not continue to do so.

Are the producing countries in a position to supply more cocoa? In this issue two articles describe cocoa growing and research in Ghana. The research workers have many problems to tackle but can demonstrate how yields could be increased. On the other hand Professor La-Anyane's paper describes several factors – legal, economic and social–which tend to be forgotten but which are a severe handicap to better farming. These problems need tackling but some of them would be overcome if the farmers' price was increased. All the major producing countries in West Africa pay a fixed price to cocoa farmers but the Ghana cocoa farmer receives the least. A better price would be an incentive to the farmers and a factor in maintaining Ghana's position as the world's leading producer.

G. A. R. Wood

Review of Production and Consumption

September 1972

A. P. Williamson, Cadbury Schweppes Limited

Production

1971-72 world production is now estimated at approximately 1,533,000 tons, nearly 100,000 tons less than expected last Christmas.

The principal shortfalls have been in Nigeria where production was 50,000 tons less than last year and Bahia where the expected increase did not materialise and, indeed, because of the poor Temperao crop, production was down on last year.

Elsewhere the outturns were more in line with expectations. In Cameroon production was a little better than forecast, but in Spanish Guinea the political upheavals have left their mark on the cocoa industry and production is not expected to be more than 20,000 tons. In New Guinea the hoped for increase has not materialised and production is similar to 1970/71.

However, despite being much less than originally predicted, the 1971/72 total of 1,533,000 tons was still an all time record.

Consumption

It has become clear that world consumption has been increasing at a greater rate than expected. Total consumption in 1971 is now estimated at 1,416,000 tons, 20,000 tons more than the estimate given in our last Bulletin.

Consumption in 1972 is now expected to reach 1,528,000 tons, an increase of nearly 8 per cent on 1971. Most major consumers have increased their usage with perhaps the most significant being the U.S.S.R. and Eastern Europe, where a rise of 13 per cent is predicted.

Stocks

The nominal surplus in 1971 has been reduced to only 66,000 tons. After allowing for the usual 1 per cent losses, this is equivalent to an effective surplus of 51,000 tons and the carry-over of old crop cocoa into 1972 was under 300,000 tons.

The change in the 1972 supply and demand position has been dramatic. Whereas nine months ago we were looking for a very sizeable surplus it is now estimated that production and consumption will be in balance and the carry-over of old crop cocoa into 1973 will not reach 300,000 tons.

Prices

Month end prices for nearby Ghana shipment cocoa have been:

December	£190·0/ton
January	£220·0/ton
February	£219·5/ton
March	£234·0/ton
April	£230·0/ton
May	£250·0/ton
June	£260·0/ton
July	£272·0/ton
August	£301·0/ton

As it became apparent that world production was going to be much less than expected, prices started to rise from their December lows and except for one or two minor corrections they have been rising steadily ever since. By the end of August they had passed through the £300 per ton barrier as people realised that with consumption expanding there would have to be another record production in the coming crop year if world stocks were not going to be reduced.

International Cocoa Agreement

There was a further U.N. Cocoa Conference in Geneva early in March. Some progress was made on a number of the outstanding points but the major question of the minimum price was not settled and the Conference was adjourned. It reopened in September.

WORLD COCOA PRODUCTION AND GRINDING DATA

Reproduced from Gill & Duffus Market Report Dated August 1972

(Thousand long tons)

Production

	1969/70	1970/71	1971/2 (Forecast)
Africa	998	1,083	1,141
America	325	314	293
West Indies	59	41	55
Asia and Oceania	36	44	44
World Total	1,418	1,482	1,533
Principal Countries			
Ghana	409	386	455
Nigeria	219	303	248
Ivory Coast	178	177	219
Cameroon	108	110	125
Equatorial Guinea	25	32	20
Brazil	197	179	157
Ecuador	54	60	58
Dominican Republic	42	25	40
Venezuela	19	18	19
Colombia	19	21	22
Mexico	26	27	27
New Guinea	22	29	28

Grindings

	1970	1971	1972 (Forecast)
Western Europe	510	528	555
Eastern Europe and U.S.S.R.	188	210	238
North America	276	291	311
Australia and New Zealand	17	17	18
Central and South America	157	169	193
Asia	50	54	59
Africa	137	147	154
World Total	1,335	1,416	1,528
Principal Countries			
United States	261	275	294
Germany (Federal Republic)	124	131	137
Netherlands	113	119	122
United Kingdom	81	83	94
U.S.S.R.	100	108	130
France	39	41	41
NOMINAL BALANCE	+83	+66	+5

The Ghana Cocoa Industry

S. La-Anyane, Faculty of Agriculture, University of Ghana

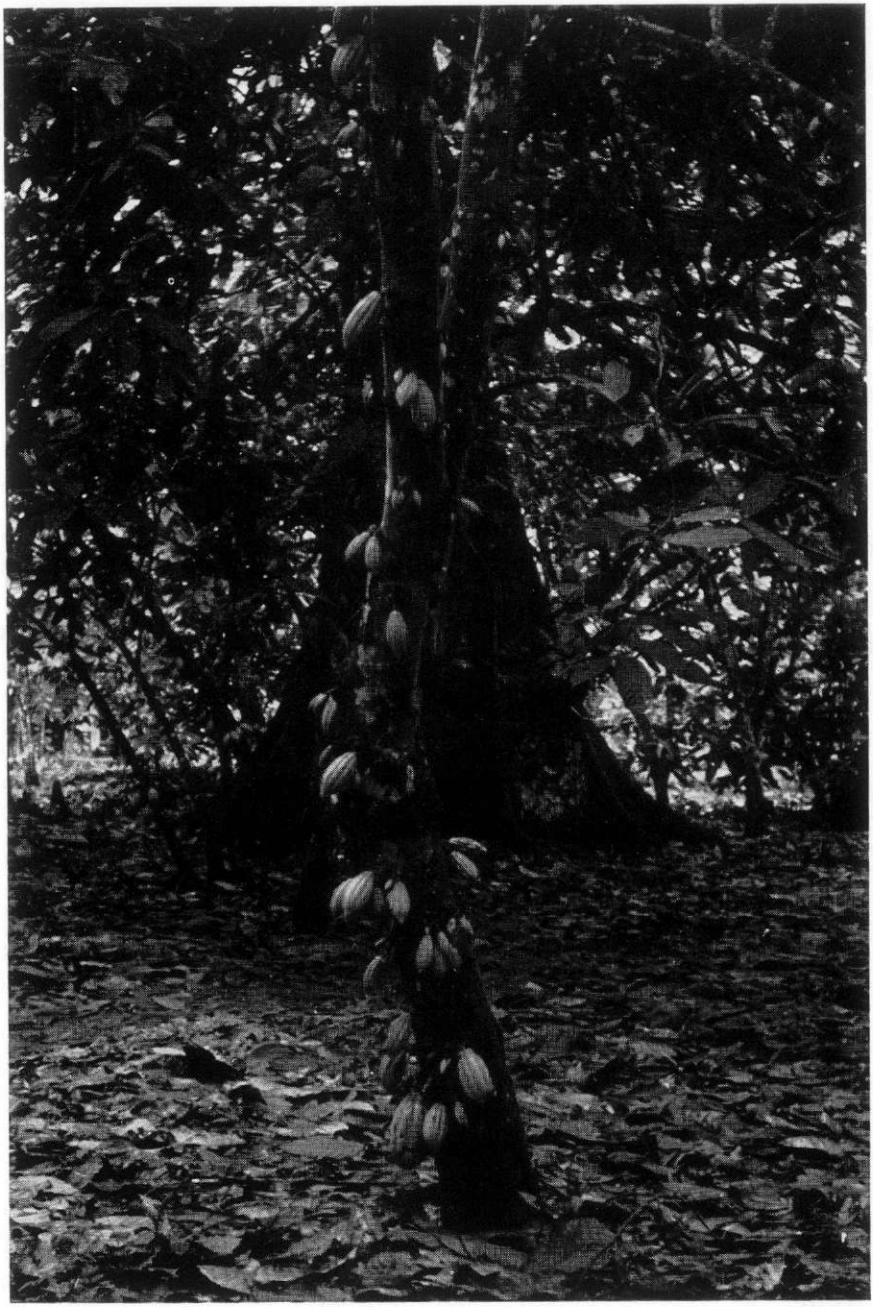
1. Introduction

Cocoa plays a crucial role in the Ghanaian economy. It accounts for about 66 per cent of the country's visible export earnings and provides a significant proportion of Government revenue.

The cocoa industry of Ghana developed from the introduction of a few Amelonado cocoa pods smuggled from Fernando Po in 1879 by Adja, an apprentice to Tetteh Quarshie, a local farmer and blacksmith. There had been earlier introductions as it is believed that cocoa seedlings were brought into the country for the first time before 1815 by the Dutch (2) and there is evidence that the Basel Mission grew cocoa introduced from the West Indies at mission stations between 1843 and 1866 (3). It was, however, through Tetteh Quarshie's initiative that the farmers' interest was aroused and the cocoa industry developed on a countrywide scale after 1879.

The initial plantings by Tetteh Quarshie were made at Mampong in the Akwapim district of the Eastern Region. Thence, production spread rapidly within the Region, to Ashanti, Western and Volta Regions and finally to Brong-Ahafo Region in the extreme north-west part of the forest belt of the country. Even though new varieties of cocoa have been introduced and have been widely planted since World War II, the bulk of the cocoa grown in Ghana remains the Amelonado type.

The first consignment of cocoa amounting to 121 lb. of beans was exported to Europe in 1885. The industry grew very rapidly from this initial export to the high level of 311,151 tons of cocoa beans exported in 1936. The low prices during the 30's slowed the rate of planting and this, coupled with the spread of swollen shoot and damage by capsids, lead to a period of stagnant production which lasted until well after the War. Then the rise in farmers' prices stimulated planting particularly in the West and North West of the Forest belt. This new planting together with widespread capsid control lead to a rapid increase in production at the end of the 50's. Cocoa exports increased from an average of 230,000 tons in the 1950's to about 430,000 tons in 1961. The substantial reduction in producer prices from 1963-66 coincided with a rising cost of living and labour shortages and this resulted in a steady decline in production in the second half of the 1960's. The current average production of cocoa is estimated at about 400,000 tons per year. The Table below shows the trend in production since World War II:



A Typical Cocoa Farm

Table 1

Cocoa Exports from Ghana 1940-70
(thousand long tons)

YEAR	BEANS	PRODUCTS
1940-44	191	—
1945-49	225	—
1950-54	232	6·6
1955-59	230	2·8
1960-64	383	16·7
1965-69	357	48·4

Sources: Economic Survey, Accra
Trade Reports

2. Production

Ghana is the world's major producer of cocoa. Between 1960 and 1966 it accounted for more than 36 per cent of world production.

It is estimated that the acreage under cocoa production in Ghana was about 4·5 million in 1968 (4). About half a million people farm this area, 60 per cent of whom are self-employed cocoa farmers; the rest are caretakers, family workers or labourers. This indicates that the cocoa industry is essentially run by those who own the cocoa farms with the help of other members of their families and labourers. Cocoa labour is to a large extent of a seasonal nature, much of which is migrant labour from the north and east of the country. A large number of farms are put in the care of "caretakers", and there is also a good deal of annual and piece-work labour.

Very little capital is employed in cocoa production in Ghana. Such capital items as are employed consist of sheds, handling and harvesting equipment, mats, sprayers and cutlasses. The most expensive equipment is the shed, and even this is a very simple structure. The rest of the capital items are insignificant.

The agronomic practices evolved by the farmers in the last century are those in general use in the cocoa industry today. The amount of work required to maintain cocoa farms is quite small. It was estimated in the 1940's that the maintenance of a bearing farm required only 25 mandays per acre per annum (1). Most farms are weeded twice a year. During this operation diseased pods, chupon growth and moribund branches from the lower jorquettes are removed at the same time and thinning is also carried out. The cocoa crop is harvested the year round, although there are two basic seasons, namely, a main crop and minor or mid-crop. The main crop starts in September, reaches a peak in November and continues until March. The mid-crop lasts from May to August, when the cocoa beans are smaller and have a slightly lower fat content. The two crops are interrelated, so that a heavy main crop, depending on favourable weather, is followed by a light minor crop.

As explained earlier, the pattern of production has changed considerably. The centre of the industry has shifted from the Eastern Region to Ashanti and Western Regions and recently to Brong Ahafo Region, which occupies the north-western part of the forest belt. Table 2 shows the regional distribution of cocoa production in the 1960's :

Table 2

Regional Distribution of Cocoa Production 1960/61 and 1968/69

(Thousand long tons)

REGION	1960/61		1968/69	
	Output	Percentage	Output	Percentage
Brong Ahafo	69	17·4	94	26·8
Ashanti	145	36·7	111	31·6
Western	20	5·0	23	6·5
Central	56	14·2	44	12·5
Eastern	78	19·6	63	18·0
Volta	28	7·1	16	4·6
Total	396	100·00	354	100·00

Source: Cocoa Marketing Board Newsletter, Nos. 22 and 44

While the Ashanti Region remains the leading area of production its proportion of Ghana production has been declining while the proportion from Brong Ahafo has been increasing. The shifts in production have also been responsible for changes in the demand for land, labour and capital for cocoa production in the various regions.

The decline in the production of cocoa from Ghana has been due to a number of factors, prominent among which are the limitations of the land tenure system, labour shortage, lack of credit facilities, low yields, inadequate road system, low producer prices paid to farmers, smuggling of cocoa, and the rapid rate of increase in the cost of living.

The prevailing labour systems, such as "abusa" and "abunu" by which the labourer receives one third and one half share of the crop respectively, tend to discourage expansion of agricultural production. Other problems are the difficulty of acquisition of land by strangers, the lack of security of tenure and the fragmentation of land resulting from the system of inheritance. In the absence of title to land, cocoa farmers have found it difficult to offer their holdings as collateral for credit but cocoa farmers have small holdings and small incomes and are chronically in need of credit.

The majority of the farmers are too old to cope with the work required to increase production. They are also unable to secure an adequate supply of labour to assist on the farm. There has been a steady drift of young labour from the rural to the urban areas, leaving the rural family unit much depleted in size and creating a labour shortage on the farms. In addition to this state of affairs, the departure of alien labour in 1970/71 created a serious shortage of labour which contributed to low output and high labour cost. This happened at a time when the producer price of cocoa was low and the cost of living relatively high.

The cost of living in Ghana has risen rapidly in the past decade. Taking 1958/59 as base year, the index of real income of the cocoa farmer in 1969/70 has been estimated to be 76·5 (5). The attraction of a better cocoa price in the neighbouring countries has thus encouraged the smuggling of cocoa across the borders of the country and reduced the size of Ghana's supply. Finally, the inadequate road system in the cocoa areas acts as a serious constraint on production.

Opening Cocoa Pods

3. Marketing

Efficient marketing encourages production. While the external marketing of Ghana's cocoa has been more efficiently organised, many problems are encountered in the organisation of internal marketing of the crop. The Ghana Cocoa Marketing Board has the sole right to organise the purchasing of cocoa from the farmers and the sale of Ghana's cocoa abroad. The Board does not buy cocoa directly from the farmers, but uses Licensed Buying Agents for the purpose. The farmer is paid a producer price which is fixed before the beginning of the season by the Board with the prior approval of the Government. This price is paid to the farmer at any buying station in the country irrespective of distance from the main ports. The farmer, however, bears the cost involved in headloading or transporting his cocoa from the farm or village to the buying station.

For several years, Ghana has sold its cocoa in Accra through the Cocoa Marketing Company (Ghana) Limited. In April 1972 this company announced its intention of transferring its marketing office to London.

There are three cocoa processing plants in the country which produce cocoa products for export. Table 1 shows that there was a steady expansion of exports of cocoa products between 1950 and 1970. The expansion of local processing would have an important effect on the external marketing of cocoa beans.

The level of effective supply of cocoa is determined in large measure by the price offered to the producer. The government's policy is one of stabilising producer prices within the country. The level at which this price has been held, however, deserves review. The level of taxation imposed on the Ghana Cocoa Marketing Board has also tended to stifle the Board's ability to develop a price stabilisation fund which will enable it to offer price incentives to farmers from time to time.

Price fluctuations both long and short term pose a serious problem for Ghana's finances. The fluctuations depend basically on the supply and demand situation but are also influenced by other factors. Price forecasting is not easy which makes the timing of sales abroad a difficult problem. It has become evident that the continued development of the cocoa industry in Ghana as in other countries will depend on the extent to which price fluctuations can be eliminated either by the joint efforts of the producing countries themselves or by an international agreement for the stabilisation of world cocoa prices. In both cases the success of a plan to stabilise cocoa prices will depend on the goodwill and co-operation of the countries involved in the cocoa industry.

4. Research and Extension

The Cocoa Research Institute of Ghana is the main organisation for research on cocoa in Ghana. It was first established as a research unit of the Gold Coast Department of Agriculture in 1938 and it was strengthened in 1944 to become the West African Cocoa Research Institute. It is now responsible to the Council for Scientific and Industrial Research. The Institute carries out research into all aspects of the cocoa crop. (The work of the Institute is described in another article.—EDITOR.)

A new area for research lies in the socio-economic aspects of the life of the cocoa producer. Such problems as population trends in the cocoa growing areas, factors which inhibit progress in the rural areas, land tenure arrangements and trends in rural family size and rural family planning are all relevant to a better

understanding of the cocoa industry of Ghana. Work on these questions is being undertaken at the University of Ghana.

Research *per se* is of little value, unless its results are effectively transmitted to the farmers who produce the crop. In Ghana, cocoa extension work is carried out by specially trained staff of the Ministry of Agriculture. The unit of operation is the district where the Ministry assigns specific areas to specialists responsible for cocoa disease and pest control. These officers also offer advice to farmers on varieties and husbandry practices. A number of cocoa stations have been developed with hostels for training farmers. The most important aspect of the Ministry's work has been the control of swollen shoot disease and capsid control. Another major activity has been the replanting of areas denuded of cocoa with correctly planted high yielding hybrid seedlings. In addition, a pilot rehabilitation project has been initiated in the Eastern Region of the country with IDA financial assistance involving some 90,000 acres and 5,000 farmers. The scheme has been designed to provide farmers with intensive technical assistance and credit facilities for the inputs they cannot easily afford.

Conclusion

The cocoa industry of Ghana faces a number of formidable problems which act as a brake on its expansion and development. Foremost amongst these problems are the establishment of an adequate level of producer price which will serve as an incentive for farmers to produce more; replanting denuded areas; swollen shoot disease and pest control; labour shortages and problems of land tenure and credit. When these problems are satisfactorily resolved, a prosperous cocoa industry could once again emerge in Ghana. The revival of a prosperous cocoa industry in Ghana would also depend on a favourable world demand for cocoa products strengthened by the expansion of consumption in other parts of the world beyond the traditional areas of the United States and Europe.

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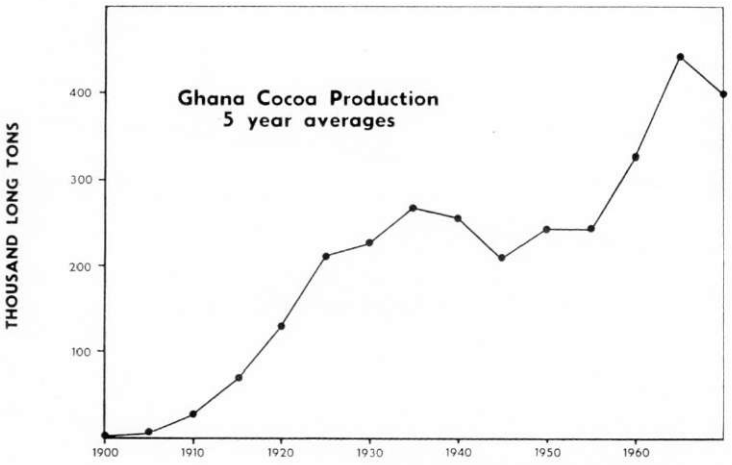
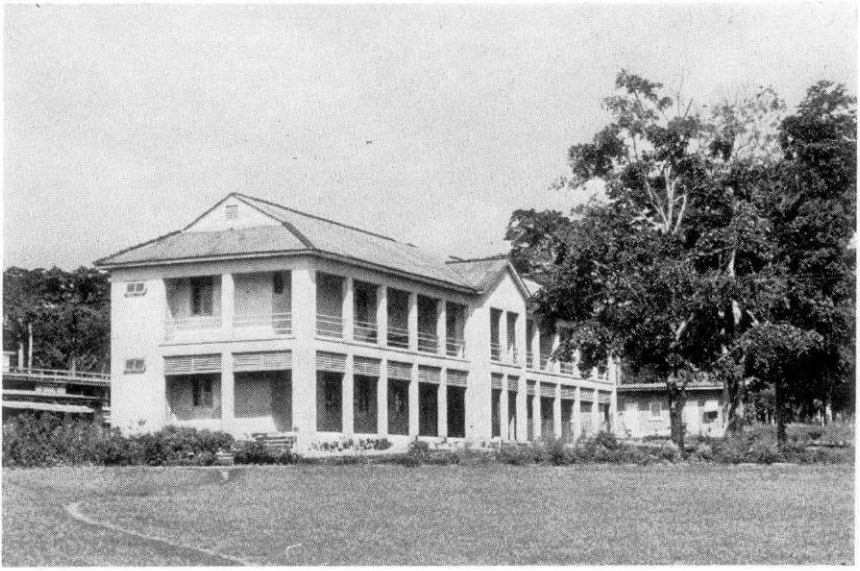


The Administration Block at Tafo



Cocoa Research in Ghana

E. J. A. Asomaning, Director, Cocoa Research Institute of Ghana, Tafo, Ghana

The Cocoa Research Institute at Tafo is responsible for research into all aspects of cocoa cultivation in Ghana. Founded originally in June 1937 as a branch of the Department of Agriculture, it was converted in 1944 into an inter-territorial organisation, the West African Cocoa Research Institute, and was charged with investigating and finding solutions to the decline of cocoa production in West Africa at that time. When the inter-territorial basis of its existence collapsed in 1962, it reverted to its original Ghanaian status and has continued to carry out its broad brief of finding cures to the problems plagueing cocoa production in Ghana. The major activities have been in the area of disease and pest control, breeding, agronomy and nutritional problems.

Diseases

(a) *The Swollen Shoot Virus:* Virus research has occupied a very prominent place in the activities of the Research Institute right from its inception. Prior to 1939, it was widely held that the swollen shoot disease was a consequence of inadequate shade leading to undue exposure of the trees. The recommended treatment then, as now, was the cutting-out of affected trees and the re-establishment in their place of new plantings. The provision of shade and windbreaks in the new plantings emphasized.

Following Posnette's demonstration of the virus nature of swollen shoot, research on the disease gained new impetus and involved detailed studies on the biology of mealybug vectors, modes of transmission and symptom expression, epidemiology, and alternative host plants.

Several isolates of the virus have been named according to the localities where they were first found. Of these isolates the New Juaben has been responsible for the greatest destruction of cocoa trees and consequently has received the closest attention.

Various mealybug species have been found to be capable of transmitting one or more of the cocoa viruses in Ghana but of these *Pseudococcoides njalensis* (Laing) appears to be the most important in the transmission of the New Juaben virus in nature. This mealybug has been used extensively and successfully for the laboratory transmission of the cocoa viruses, but this method has been replaced by mechanical transmission, which is now used almost exclusively in the greenhouse screening of vast numbers of seedlings in resistance and tolerance studies, thus permitting better standardization of method.

Amelonado cocoa, most widely grown in Ghana, has been shown to be more susceptible to the cocoa swollen shoot viruses than certain Trinitario and Upper Amazon selections. Seedling screening experiments have shown that parents of Nanay (Upper Amazon) origin perform well in many resistant crosses, with the inter-Nanay cross Na 33 x Na 34 showing up best.

The production of virus-resistant cocoa, i.e., cocoa that will be immune to primary infection is a long-term goal, but in it lies the best approach to

the swollen shoot menace. Within the present context of swollen shoot control, however, it is considered that virus-tolerant material can only be of limited value, or possibly a menace. The present system of controlling swollen shoot is based on limiting its spread from known outbreaks by the destruction of infected trees and their contacts followed by replanting. If such replanted material should be tolerant in the sense of being symptomless carriers of the disease, then such trees would serve as foci for further infection.

(b) *Black Pod Disease:* This disease is favoured by high humidity which encourages the rapid growth of the causative fungus *Phytophthora palmivora*. It occurs throughout the 4½ million acres in Ghana and may have been endemic in the country prior to the introduction of the crop. The parts of the plant most susceptible to attack are cotyledons, young shoots and leaves, roots, and all stages of the developing pod. It also produces cankers in the stem of mature trees and on flower cushions. Total crop loss due to this disease in Ghana has been estimated at *ca* 19 per cent but losses on individual farms will vary from farm to farm and from year to year. Total losses also correlate positively with total number of pods per acre, and shade increases the losses.

There is at present little conscious effort among Ghanaian farmers to control black pod. The Ministry of Agriculture recommends monthly harvesting during the crop season, but farmers do not heed this recommendation, because on their small holdings they allow the crop to build up to permit harvests adequate for proper fermentation. Recent work in Ghana with copper fungicides has shown that they provide a measure of control if applied early enough in the year (May-June) before the start of a black pod outbreak. Tin compounds are also being tried.

There is evidence of the existence of resistance to black pod in Ghana. Tests for resistance include a rapid method involving the use of four-day-old germinated beans which are inoculated before planting. By this method, high seedling mortality occurs among susceptible progenies before or shortly after development of the first flush leaves whilst the survival rate among resistant varieties remains high.

Clones which show resistance to pod infection in the field behave similarly with respect to resistance to root infection and the formation of canker. Resistance is therefore considered to be a systemic attribute of the whole plant and not just some of its parts.

There are also cases of apparent resistance involving plants whose fruiting periods fall outside the wet and humid seasons most favourable for black pod. But resistance, whether real or apparent, certainly appears to be heritable – a property which should be exploited in the future.

Plant Breeding and Selection

High yield and bean quality were the major considerations which guided the early attempts at cocoa breeding and selection in Ghana. The selection programme began in 1937 and was based on selected Amelonado trees on which yield records had been taken for a number of years previously. Local Trinitario hybrids became the next source of selection, but the range of genetic variability was greatly broadened by the introduction from Trinidad in 1944 of seed material from Pound's collection. The majority of these introductions were from

open-pollinated pods from the parent clones or seedlings, but about one-third were derived from controlled pollinations both within and between the different groups. These seedling progenies were also planted in progeny trials at Tafo. It became apparent very early in the Tafo breeding programme that the Upper Amazon types were far superior in many respects to the other types.

The now well-documented hybrid vigour resulting from crosses between certain Upper Amazon and local types including Amelonado formed the basis of the establishment of hybrid seed gardens. Hybrid varieties have been produced by crossing either two self-incompatible parents or one self-incompatible and a self-compatible parent and relying on the agency of natural pollination. Improved seed produced from seed gardens planted on cocoa stations of the Ministry of Agriculture have been available since 1964 for supply to farmers. Known as the Series II or "New Tafo" hybrids, these new varieties establish more easily than Amelonado, have precocious bearing characteristics, are high-yielding and possess all the necessary attributes of commercial acceptability. Although the Series II or "New Tafo" hybrids satisfy the various criteria for yield and quality, they have not been shown to be particularly resistant to swollen shoot and black pod diseases. The agronomic characters of many of the hybrids differ markedly from those of Amelonado and these pose problems in management to the farmer.

In addition to breeding for yield and quality, the present programme includes schemes for swollen shoot, black pod, and drought resistance. These studies will necessarily be long-term but initial results are promising.

Cocoa pollination studies in Ghana commenced after the discovery of self-incompatibility in some of the Upper Amazon varieties, and centred around identification of the pollinating agents. There has recently been renewed interest in pollination as a result of the unexpectedly low pod production observed in some seed gardens in spite of profuse flowering of the parent clones. Resort to hand pollination has given encouraging results, but the reasons for the failure of natural pollination are yet to be fully explained.

Apart from the breeding objectives already mentioned, some of the more important fields of study lie in the tailoring of varieties better to fit the Ghana cocoa farmer's system of cultivation and management. Although they may have high potential yielding capacity many of the newer varieties currently available cannot realise their potential when grown under the same management system used, and often used very successfully, for the traditional variety – Amelonado.

Characters of great importance to the local farmer are:

(a) ability of the variety to crop well at close spacings – to reduce the maintenance requirement in the early years after planting;

(b) low tree height maturity – to make harvesting easier;

(c) a high degree of tree-to-tree uniformity in size and in pod production – as the thinning out of unproductive trees is a practice unlikely to be adopted readily;

(d) a sharply peaked and late cropping pattern with few pods produced at other times of the year – to reduce the need for frequent harvesting and to avoid the main black pod epidemic period.

Pests

Capsids (or mirids) are the major pests of cocoa in Ghana and a large number of species have been described. Four species are commonly found associated with cocoa, of which *Distantiella theobroma* and *Sahlbergella singularis* do the most damage to cocoa.

Capsids produce lesions on the tissue (shoots and pods) on which they feed, eventually causing the death of those tissues. Shoots die off when they become ringed by lesions. It is known that fresh lesions are often invaded by the fungus *Calonectria rigidiuscula* thus further affecting tree vigour. Persistent capsid attack leads to a "blasting" of the tree with dead brown leaves left hanging. Capsid "pockets" develop when large groups of trees are attacked. Eventually the dead leaves drop, leaving bare dead twigs. Both mature cocoa and young seedlings are subject to attack, and capsid attacks have been known to prevent altogether the establishment of new farms.

Much research has gone into finding effective means of controlling capsids. Control measures considered have been both biological and insecticidal. Biological control measures have relied on the use of capsid predators and parasites but have not so far proved to be outstandingly successful. The capsid control programme in Ghana is at present entirely dependent on the use of insecticides.

The use of lindane was enormously successful in a determined, Government-subsidized campaign for countrywide capsid control, and may have been responsible for the large increases in cocoa production around 1960.

Failure of lindane to achieve control of capsids was first observed at a cocoa station in 1961. Further studies showed that resistance existed in large areas of the Eastern and Ashanti Regions of Ghana, a demonstration which led to an intensified search for alternative insecticides. Extensive testing of numerous candidate substitutes has shown that Baygon (arprocarb) and Azodrin (monocrotophos) are effective alternatives in areas where capsids have become resistant to lindane.

It has been of utmost importance in the assessment of insecticides for capsid control to aim for the following properties:—

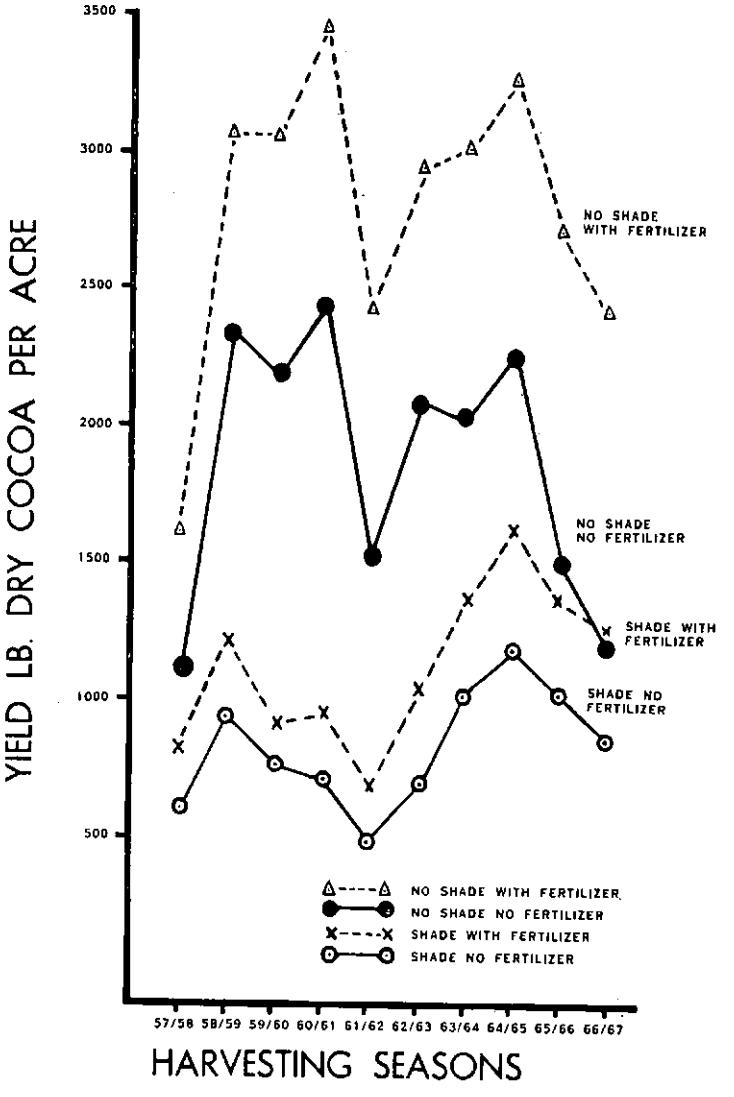
(a) High efficiency combined with low mammalian toxicity;
(b) Low persistence;
(c) The absence of taint and residues in cocoa and cocoa products.

The quest for these properties necessarily makes insecticide trials with a permanent tree crop like cocoa very time-consuming and delicate.

Heavy spraying with insecticides for capsid control has been shown to be associated with changes in the population of certain minor cocoa pests, for instance, a sharp rise in the incidence of the cocoa pod husk miner *Marmara* following spraying with dieldrin. The importance of this pest lies in the fact that larvae infest the epidermis of maturing cocoa pods and cause a browning of the pod surface making it difficult to determine when a pod is ripe. A very high population rise of the coreid *Pseudotheraptus devastans* was observed in plots which had been sprayed with Sevin. This insect is a pod feeder which causes pod malformations and abnormal development of beans within the pod; it disappeared when spraying with Sevin was stopped. Another pest whose population in cocoa farms has been rising rapidly is the pentatomid *Bathycoelia thalassina* which causes large

Figure 1

Yield (Lb. Dry Cocoa/Acre) Pattern showing pre-treatment and post-treatment of the shade and manurial experiment K1 over 10 seasons: 1957/58 to 1966/67 inclusive.



From Ahenkorah, Y. and Akrofi, G. S. (1969). "The status of an Amelonado shade and manurial experiment (K1) at Tafo." *Proc. 2nd Inter. Cocoa Res. Conf. Salvador, Brazil*, 1967, 325.

crop losses by inhibition of bean development and by inducing premature pod ripening.

It is anticipated that persistent and widespread application of broad spectrum insecticides for capsid control will exacerbate the problem of minor pests. The pest control programme will, therefore, seem to benefit from a thorough study of the total insect ecology within the cocoa farm. The aim of such a study will be to chart the course of predation among the cocoa insect fauna in order to achieve a more selective means of pest control.

Agronomy

Since 1956 research on shade management and fertilizers has proved outstandingly successful as a result of the availability of uniform cocoa consequent upon the development of improved methods of pest and disease control. It has been shown conclusively that in Ghana Amelonado cocoa responds favourably to reduced overhead shade and combined NPK Mg fertilizer application as shown in Fig. 1. Yield increases due to reduced shade and fertilizer application averaged 145 per cent and 45 per cent respectively over a ten-year period. Similar effects have been observed with Upper Amazon cocoa.

Many attempts have been made to correlate seasonal variations in climate with the behaviour of cocoa in terms of leaf production (flushing), flowering, pod production and pod losses through physiological wilting (cherelle wilt). Flushing is periodical and occurs in cycles of approximately 6 - 10 weeks throughout the year. It is promoted by adequate moisture, light and temperature.

A general correlation exists between flowering and rainfall and percentage cherelle wilt is decreased by less shade but accentuated when the production of young cherelles coincides with a major leaf flush.

Optimum planting density and spacing of cocoa, and possible competitive effects between cocoa and planted shade trees have been studied. For sustained high yields over long periods, spacings of $7\frac{1}{2}' \times 7\frac{1}{2}'$ for Amelonado and $10' \times 10'$ for Amazon are commonly adopted at Tafo. Farmers usually plant randomly at closer spacing, *ca* $4' \times 4'$. While this high planting density initially produces relatively high yields per acre, competition between plants becomes very intense as they mature and yields drop sharply as a result.

Rehabilitation

If it were possible for Ghana to initiate a fresh programme of cocoa production in new areas the research results already accumulated would be used to great advantage, but nearly all the suitable lands are already carrying cocoa. Convincing the farmer of the advantages of replacing existing low-yielding cocoa with more productive varieties is a difficult task but the Government has embarked on a project of cocoa rehabilitation in a section of the Eastern Region badly devastated by swollen shoot.

This is only the first phase of a general programme to rehabilitate cocoa throughout the areas where the crop is grown in Ghana.

Fourth International Cocoa Research Conference

The Fourth International Cocoa Research Conference was held in Trinidad, Tobago and Grenada in January 1972. The previous conferences in this series were held in Abidjan in 1965, Salvador in 1967 and Accra in 1969, and the proceedings of these three conferences have been published. The conference in Trinidad was attended by nearly 100 delegates from 23 countries; at least 85 papers were presented and the following notes give some of the more important points raised in them.

Breeding

The introduction of Amazon seeds from Trinidad to West Africa in 1944 was the first major advance in providing better planting material. As this introduction was limited in scope the Cocoa Research Institute of Nigeria embarked on a long programme of introductions from Trinidad of seeds and budwood. This programme, supported by UK manufacturers, started in 1962 and was completed in 1970; it involved the introduction of a large number of selections from the various Amazon populations: Nanay, Parinari, Iquitos and Scavina, together with the 'P' clones and other selections. As a result Nigeria has a very large collection of cocoa clones on which to base its breeding programme.

In Ghana the breeding programme produced a small number of selected hybrids, the seed of which is being produced in several large seed gardens. This programme ran into difficulties when the yield from the seed gardens proved to be less than 200 lb. per acre. This was due to competition between the two parents, one of which was usually outgrown and suppressed by the other. This led to little pollen being available and hence to low pod setting. In addition the pods were not produced at the right time of the year. These problems have been overcome by hand pollination coupled with removal of cherelles resulting from natural setting. Apart from giving a good yield of seed at the right time, it was found that pollination of many flowers at the same time leads to small losses from cherelle wilt.

The Trinidad Cocoa Board has been conducting a cocoa breeding programme which, by repeated crossing and selection, has produced progeny which yield well, have large beans and are resistant to witches' broom and Ceratostomella wilt. The Board is also making an attempt to grow cocoa very intensively by planting at $3' \times 3'$ without shade, allowing the plants to grow 6' before jorquetting, and fertilising heavily. By this means yields of 5000 lb. per acre are hoped for, while costs of maintenance will be low. This is an original approach which will be followed with interest.

Pound's expeditions to South America covered a small part of the Amazon basin but produced selections resistant to witches' broom thus fulfilling the principal object of his expeditions. In Ecuador these selections are no longer resistant to the disease so there is a clear need to explore other parts of the Amazon basin. With new oil discoveries in that area and deforestation proceeding rapidly, this needs to be tackled urgently.

Soils, Physiology, Agronomy

Recent studies of cocoa nutrition in Ghana have helped to clarify the factors involved. In early days poor results were obtained from fertilizer trials and this was due to heavy shade. The well-known shade and fertilizer trial on Amelonado cocoa made the relationship between shade and fertilizer clear but at the same time a high level of cropping seemed to lead to a short tree life.

Amazon cocoa has proved to be different from Amelonado in its nutrient requirements. The root system of Amazon cocoa tends to be restricted to the top few inches of the tap root. This leads to rapid growth of the young trees but to depletion of nutrient levels under mature cocoa; the level of K in the Amazon shade and fertiliser trial is being rapidly depleted. The nutrient requirement of different varieties of cocoa is being studied.

In a full review of the physiological responses of cocoa to environmental factors some new findings of flowering and pod development are set out. It was originally thought that temperature was an important factor influencing flowering but new evidence shows that temperature is less important than competition between fruit and flowers, in other words, a developing crop suppresses flowering. This factor and moisture level are put forward as the main factors affecting flowering. The rate of pod development varies according to mean temperature. The "safra" or main crop in Bahia takes longer to develop than the "temperao" crop which grows during warmer months.

In Nigeria a study of nutrient deficiencies showed that N deficiency was widespread in parts of Western Nigeria. There were no signs of P deficiency although in the factorial fertiliser trials on Amelonado cocoa in Western Nigeria application of P gave a significant response at several sites while N + P gave a response at certain sites. Significant results occurred three years after treatment started.

Studies on shade and fertilizer in New Guinea gave results which were similar to but less dramatic than those from such trials in West Africa. In addition it was found that frequent applications of small amounts of fertilizer were as effective as infrequent applications of much larger amounts.

Pathology

A large number of papers on black pod reflects the importance of this disease. Since the previous conference when recommendations for future research were put forward by Dr. P. H. Gregory, a committee to co-ordinate research on this disease has been formed and regional meetings of pathologists working in West Africa and the Americas have been held.

There are many possible sources of fungal spores and some work on this was reported.

Work in Cameroon has shown that in East Cameroon black pod infection rises from the foot of the tree up the trunk to the branches; in West Cameroon this is not so: the highest infection rate occurs in the middle of the trunk and is higher on the branches in the early crop.

In Nigeria the various reservoirs of *Phytophthora palmivora* have been studied. The possibility of soil infection is highest in the wet season; insects have been shown to play a part in disease transmission and application of a mixture of fungicides and insecticides is more effective than fungicides alone.

Despite this work the importance of the various sources of infection has not been evaluated. This will probably vary from one country to another but a method of evaluation is urgently needed.

It has been known for some time that *Fusarium* sp. is the cause of cushion gall disease. This has affected many plantings in the Americas causing a slow decline in yield. Another form of the fungus is *Calonectria rigidiuscula* which is involved in the die-back resulting from capsid attack in West Africa. Workers in California, who have studied the species of fungus, rank the *Fusarium* disease complex as "one of the three most important diseases of cocoa".

Entomology

In West Africa cocoa farms have their mosaic of ants in which one species is usually dominant, and this is influenced by shade and surrounding vegetation which affect nesting sites. *Oecophylla* and *Macromischoides* ants help to control capsids but are affected by insecticide sprays. *Crematogaster* ants are less affected by spraying because their nests are higher up but they do not control capsids and are involved in the spread of the swollen shoot virus. Spraying can therefore influence the ant population in a manner detrimental to cocoa. A control programme involving selective spraying is being studied.

Work in Cameroon on spraying methods has shown that ultra low volume spraying or fogging has economic advantages over normal low volume spraying.

Insecticide trials on the control of *Bathycoelia thalassina* have shown that heavy doses of insecticides, e.g., Gammalin/Baygon, Agrothion or Thiodan, are needed, so it is recommended that parasites and predators should be studied.

In the Solomon Islands the Pantorhytes beetle causes much damage and is proving difficult to control. As with capsids *Oecophylla* ants have a negative correlation with the beetle, but it is uncertain whether this can be employed in controlling the beetle.

Not much is known about the pollinating midges and any new work is welcome. In Brazil the population of these midges has been found to be highest in the wet season and lowest in the dry season when the cocoa trees are flowering; is it possible that the midge population is a factor limiting yields?

Processing

The tray method of fermentation has been tried in Venezuela and there it is recommended that the stacks of trays should hold three to five trays and that the beans should be stirred during fermentation which should last for five or six days according to variety. (These recommendations make the method unattractive, taking away the advantages of tall stacks which remain unstirred.)

In Bahia cocoa is usually dried artificially using traditional simple dryers. The whole subject is being studied and several new dryers employing new methods are being tried.

After the sessions at which the papers were presented, the delegates visited Tobago and then flew to Grenada where the closing session was held.

G. A. R. Wood.

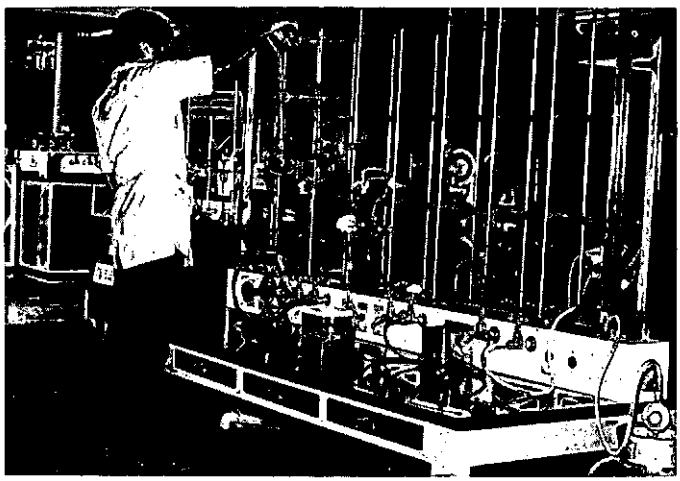
CEPEC, Brazil

The Centro de Pesquisas do Cacau (CEPEC) is the research department of CEPLAC, the commission whose duty is to develop the cocoa zone of Bahia, Brazil.

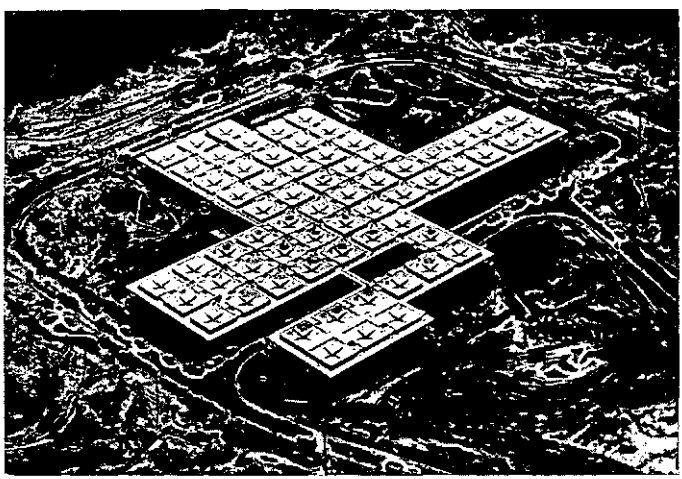
CEPEC was established in 1963 at a new research station near Itabuna in the heart of the cocoa zone. Since its inception the research work has been directed by Dr. Paulo de T. Alvim who has done much valuable research on the physiology of the cocoa tree.

In June of this year CEPEC opened its new laboratories which are illustrated here. We extend our best wishes to Dr. Alvim and his staff and intend to describe the cocoa zone of Bahia and the work of CEPEC and CEPLAC in a future issue.

G. A. R. Wood



The Plant Physiology Laboratory



New Laboratories of CEPEC at Itabuna

Notes on Contributors

E. J. A. Asomaning, B.Sc., M.Sc., Ph.D.

Graduated from Iowa State University with B.Sc. in 1956. Took postgraduate studies at Yale gaining M.Sc. in 1958 and Ph.D. in 1960.

Joined West African Cocoa Research Institute (now Cocoa Research Institute in Ghana) as a plant physiologist in 1960. Appointed Acting Director in 1965 and Director in 1969.

Basic research interests: mineral nutrition and growth physiology of cocoa.

S. La-Anyane

Born in Ghana on 12 June 1922. Educated at Mfantsipim and Achimota Schools in Ghana from 1935 to 1943; University of Reading (1944-46), B.Sc. (Agriculture); London School of Economics (1947-51) M.Sc. (Economics); Stanford University, U.S.A. (1963-65) M.A., Ph.D. Served in the Ghana Ministry of Agriculture as agricultural economist from 1952 to 1962. Joined University of Ghana in 1962 and is currently Professor of Agricultural Economics and Dean of the Faculty of Agriculture. His main field of study has been Agricultural Development and Agricultural Policy.

Cocoa Publications

Stocks of the following publications are available at Bournville:

Proceedings of Cocoa Conferences, London, 1948-1955.
Research reports, Trinidad: 1952, 1953, 1954, 1955-56, 1957-58, 1959-60.

Reports on cocoa growing in the following countries:

Brazil.
Venezuela, Colombia and Ecuador.
Dominican Republic, Mexico and Costa Rica.
Jamaica.
Sierra Leone.
Ivory Coast.
Uganda and Zanzibar.
India
Nyasaland (now Malawi).
North Borneo (now Sabah).

Cocoa Growing Costs.
Reprints of Papers on Fermentation and Drying.
Previous issues of the "Cocoa Growers' Bulletin".
The Samoan Cocoa Drier.

The quantities available are not large but while they last they will be despatched to any reader requesting them. Requests should be addressed to:—

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The Cocoa, Chocolate and Confectionery Alliance, who published the proceedings of the London Cocoa Conferences also has stocks of them including the last two conferences held in 1957 and 1961. Requests will be referred to them if necessary.

Cocoa Abstracts

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

December, 1971

Rourke, B. E. Ghana's contribution to year-to-year changes in world production of cocoa beans. Ghana J. Agr. Sci. 4, 1, p. 3-6 (1971).

Although Ghana provides only about 33 per cent of the world supply of cocoa beans, increased production of cocoa beans in Ghana has usually meant much lower world prices for this commodity. It is found that changes in Ghana's production of cocoa beans from year to year are closely associated with those of other W. African countries, but not with changes in Brazil's production. A large part of the variability in year-to-year changes in world production of cocoa beans is explained by changes in Ghana's production plus associated changes in the production of other countries. Author's summary. French summary. Tables. 7 refs.

Asomaning, E. J. A., et al. Physiological studies on an Amazon shade and fertilizer trial at the Cocoa Research Institute, Ghana. Ghana J. Agr. Sci. 4, 1, p. 47-64 (1971).

Various physiological aspects affecting the yields of Amazon cacao are discussed. Deshading and NPK fertilizers promoted flushing and significantly increased flower numbers of the trees. Most cherelles set on lightly-shaded, fertilized trees. Pod setting pattern was not reflected in that of mature pod production, the latter being largely altered by the cherelle wilt degree. Final yield was not related to the degree of flowering and setting, and was limited by the tree's nutritional condition. Shading and fertilizers reduced wilt by 10 and 2 per cent, respectively. Possible mechanisms of cherelle wilt are discussed. Seasonal patterns of physiological behaviour and climate are presented and the phenology of cacao is discussed in detail. French summary. Tables. Graphs. 28 refs.

Johnson, C. G., and Burge, G. A. Field-trials of anti-capsid insecticides on farmers' cocoa in Ghana, 1956-60. 2, Effects of different insecticides compared by counting capsids, and capsid-counting compared with counting the percentage of newly damaged trees. Ghana J. Agr. Sci. 4, 1, p. 33-8 (1971).

The capsids (*Sahlbergella singularis* and *Distantiella theobroma*), were counted on every tree in each plot and the numbers used to assess the effects of spraying. The average number of capsids per 100 trees assessed 2, 4 and 6 times after the second spraying, sufficiently indicated the initial effect of a "treatment". The average of five or six fortnightly counts did not improve the assessment commensurate with the extra labour involved. Counting newly damaged trees gave a slightly more reliable assessment than counting capsids. However, both methods gave similar results for assessing the initial effects of insecticides. From authors' summary. French summary. Tables. Graphs. 1 ref.

January, 1972

Piccinini, A. Il mercato mondiale del cacao. (The world cocoa market). Riv. Agr. Subtrop. Trop. 65, 1-3, p. 12-20 (1971).

General characteristics of the cocoa production, consumption and marketing situation in the world are reviewed and relevant figures are presented. The price fluctuation aspect is examined. The author pleads for price regulation by means of national marketing or stabilization boards in producing countries. English, French and Spanish summaries. Table. Graphs. 1 ref.

Bartley, B. G. D., and Chalmers, W. S. Cacao germplasm collection at the University of the West Indies. Plant Genetic Resourc. Newsletter 26, p. 2-4 (1971).

An outline is presented of the important cacao improvement work, in particular germplasm collection, conducted since 1930 in Trinidad by the Faculty of Agriculture of the University of the W. Indies. Both natural populations mainly from Latin America and selections within cultivated varieties were collected, many of which have shown to be important sources of superior genes for the development of new varieties. In 1969, a list of the stocks available for distribution was compiled containing approx. 750 entries and giving all known data on useful characteristics. Planting material may be supplied through intermediate quarantine facilities such as the U.S.D.A. Federal Experiment Station, Mayaguez, Puerto Rico and the Royal Botanic Gardens, Kew, Richmond, England.

Evans, H. C. Transmission of Phytophthora pod rot of cocoa by invertebrates Nature 232, 5309, p. 346-7 (1971).

Preliminary results of studies conducted in Ghana indicated that tent-building ants are mainly responsible for vertical pod rot disease transmission. Ants (*Crematogaster*, especially *C. striatula*) remove outer layers of healthy and diseased pods, left on the ground or hanging on the tree, to construct tents serving as shelter for scale insects which usually feed on the pod peduncle. Other ant species, mostly using soil in tent building, may also contribute to spreading *Phytophthora palmivora* to healthy pods. Available knowledge on the still unexplained horizontal dispersion of black pod rot is reviewed. Black pod rot may be controlled better by using an insecticide in addition to fungicidal treatment and by removal of diseased pods. 9 refs.

February 1972

Oni, S. A. (Dep. Agr. Econ. Ext., Univ. Ibadan, Nigeria). **The demand for Nigerian cocoa: a statistical analysis of regional markets and projections.** Nigerian J. Econ. Social Stud. 12, 1, p. 61-71 (1970).

A prototype econometric demand model was used in attempting to estimate the elasticities of demand for Nigerian cocoa in the U.K., the U.S.A., the Netherlands, W. Germany, Canada and Japan. The calculations indicated that: (1) there is an inelastic demand for cocoa in each of these countries; and (2) sugar is a substitute for cocoa in the U.K., W. Germany, Canada and Japan, but a complement in the U.S.A. and the Netherlands. Some cocoa demand projections were made on the basis of constant price assumptions. Demands in the U.S.A. and the U.K. are expected to decrease in the next decade; those of

the other markets will further expand (Japan, U.S.S.R., E. European countries) or substantially increase (W. Germany, the Netherlands). Tables. 11 refs.

Dyanat-Nejad, H. (Lab. Morphol., Fac. Sci., Orsay, France). **Correlations intervenant dans la morphogenèse de l'appareil souterrain du cacaoyer (Theobroma cacao L.).** (Relationships interfering in the morphogenesis of the cacao root system). Café, Cacao, Thé 15, 2, p. 105-14 1971).

The main findings and conclusions of basic studies recently conducted on the morphogenesis of the cacao root system are summarized. Attention was mainly given to three natural relationships that control growth, viz. (1) lengthening of the hypocotyl-radicle; (2) initiation, growth and determination of tropism of the lateral roots; and (3) variations in the number of bundles in the main and lateral roots. Cotyledons and taproot most markedly influence each other during initial growth. The root system is definitely determined within fifteen days after germination. English, German, and Spanish summaries. Figs. 24 refs.

Vello F., and Nascimento, I. F. (Div. Genética CEPEC, Itabuna, Brazil). **Influência da origem do pólen na produção do cacaueiro.** (Effect of the origin of the pollen on the yield of cacao). Rev. Theobroma 1, 1, p. 7-14 (1971).

Four groups of 25 cacao trees of the Catonga var. at Uruçuca, Brazil, were hand-pollinated with pollen from clones IMC 67, UF 677, UF 613 and ICS 6, respectively. All fruits resulting from open pollination were removed. The percentages of hand-pollinations resulting in fruit setting were 38·8, 21·6, 14·1 and 13·5, respectively. The differences between these figures were, however, considerably reduced by differences in the proportions of cherelles wilting; the percentages of hand-pollinations resulting in mature fruits were 15·1, 14·9, 11·7 and 10·2, respectively. English summary. Table 21 refs.

Molina Maggi. C. Estudios de las rehabilitaciones de plantaciones viejas de cacao en la zona de Barlovento. (Study of the rehabilitation of old cacao plantations in the Barlovento region). Cacao, Bol. Inform. 7, 1/2, p. 1-27, A1-12 (1970).

A study was made of the effects of a cacao replanting programme in the Barlovento region of Venezuela. Replanting was started on 89 farms in 1959-64; in 1968, it had been completed on 21 farms, was still under way on 33 farms, and had been discontinued in 35 cases. Detailed data are presented of 11 farms averaging 6·1 ha which in 1668 had been rejuvenated by planting improved seedlings on empty sites, and of 9 farms averaging 48·2 ha of which parts had been improved by planting rows of young cacao between the old trees. Average yields in 1968, when only 20 per cent of the young plants were productive, had risen to 216 kg/ha from a minimum of 136 kg/ha in 1964. Tables. 9 refs.

Miranda, Emo R. de, and Morais, F. I. (Div. Solos CEPEC, Brazil). **Situação de programa de adubação na região cacaueira da Bahia.** (Report on fertilizer programme in the cacao region of Bahia). Cacau Atualidades 7, 2, p. 5-8 (1970.

The Brazilian government seriously attempts to increase fertilizer consumption and to stimulate farmers to use fertilizers in a proper way. A fertilizer programme for the cacao region in Bahia was started in 1963. Initially, it involved assessment of soil nutrient deficiencies, conduct of pot experiments and field trials with, among others, attention to shade × fertilizer interaction. Based on the results, 5 different NPK-fertilizer mixture recommendations

became available. Fertilizer use by cacao farmers rapidly increased, especially since 1968. At present, approx. 80,000 ha or 21% of the total cacao area are fertilized. Tables. Graph. Map.

Friend, D. (Dala Exp. Stat., Malaita, Solomon Isl.). **Rat damage to cocoa in the Solomons.** S. Pac. Bull. 21, 1, p. 19-22 (1971).

Pod damage in cacao fields by rats is common in the Solomon Islands and very severe in isolated plantings. Observations conducted revealed that the presence of ants (*Oecophylla smaragdina*) in cacao plantings does not have any effect on rat populations and extent of pod damage. It was also found that field sanitation alone will not eliminate rat damage and so control (normally by poisoning) is unavoidable. It proved to be very economical to use a warfarin containing commercial bait in bamboo joints (38/ha) placed in the jorquettes of the cacao trees. Tables. Photos. 6 refs.

Smith, G. E., et al. (Div. Entomol. CEPEC, Itabuna, Brazil). **Competição de inseticidas no combate ao tripes do cacaueiro, Selenothrips rubrocinctus (Giard), no Espírito Santo, Brasil.** (Comparison of insecticides for the control of the cacao thrips in Espirito Santo, Brazil). Rev. Theobroma 1, 1, p. 15-21 (1971).

Trials conducted in Brazil compared the effects of 6 insecticides on thrips attacking leaves and fruits of cacao. Dusts containing 1.5% BHC, 4% malathion, or 5% DDT were applied at a rate of 18 kg/ha, sprays containing 0.4% malathion, phosalone or arprocarb at a rate of 80 l/ha. All these chemicals except phosalone were highly effective shortly after treatment, but only BHC and arprocarb gave satisfactory protection for 2 weeks. Mortality was higher in adult thrips than in larvae. English summary. Tables . 6 refs.

Opeke, L. K. (Cocoa Res. Inst., Ibadan, Nigeria). **Development of cocoa industry in Nigeria.** Proc. Agr. Soc. Nigeria 6, p. 13-8 (1969; received 1971).

The history of cacao cultivation in Nigeria is outlined. The main subjects discussed are: introduction of the crop into Nigeria, development of its production since 1930, the grave situation caused by various diseases, the swollen-shoot eradication campaign, control of *Phytophthora* and mirids, breeding for high yields and for resistance to diseases in connection with the replanting programme, improvement of processing methods, and marketing organizations. Tables. 15 refs.

Vello, F. (Div. Genética CEPEC, Brazil). **Cacauicultura baiana e suas perspectivas.** (The cacao culture of Bahia and its prospects). Cacau Atualidades 7, 2, p. 2-4 (1970).

Present area under cacao in Bahia, Brazil, amounts to 400,000 ha. The low yield level (450 kg/ha of dry beans) is put down to the fact, that plantings were established using inadequate techniques and inferior planting material, and were not properly maintained, and are over-aged. Experiments have shown that by shade reduction, use of fertilizers, crop protection practices, and drainage yields 5 times higher than the traditional average can be obtained. Possible average yield level for the regions as a whole is set at 1,200-1,500 kg/ha. As yet, the area has remained free from serious pests and diseases. However, yield losses due to *Phytophthora* pod rot average 15%; due to the low productivity of existing plantings, chemical control is not profitable.

Lotodé, R. (Rech. O.R.S.T.O.M., Sect. Biométrie I.F.C.C., Cameroun). **Possibilités d'amélioration de l'expérimentation sur cacaoyers.** (The possibilities of improving cacao experimentation). Café, Cacao, Thé 15, 2, p. 91-104 (1971).

Cards were used from the N'Koemvone Cacao Experimental Station in the Cameroon Rep., which recorded from 1950 until 1960, per tree data for a cacao collection in an attempt to improve certain aspects of cacao experimental field lay-out and data analysis techniques. Work done covered, among others, the following aspects: optimum plot size, field trial accuracy as related to lay-out, and the missing trees problem. A relation between trunk diameter at a given age and subsequent cumulative production was proved to exist. In determining plot size, in case border rows are not required, total randomization should be employed, tree by tree; when border rows are necessary, the number of trees should be limited to 12-25, depending on the conditions. English, German, and Spanish summaries. Tables. Graphs.

March, 1972

Soria, S. de J. (Dep. Ciencias Básicas, Univ. Nac. Colombia, Palmira, Colombia). **La periodicidad del cacao bajo condiciones climáticas del bosque tropical humedo en Turrialba y La Lola, Costa Rica.** (Periodicity of cacao under the climatic conditions of the wet tropical forest at Turrialba and La Lola, Costa Rica). Cacao Inst. Interamer. Ciencias Agr. 15, 4, p. 1-4 (1970).

The periodicity of growth in cacao is correlated with several climatic factors all dependent on the amount of incoming solar energy. In Costa Rica, the daily amount of incoming energy shows max. of 925 cal/cm^2 in July, and a secondary min. of 850 cal/cm^2 in Dec. Two periods of flushing correspond with periods of maximum incoming energy, the 2 periods of flowering lag 2 months behind. The number of flowers per tree was found to be linearly correlated with the amount of incoming energy 2 months beforehand. English summary. Graphs. 8 refs.

Cadima Z., A. Estudo do sistema radicular do cacaueiro em alguns tipos de solos da região cacaueira do Sul da Bahia. (Study of the root system of cacao in some soil types of the cacao belt in southern Bahia). Bol. Técn. Centro Pesquisas Cacau, Brasil 5, p. 1-28 (1970).

The structure and development of the root system of cacao are described from young seedlings grown in plastic bags and from older trees excavated in the field. Depth of rooting and distribution of the roots in the soil profile were studied in 5 soil types of different origin and texture occurring in the cacao-growing region of the Brazilian State of Bahia, and discussed in their relation to the physical and chemical properties of these soils. Tables. Photos. 9 refs.

Silva, L. F. da, and Miranda, E. R. de. (CEPEC, Itabuna, Brazil). **Capacidade produtiva de latossolos da região cacaueira baiana.** (Production capacity of latosols in the cacao zone of Bahia). Rev. Theobroma 1, 1, p. 37-44 (1971).

Cacao seedlings were planted in plastic bags containing 10 kg. of one of 4 types of latosols from the Bahia cacao belt in Brazil. The bags received no fertilizer, NPK fertilizers, providing 1 g N, 1,5 g P_2O_5 and 1 g K plus lime according to the acidity of the soil, or twice as much fertilizers and lime. Without fertilizer the growth of the cacao in the 4 soil types varied from very slow to fairly well, the

differences being connected with the nutrient contents of the soils. The single fertilizer dosage increased the plant size on all 4 soil types to the same level; doubling the dosage had little or no effect. The results indicate that more of the 1·5 million ha of latosols in the cacao belt should be used for growing crops. English summary. Tables. Graph. Photos. 8 refs.

Jiménez Sáenz, E., and Bonates, A. de Brito I. (CEPEC, Itabuna, Brazil). **Tolerancia del cacao (Theobroma cacao L.) al nematicida 1,2 dibroma-3-chloropropane.** (Tolerance of cacao to the nematicide 1,2-dibromo-3-chloropropane). Rev.Theobroma 1, 1, p. 30-6 (1971).

At Itabuna, Brazil, cacao seeds were found to germinate normally in emulsions of Nemagon-75 containing up to 300 ppm of the active ingredient; concentrations of 1,500 and 3,000 ppm a.i. retarded seedling growth, but were not lethal. No adverse effects on germination or growth were observed when seeds were planted in soil treated 8 days beforehand with the nematicide at a rate of 0·25 g a.i./kg, and when up to 4·5 g a.i. per tree was injected around the trunks of young cacao trees in the yield. English summary. Table. Photos. 3 refs.

Rocha, H. M., and Ram, C. (CEPEC, Itabuna, Brazil). **Cancro em cacaueiros na Bahia.** (Canker in cacao fields in Bahia). Rev. Theobroma 1, 1, p. 44-7 (1971).

Canker of cacao caused by *Phytophthora* has always been a rare occurrence in Brazil until 1970, when serious outbreaks were observed in various areas of the State of Bahia. The outbreaks are ascribed to a long period of exceptionally humid weather conditions. Symptoms of cacao canker are described; it is recommended to treat the surviving trees by excision of diseased bark tissue and treatment with 0·5% sodium hypochlorite, while pruning utensils should be disinfected. The canker was found to be due to the same strain of *Ph. palmivora* that is also responsible for pod rot in the region. Photo. 8 refs.

Jorgensen, H. Monilia pod rot of cacao in Ecuador. Cacao Inst. Interamer. Ciencias Agr. 15, 4, p. 4-13 (1970).

The information gathered about the cacao disease caused by *Monilia roreri* is reviewed on the basis of the literature. Successive sections discuss: the discovery of the disease, its spread, and its impact on the cacao production in Ecuador; symptoms of the disease; research on its aetiology and related subjects; and research on its control. An economic method of control has not yet been found; spraying with zineb may considerably reduce pod losses, but certainly does not pay in older fields and probably not in younger plantations. Spanish summary. Tables. 39 refs.

Alvim, P. de T., and Seeschaaf, K. W. (CEPEC, Itabuna, Brazil). **Morte de cacaueiros causada por uma nova espécie de árvore parasitária.** (Death of cacao caused by a new species of parasitic tree). Rev. Theobroma 1, 1, p. 22-9 (1971).

In 1938, Reis reported that a certain tree occurring in eastern Brazil caused the death of adjacent cacao trees; the effect was ascribed to root excretions. The noxious tree was recently described by Barroso as *Acanthosyris paulo-alvinii* sp.n. (fam. *Santalaceae*). Investigations by the authors of this paper showed that it is a true parasite, its roots making contact with those of cacao by means of haustoria. English summary. Table. Figs. Photos. 2 refs.

Nguyen Ban, J. (Lab. Entomol., I.F.C.C., Ivory Coast). **Progrès récents dans al lutte chimique contre les mirides du cacaoyer.** (Recent progress with chemical control of cacao capsids). Café, Cacao, Thé 15, 2, p. 129-34 (1971).

In the Ivory Coast, capsid pests in cacao commonly are controlled by insecticidal mist spraying. Portable equipment with a 4-mm diameter atomizing nozzle consumes 80 l water to cover 1 ha of adult productive cacao. Experiments were conducted with different insecticides using metal atomizing nozzles of 2·2 and 3·8 mm diameter. In particular with lindane 20, capsid mortality at spraying volumes of 40 and 60 l/ha was equal to that usually obtained at a 80-l water volume. Current treatment methods are likely to be replaced by low-volume atomizing using oily solutions as the carrier. Treatment with 3 to 4 l of formulation/ha without addition of water, however, is too costly. English, German and Spanish summaries. Tables. Photos. 5 refs.

Lavabre, E.-M. (Serve. Défense Cultures I.F.C.C., Paris, France). **Première-observations sur les traitements anti-mirides appliqués sous un volume extrêmement réduit (ULV).** (Preliminary results of ultra-low-volume spraying against capsids). Café, Cacao, Thé 15, 2, p. 135-42 (1971).

Series of experiments conducted so far in the Ivory Coast on uniform plots showed that the ultra-low-volume (ULV) spraying technique (2 l spray volume/ha) is effective, in particular with endosulfan and Nuvacron, in the control of cacao capsids (*Sahlbergella* and *Distantiella* spp.). In view of the increased risks for the operator, rearward spraying with the nozzle pointing in the direction opposite to the movement of the operator and use of a ventilator-guard and a rather larger diameter of the atomizing nozzle are required. English, German, and Spanish summaries. Tables. Fig. Photo.

April, 1972

Barroco, H. E. Pontos de convergência da comercialização do cacau em grãos na região caceueira do sul da Bahia. (Convergence points for the cocoa bean trade in the cacao belt of southern Bahia). Bol. Técn. Centro Pesquisas Cacau, Brasil 4, p. 1-51 (1970).

This paper analyses the flow of processed cocoa beans from the producer in the cacao belt of southern Bahia, Brazil, to the ports. It contains data on the production of cocoa in the various districts of the area during the period 1966-69, centres of collection, transport by pack animals and roads, exporting firms and their relative importance, and export volumes of the ports. Over 60% of the area still depends on pack animals for transport to the nearest town. The port of Ilhéus exports 88% of the total volume, followed by Salvador with 6% Appendixes. Tables, Figs. Map. 7 refs.

Santana, B. M., et al. Nivel nutricional dos solos da região cacaueira de Bahia. (Nutritional level of the soils in the cacao belt of Bahia). Bol. Técn. Centro Pesquisas Cacau, Brasil 6, p. 1-24 (1970).

Maps of a 24·5 × 11·25 km zone in the southern part of the State of Bahia, Brazil, including almost the whole cacao area of that region, show its physiography, geology, geomorphology, natural vegetation, and the origin, fertility and agricultural use of its soils. For each of the 3 zones of the cacao belt proper,

maps, graphs and tables indicate the fertility level and nutrient contents of the main soil types. In general these soils are fairly rich in Ca, Mg and K but poor in P, while the pH varies from below 5 to slightly below 7. Appendix. Tables. Maps (one coloured). 15 refs.

Toxopeus, H. (Stichting voor Plantenveredeling (SVP, Wageningen, the Netherlands). **Cacao-populaties, hun verspreiding en het optreden van heterosis.** (Cacao populations, their spread and the occurrence of heterosis). Landbouwk. T. 83, 10, p. 425-9 (1971).

Plantings of criollo cacao in Asia and of amelonado cacao in Brazil and W. Africa originated from limited amounts of planting material brought over from wild or semi-wild populations in Central America and the Amazon Basin. This will at least partly explain why hybrid populations of the 2 types exhibited strong heterotic effects. Such hybrids arose in the Caribbean in the 18th century (trinitario), in Java around 1900 (Djatiroenggo hybrid), and more recently in Fernando Po, Mexico and Nigeria. Another population showing heterosis resulted from crossing amelonado with Upper Amazon cacao in the W. Indies and W. Africa. Cacao breeding programmes should aim at obtaining heterotic effects. English summary. Table. Graphs. Maps. 12 refs..

Lockwood, G. (Cocoa Res. Ist., (C.S.I.R.), P.O. Box 8, Tafo, Ghana). **Early results from a trial of Upper Amazon cocoa clones in Ghana.** Exp. Agr. 7, 4, p. 321-7 (1971).

Yields in a trial of Upper Amazon cacao clones, derived from high-yielding Upper Amazon selections, were low in the early years. One Upper Amazon clone was significantly higher yielding than any other clone, but generally yields from the Upper Amazon were comparable to those of local Trinitario selections included as controls. The Upper Amazon clones were highly variable in establishment, yield and losses from diseases. The relationship between the performance of some of the clones and their parent seedlings is discussed. Author's summary. Tables. Fig. 21 refs.

Vello, F., and Garcia, J. Reis. (Div. Genética CEPEC, Caixa Postal 7, Itabuna, Bahia, Brasil). **Caracteristicas das principais variedades de cacau cultivadas na Bahia.** (Characteristics of the main cacao varieties grown in Bahia). Rev. Theobroma 1, 2, p. 3-10 (1971).

The introduction of various cacao types from the Amazon Basin into the State of Bahia is discussed. On the basis of pod characters the authors distinguish the var. Comum, Pará (with the forms Pará and Parazinho), and Maranhão (with the forms Liso, Rugoso and Gigante). Observations of 10 trees, all over 60 years old, of each of these forms during 3 years indicated that the Maranhão forms are more susceptible to *Phytophthora* than the var. Pará and Comum, and that Maranhão Rugosa is more productive than all other forms. Some biometric characteristics of the pods are compared. English summary. Tables. 10 refs.

Atanda, O. A., and Jacob, V. J. (Cocoa Res. Inst. Nigeria, Ibadan, Nigeria). **"Bean" germination studies in Theobroma cacao L.** Cacao Inst. Interamer. Ciencias Agr. 15, 4, p. 13-8 (1970).

The percentage and velocity of germination of seeds from amelonado and F_3

Amazon cacao were investigated in Nigeria, first in a pilot experiment conducted in 1965 and subsequently in weekly sowings performed from April 1966 to March 1968. Peeled seeds germinated more rapidly and showed a higher germination percentage than unpeeled seeds. Amelonado seeds had a lower germination percentage than Amazon seeds owing to their thicker seed coat. Weathered sawdust was a better medium than forest top soil. Seasonal effects on germination were rather strong in each separate year but weak in the 3-year monthly means. The findings indicate the desirability of standardizing germination tests for cacao. Spanish summary. Tables. Graphs. 13 refs.

Capot, J. (Inst. Franç, Café Cacao, Bingerville, Ivory Coast). **Le désherbage chimique des cacaoyères en Côte d'Ivoire.** (Chemical weed control in cacao plantations in the Ivory Coast). (Contributions au) Symposium sur le désherbage des cultures tropicales, Antibes, 7-8 septembre 1971, 6 p. (1971).

The main weeds in cacao plantations in the Ivory Coast are mentioned, such as *Paspalum conjugatum*, *Eleusine indica*, *Sporobolus pyramidalis* and *Digitaria adscendens*. Paraquat at 1·5-1·8 l commercial product (c.p.) ha + wetting agent gave effective control. Promising results were obtained also with MSMA at 2·5-3·1 c.p./ha. The economic aspects are discussed. Tables.

Recommended methods for the detection and measurement of resistance of agricultural pests to pesticides. Tentative method for nymphs of cocoa mirids (Distantiella theobroma Dist. and Sahlbergella singularis Hagl.) - FAO Method No. 9. FAO Plant Prot. Bull. 19, 3, p. 62-5 (1971).

Nymphal mirids at 4th and 5th instars of the cacao capsids are collected. They are confined in groups of 10 on to filter papers impregnated with an insecticide. The percentage of knockdown is plotted against time on logarithmic probability paper, so that LT 50 and LT 90 values can be estimated. Baseline data for various insecticides are thus established for susceptible strains. It is then possible to select discriminating exposure periods which can be used to screen samples of mirids for resistance. From English summary. Table. Fig.

May, 1972

Silva, L. F. da, and Carvalho, R. Filho. (Setor, Pedologia Div. Solos CEPEC, Caixa Postal 7, Itabuna, Bahia, Brazil). **Classes de solos para cacau na Bahia, Brasil.** (Soil classes for cacao in Bahia, Brazil). Rev. Theobroma 1, 2, p. 39-54 (1971).

Soils can be classified according to their suitability for cacao on the basis of the degree to which a soil deviates from the ideal cacao soil with respect to chemical fertility, liability to water deficiency, liability to excess moisture, and mineral reserve. Among these 4 factors, liability to moisture deficiency is by far the most important. Soil maps of the cacao-growing region in the Brazilian State of Bahia now distinguish 32 soil units; a table shows the percentages of the area of each unit that is occupied by each of the 4 soil classes, viz., soils excellently, well, moderately, and not suitable for cacao growing. English summary. Tables. Photos. 16 refs.

Chalmers, W. S. Collecting expedition in the Oriente region of Ecuador. Ann. Rep. Cacao Res. 1970, p. 34-7 (1970).

Like in 1968 and 1969, an expedition was sent to eastern Ecuador in 1970 to collect seeds and budwood of cacao trees for the germ-plasm collections in

Trinidad, at Pichilingue in Ecuador, and at Mayaguez in Puerto Rico. In all, 108 trees have been selected on the basis of low witches broom infection and other characters. The 63 trees of which material was examined in 1970, resulting in the selection of 34 trees, all pertained to the Amazon Forastero type with green pods; a surprising finding was that at some locations a very high proportion of these trees had seeds with white cotyledons. Tables.

Bartley, B. G. D., and Chalmers, W. S. Las Hermanas progeny trials. Ann. Rep. Cacao Res. 1970, p. 7-27 (1970).

Yields of the cacao progeny trials at Las Hermanas Estate, Trinidad, in 1969/70 were much higher than in the preceding year. Those of the 5 trials established in 1958-64, in which clonal crosses are compared, confirmed the outstanding quality of SCA 6 as a parent clone. Its highest-yielding progenies in trials 1 and 2 reached a level of almost 3 tons of dry beans per ha at the ages of 12 and 9 years, respectively, or 2·5 times as much as the yield of the standard clone ICS 95. SCA 6 × trinitario hybrid progenies have a low incidence of witches broom disease, but are not immune, and resistance to the disease appears to decline with increasing age. A drawback of SCA 6 is that most of its progenies have small pods. Tables. Graph.

Miranda, E. Ruy de, and Morais, F. Ilton de O. (Setor Fertilidade Div. Solos CEPEC, Caixa Postal, 7, Itabuna, Bahia, Brazil). **Efeitos da combinação de diferentes fontes de nitrogénio e potássio no desenvolvimento de plântulas de cacau.** (Effects of the combination of different N and P sources on the development of young cacao plants). Rev, Theobroma 1, 2, p. 29-38 (1971).

Cacao seedlings were grown for 9 months in a poor acid soil from the Bahia, Brazil, cacao belt. The main treatments were: no fertilizers, and NPK fertilizers; sub-treatments were: no liming, and application of ground dolomitic limestone. P was applied in the form of triple superphosphate, N as urea or ammonium sulphate, K as chloride or sulphate. Both liming and NPK fertilizers improved the growth of the cacao. In unlimed soil the best NK fertilizer combination was urea plus K_2SO_4, whereas the best results in combination with liming were obtained from urea plus KCl and ammonium sulphate plus K_2SO_4. English summary. Tables. 28 refs.

Miranda, E. R. de, et al. Respostas à adubação em algumas unidades de sollos da região cacaueira de Bahia. (Responses to fertilizers on some soil units in the Bahia cacao belt). Bol. Técn. Centro Pesquisas Cacau, Brasil 7, p. 1-25 (1971).

A series of 21 uniform shade removal × fertilizer trials with cacao have been conducted on various soil types in southern Bahia, Brazil. Results over 5 years showed that removal of shade increased the yields, and that fertilizer applications were much more beneficial in unshaded plots than in plots with shade trees. The size of these effects depended on the soil type. For the time being, removal of shade trees is not recommended, because of the risks of excessive weed growth and drying-out of the soil, in particular in fields with wide spacing or open patches. English summary. Tables. Graphs. 20 refs.

Santana, M. B. M., et al. (Setor Fertilidade Div. Solos CEPEC, Caixa Postal 7, Itabuna, Bahia, Brazil). **Efeitos da incorporação de doses crescentes de calcario em alguns solos da região cacaueira da Bahia.** (Effects of incorporating increasing amounts of lime in some soils of the Bahia cacao belt). Rev. Theobroma 1, 2, p. 17-28 (1971).

Different amounts of ground dolomitic limestone and uniform amounts of NPK fertilizers were applied to containers filled with 5 acid soils from the Bahia, Brazil, cacao belt, and cacao seedlings were grown in them for 6 months. The effect of lime on the pH of the soils was inversely related to their buffering capacity; in all soils the pH decreased again during at least 120 days after liming. Liming also increased the soil contents of exchangeable Ca and Mg, and reduced the exchangeable Al content in the single soil in which this was appreciable. The growth of the cacao was improved by liming in the 3 soils with the highest buffering capacity. English summary. Tables, Graphs. 24 refs.

Espinoza, A. S., and Delgado, J. C. (Dep. Fitopatló. Estac. Exp. Trop. "Pichilingue", Quevedo, Los Ríos, Ecuador). **Factores intrinsecos que influyen en la eficacia de la prueba de laboratoria usada para evaluar la resistencia a Ceratocystis fimbriata en cacao.** (Intrinsic factors influencing the effectiveness of laboratory trials to evaluate resistance of cacao to *Ceratocystis fimbriata*). Turrialba, Rev. Interamer. Ciencais Agr. 21, 1, p. 13-7 (1971).

In Ecuador, the influence of different inoculation methods was studied to evaluate resistance of cacao varieties to *Ceratocystis fimbriata*. A reduced growth of the fungus was found when sections of chupons, even of susceptible clones were inoculated. Variations in the growth were reduced when sections of fan branches were inoculated, and for this reason, they should be used in the laboratory tests. Also the age of the colonies used for inoculation had considerable influence on the fungus growth, probably due to reduction in spore viability after 30 days. English summary. Tables. 19 refs.

Friend, D., and Brown, J. F. (Dep. Agr., British Solomon Isl. Protectorate). **The incidence and importance of diseases of cacao in the British Solomon Islands Protectorate.** Plant Disease Reporter, USDA 55, 10, p. 885-8 (1971).

Results of detailed field observations and surveys of the incidence and relative importance of various diseases of Trinitario cacao are discussed. Black pod caused by the fungus *Phytophthora palmivora*, was the most dominant disease and caused annual pod losses varying from 12.85% (1968) to 26.4% (1969). No other pod disease was observed. Canker was widespread throughout the islands and the disease incidence increased from $< 1\%$ in 1967 to 3% in 1971. The disease incidence on living trees varied among farms surveyed and ranged from 1.3 to 16.3%. In 1 plantation, the disease caused the death of 38.5% of the trees. Pink disease (*Corticum salmonicolor*) and the thread blights (*Marasmius* spp.) were less important than black pod and canker diseases. Tables. 8 refs.

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