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Cadbury Limited
Bournville

Editorial

Cocoa Production

During the past 15 years cocoa production has risen from 1·15 m. tonnes to 1·5 m. tonnes, an increase of about 30%. The bulk of this increase has come from Brazil and the Ivory Coast which have risen by 100,000 tonnes and 120,000 tonnes respectively. There have also been increases from Cameroon, Nigeria and Ecuador together with smaller but significant increases from Malaysia and Papua New Guinea.

These seven countries, which aggregate about 900,000 tonnes, have increased their production. Another 25 countries listed in Gill & Duffus statistics have either declined or remained static. The most significant country in this group is Ghana which has shown a slight decline during the past 15 years.

This is not the occasion to examine the reasons for the poor performance of so many countries but to look at future possibilities. How much more can we expect from the seven countries mentioned above?

Production in Brazil was dealt with in detail in our last issue from which it was clear that extra production in the near future would have to come from rehabilitation of old farms in Bahia although new plantings in other areas may add to production at a later date. Presumably the law of diminishing returns applies to this exercise so that further increases may prove to be limited.

Ivory Coast, which we hope to deal with in a future issue, has plenty of land to develop in the west of the country, but the rainfall increases to the west so that conditions become less favourable for cocoa. Nevertheless the Government has expressed the intention of making Ivory Coast the leading producer.

It is more difficult to forecast future trends in Cameroon, Nigeria and Ecuador. In all these countries the land suitable for cocoa has been largely exploited. Therefore increases must come from higher yields and it is difficult to judge the likely effect of extension programmes designed to effect this.

The only bright prospect elsewhere is Malaysia. Currently producing only 15,000 tonnes, it will undoubtedly grow rapidly and should reach 30–40,000 tonnes by 1980.

All in all the prospects for increased production appear modest and it is difficult to share the optimism of the International Cocoa Organisation which has forecast production of 1·79 m. tonnes in 1979/80 and 2·3 m. tonnes in 1984/85.

Extra production must come increasingly from higher yields as areas of forest on suitable land are rapidly shrinking. Higher yields can result from planting new varieties, reduction of shade, use of fertilisers or more effective control of pests and diseases, and there is much advice on these techniques that could be applied. There are, however, problems – quite substantial problems – in passing on this advice to large numbers of smallholders. These problems will have to be overcome if the cocoa growers of West Africa and elsewhere are to achieve a rising standing of living.

G. A. R. Wood

Review of Production and Consumption

April 1976

A. B. Cook, Cadbury Schweppes Limited

Production

The latest Gill & Duffus forecast of 1975/76 production predicts a world total of 1,511,000 metric tons, which is 33,000 metric tons down on the estimated 1974/75 figure of 1,544,000 metric tons, but still substantially up on the final 1972/73 and 1973/74 figures of 1,398,000 and 1,446,000 metric tons respectively.

The principal change from last season is in Brazil. The main crop has reached approximately 1·93 million bags, the second highest on record, compared with last year's 1·6 million bags. A good outturn of 1·92 million bags is forecast for the coming temporao crop, but this is still a long way below last year's record of 2·63 million bags. Consequently the total for the year is expected to be 3·85 million bags, approximately 0·4 million bags or 24,000 metric tons below last year's record level.

In West Africa small increases in Ghana and Nigeria are expected to be offset by decreases in Ivory Coast and Cameroon.

Consumption

World consumption in 1976 is forecast by Gill & Duffus at 1,506,000 metric tons. This would be 64,000 metric tons above the 1975 estimate and 30,000 metric tons above the 1974 figure.

However, it needs to be borne in mind that this 1976 figure will still be over 50,000 metric tons below the 1972 and 1973 figures. Although the lower prices of mid-1975 have contributed to a recovery in consumption, there is a long way to go before the long term rising trend is firmly re-established.

Stocks

Gill & Duffus estimate that the 1974/75 end of season stocks were 435,000 metric tons (3·7 months usage). However, this figure is a little misleading in that a much larger proportion than usual of this stock was from the record Brazilian Temporao crop, much of which was not shipped until after September 30th and also a sizeable tonnage of Nigerian cocoa had still not been shipped at that date because of shipping congestion in Lagos.

Gill & Duffus are forecasting a surplus in the 1975/76 season of 7,000 metric tons. This would leave the end of season stocks at 442,000 metric tons (3·6 months usage). However it must be remembered that again a good outturn is expected from the Brazilian Temporao crop and that therefore not all this stock will necessarily have been shipped from origin at the end of season date.

Prices

Month end prices for nearby Ghana shipment cocoa have been:

1975	August	£715/metric ton
	September	£670/metric ton
	October	£705/metric ton
	November	£695/metric ton
	December	£750/metric ton
1976	January	£790/metric ton
	February	£760/metric ton
	March	£835/metric ton
	April	£1105/metric ton

The improved supply situation in 1974/75 brought about a decline in prices although the delay in availability of tonnages from Brazil and Nigeria meant that the decline was less than might have been expected. With production and consumption effectively in balance for the 1975/76 season one could have expected prices to remain at similar levels. Instead we have seen a sharp rise in prices, particularly during April. It is hard to pinpoint any specific reason for this but the decline in the value of sterling against other currencies, world-wide inflation, and the increasing buying of commodities by speculative interests as a hedge against inflation have all played a part.

WORLD COCOA PRODUCTION AND GRINDING DATA

Reproduced from Gill & Duffus Market Report
Dated 27th April 1976

(Thousand Metric Tons)

Production

	1973/74	1974/75 (Estimate)	1975/76 (Forecast)
Africa...	953	1,007	1,012
America	397	439	400
West Indies	43	41	39
Asia and Oceania	53	57	60
World Total	1,446	1,544	1,511
Principal Countries			
Ghana	350	377	400
Nigeria	215	214	220
Ivory Coast	209	242	225
Cameroon	109	118	110
Equatorial Guinea	12	12	10
Brazil	246	273	249
Ecuador	72	78	65
Dominican Republic	30	27	27
Venezuela	17	19	15
Colombia	23	25	26
Mexico	28	32	33
New Guinea	31	33	32

Grindings

	1974	1975 (Estimate)	1976 (Forecast)
Western Europe	539	509	523
Eastern Europe and U.S.S.R.	258	276	274
North America	246	217	241
Central and South America	209	209	223
Australia and New Zealand	20	18	19
Asia	58	59	63
Africa...	146	156	163
World Total	1,476	1,444	1,506
Principal Countires			
United States	230	206	230
Germany (Federal Republic)	138	139	140
Netherlands...	115	119	120
United Kingdom	93	73	80
U.S.S.R.	143	155	150
France	37	34	36

A FRAMEWORK FOR THE PHYSIOLOGY OF COCOA

Part 1

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The purpose of this contribution is to present a general outline of the physiology of cocoa, showing the main processes and conditions which control growth and yield. An understanding of these processes and of the general functioning (physiology) of the tree should be of fundamental value to both the cocoa grower and research worker, as physiological principles form the basis of sound agronomy and management, and indicate ways by which the efficiency of the tree can be improved. As this article is of an introductory nature, the emphasis will be on building a framework; it is intended that some of the more important sections of the model will be dealt with in more depth in future contributions to the "Cocoa Growers' Bulletin".

Yield is determined by the structure and functioning of the tree, which in turn vary with the genotype, growing conditions (climate and agronomy) and management:

GENOTYPE ENVIRONMENTAL AND SOIL CONDITIONS CULTURAL PRACTICES (SOME) PESTS AND DISEASES	STRUCTURE AND FUNCTIONING OF THE TREE	GROWTH AND YIELD

The physiology of the tree, being the first step removed from yield is most fundamental and knowledge about the functioning of cocoa should therefore have the widest application. Yield can be increased by plant breeding or by providing improved growing conditions and management, but all operate in basically the same way – by modifying the physiology of the tree.

A BASIC MODEL OF COCOA PHYSIOLOGY

The basic physiology of cocoa can conveniently be discussed with reference to the production and partitioning of dry matter by the tree. The approximate annual dry matter balance sheet for a 15-year old Amelonado tree is shown in Fig. 1 – which is the basic model to be expanded below. Dry matter produced by photosynthesis and mineral absorption is partitioned among the various growing points on the tree, some being respired and some possibly being stored for future use.

The respiratory losses shown in the diagram are guesstimates based on some published data for similar trees and on theoretical considerations mentioned below. The partitioning is based on the measured dry matter distribution in a group of six Amelonado trees growing in apparently normal field conditions, taking account of the estimated rate of leaf turnover and the growth pattern, and of the cropping history of the trees. The partitioning pattern in cocoa is known to vary with several factors, and the pattern shown is not necessarily

*Seconded on technical assistance by the U.K. Ministry of Overseas Development

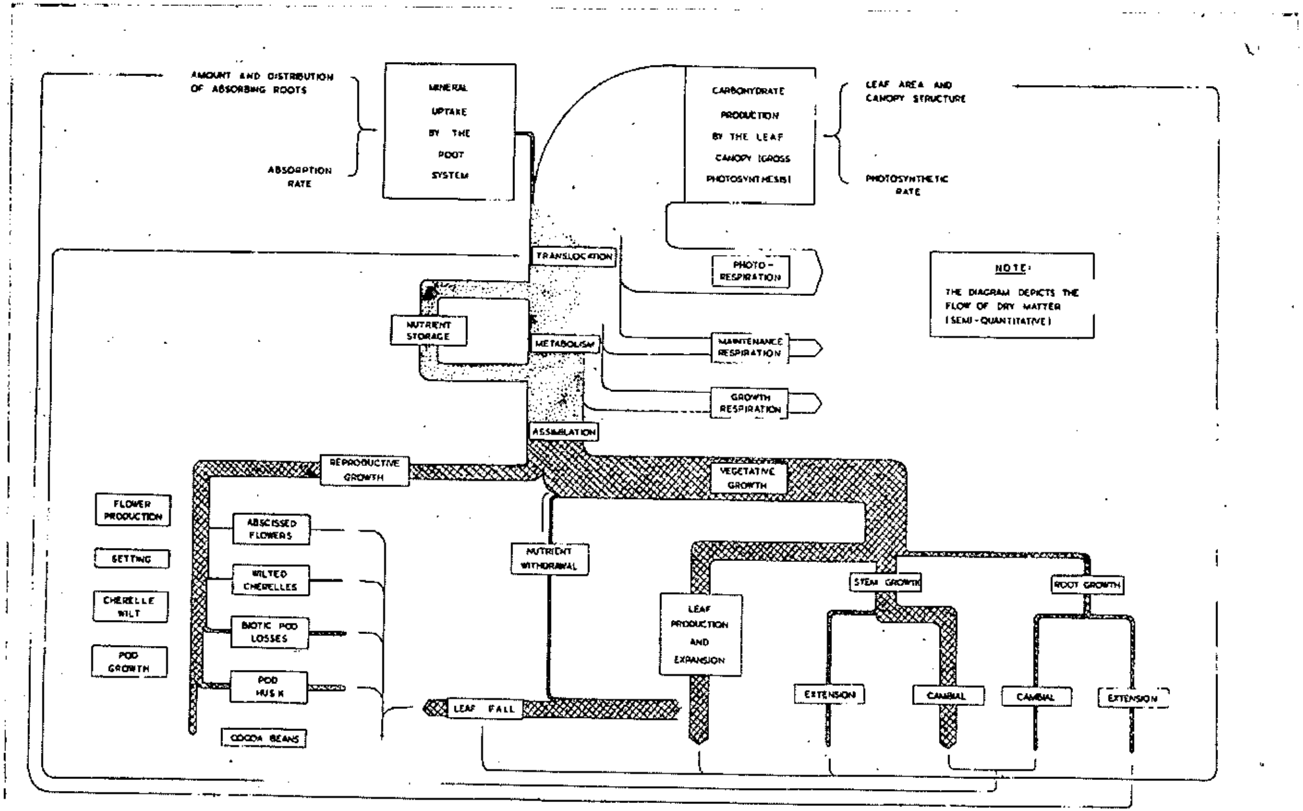

Fig. 1. A dry matter balance sheet for cocoa, showing the gross physiological processes affecting yield.

typical of cocoa; more accurate data on partitioning are presently being collected for a range of genotypes and growing conditions. The diagram is intended primarily as a mental picture of the physiology of cocoa, and the pattern of dry matter expenditure should be regarded as being an initial approximation. The diagram is useful in showing where the losses of potential yield occur and hence indicates how the efficiency of the tree may be improved.

DRY MATTER PRODUCTION

Primary dry matter production is the result of the manufacture of carbohydrates by photosynthesis and mineral absorption; all compounds in the plant are synthesised from these basic materials. As the mineral content of most plant tissue is about 5%, dry matter production is largely the result of photosynthesis – which in many field situations seems to be the main process controlling the yield of cocoa.

Photosynthesis

Total photosynthesis may be regarded as the product of leaf area (usually expressed as the LAI – i.e. the leaf area per unit ground covered) and the average rate of CO_2 adsorption per unit leaf area, integrated over time. Both the LAI and the photosynthetic rate (PR) vary seasonally and from site to site, but a substantial part of the variation in yield – whether between years or between locations – is apparently due to variation in the LAI.

Total gross photosynthesis by the canopy increases with increasing LAI but in terms of dry matter production there is an optimal value of LAI for a given set of light conditions and canopy structure, as respiration by the canopy also increases with the amount of leaf tissue (see below). The optimal LAI varies from day to day as a result of variation in the daily pattern of radiation, and often from season to season as a result of changes in the density of overhead shade through leaf growth or leaf fall. In practical agronomy, therefore, the optimal LAI can only be an average value based on assumptions about weather and shade conditions, and on knowledge about the photosynthetic characteristics of individual leaves and light extinction by the cocoa canopy. Nevertheless, the optimal LAI is a useful general concept.

Weather, management, genotype, soil, pest damage, etc., often affect yield largely through affecting the LAI. During the establishment of cocoa it is particularly important to provide conditions which lead to a rapid increase in LAI (mainly a low light intensity and absence from water stress) so that light interception and dry matter production can commence at an early age. The processes which determine LAI – leaf production, expansion and fall – are mentioned later.

The canopy architecture also affects photosynthesis through affecting the pattern of light penetration into the canopy. As photosynthesis by an individual cocoa leaf is light-saturated at an intensity of about 15% of full midday sunlight, CO_2 absorption by the whole canopy is highest when the available light is distributed evenly on leaves throughout the depth of the canopy. For a high LAI the ideal canopy consists of near vertical leaves at the top changing gradually to horizontal leaves at the bottom. Little is known about the canopy architecture of cocoa but in some crops – e.g. tea – there is genetic variation in respect of leaf angle which may be important in determining photosynthesis and yield.

The PR (photosynthetic rate) of a leaf varies with the CO_2 supply, the intensity of light in the 400–700 nm waveband, the stomatal conductance, the leaf water status, leaf nutrient status, leaf temperature, leaf chlorophyll content, leaf age, and on the rate at which photosynthates are removed from the leaf. Data on PR in relation to some of these factors are given by Hutcheon (2). PR of a leaf is limited mainly by light when the intensity is below 15% of full midday sunlight and largely by the stomatal conductance when light is saturating. PR may well vary with the genotype but there is as yet little information. PR varies with the other variables listed above, but, within the range normally encountered in the field, they seem of somewhat lesser importance than light and stomatal conductance. Water stress affects PR in several ways but mainly by decreasing the stomatal conductance to CO_2.

There has been much argument as to whether plant growth limits photosynthesis, or whether photosynthesis limits growth. There is some evidence that in cocoa and many other plants the presence of "sinks" – e.g. rapidly growing pods – accelerates removal of carbohydrate from the leaves and phloem and increases PR. While growth may affect PR it seems that most factors which increase photosynthesis in cocoa increase the yield, so it seems likely that photosynthesis is often limiting.

Total photosynthesis is therefore maximal when there is a good canopy of young efficient leaves exposed to a high light intensity and well supplied with nutrients and water. Most of the important agronomic factors – shade, fertiliser, irrigation, spacing, pruning – affect yield largely through their effects on photosynthesis.

Mineral Uptake

Though mineral nutrients are absorbed in relatively small quantities – of the order of 1 part minerals: 40 parts carbohydrate – they are of great importance to growth and yield. Minerals strongly affect photosynthesis through affecting leaf growth and retention, and by affecting PR – and play a vital role in nearly all physiological processes in the plant.

Total nutrient uptake varies with the extent of the root system and with the absorption rate, in the same way as variations in photosynthesis are due to either the LAI or the PR. Absorption rate varies mainly with the available nutrient supply, soil aeration, soil temperature, soil pH and with the rate of movement of the transpiration stream. Both photosynthesis and nutrient uptake are correlated with transpiration, and this tends to balance the supply of carbohydrates and minerals. A balanced supply is essential for optimal functioning, and minerals are thus most needed when conditions for photosynthesis are most favourable – e.g. unshaded conditions.

RESPIRATORY LOSS OF DRY MATTER

The diagram shows that a substantial proportion of the dry matter produced by photosynthesis is lost by respiration. Two types of respiration are recognised in most plants: in the C_3* species, a proportion of the CO_2 fixed is lost by photorespiration in a process which responds to light in much the same way as photosynthesis. "Dark" respiration proceeds in all species in both light and dark and on a functional basis can be considered to comprise maintenance respiration and growth respiration.

Photorespiration

Cocoa has many of the features of a C_3 species so we may assume that a proportion of the CO_2 fixed is lost by photorespiration. The extent of photorespiration in cocoa is unknown but estimates of 20–50% of gross photosynthesis have been made for most C_3 species studied. As photorespiration increases with temperature and is thus of particular importance under tropical conditions, a value of 40% of gross photosynthesis had been used in constructing Fig. 1.

Though various possible functions of photorespiration have been postulated (7) it is not clear whether it confers an evolutionary advantage or whether it is an unfortunate consequence of C_3 photosynthesis. Photorespiration apparently does not yield useful chemical energy and in crop plants is regarded as a serious loss of potential productivity which should, if possible, be minimised or eliminated. The extent of photorespiration has been shown to vary with the genotype in many C_3 species so it may be possible to breed plants with low rates of photorespiration. With reference to cocoa, photorespiration presently appears to be an unavoidable loss which may possibly be tackled by the plant breeder at a later date when simpler techniques for measuring photorespiration may be available. There are several differences in the physiology and leaf anatomy of C_3 and C_4 species but the relatively high productivity of C_4 species may be partly attributable to their low rates of apparent photorespiration.

Maintenance and Growth Respiration

Maintenance and growth respiration are identical biochemically but it is instructive to distinguish between them in modelling respiratory loss of dry matter. Growth respiration is associated with the assimilation of new plant tissue and represents the metabolic cost of converting raw materials or phloem translocate into cellular tissue. Maintenance respiration is associated with the normal metabolism of all living tissue and is the energy used for the replacement of degraded proteins and other maintenance processes. A third type of respiration termed "idling respiration" has been postulated which does not release useful energy (ATP) and would therefore represent a real waste.

The loss of dry matter in growth respiration depends on the composition of the tissue being assimilated – principally the energy content. Production values on a dry weight basis have been calculated for the synthesis of various materials from glucose: for example, one unit of glucose should yield about 0·85 units of

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*C_3 species fix CO_2 by the Calvin cycle, the first organic compound being a 3-carbon molecule; C_4 species fix CO_2 by the Hatch-Slack pathway, the primary product being a 4-carbon dicarboxylic acid. C_4 plants – which include maize and sugar-cane – have several important physiological characteristics including very low rates of apparent photorespiration, a light saturation point for leaf photosynthesis approaching full sunlight, and high rates of net photosynthesis and dry matter production relative to C_3 species (see 7).

cellulose or about 0·36 units of lipid (4). The approximate production value for plant tissue of known composition can thus be calculated and a value of about 0·75 is common – i.e. 1 g of carbohydrate yields about 0·75 g plant tissue with a growth respiration loss of 0·25 g. The energy cost of translocating the materials to the site of growth may be included in growth respiration but this is relatively small

Growth respiration is therefore directly related to the synthesis of cellular tissue, but in most cases it is closely related to gross apparent photosynthesis (i.e. gross photosynthesis less photorespiration). For some herbaceous plants growth respiration was found to be 25% of gross apparent photosynthesis (3). It will be much higher when, for example, cocoa bean tissue with a high fat content is being assimilated. Growth respiration is shown as 25% of gross apparent photosynthesis in the diagram. It should be emphasised that growth respiration is not an unnecessary waste of dry matter fixed by photosynthesis but is an essential process for growth. Both the dry matter and the energy contained in the initial products of photosynthesis are used efficiently in producing new plant tissue. Hence growth respiration is efficient and there would seem to be little scope for improving productivity by means of manipulating this process.

Maintenance respiration cannot yet be accurately derived theoretically as the factors influencing maintenance are not fully understood. The main maintenance processes are the turnover of proteins and transport processes to maintain ion concentrations in cells. Maintenance respiration rates vary with the type of tissue being maintained and with environmental and external factors which influence directly or indirectly the rate of maintenance processes – e.g. temperature, water stress, etc. Rates are usually expressed on a dry weight basis; hence McCree (3) found the daily maintenance respiration of young herbaceous plants to be 1·5% of the plant dry weight, and Penning de Vries (5) derived similar values. For storage and woody tissue in which there is less metabolic activity the rate is thought to be lower. Maintenance respiration rates have been found to be more uniform when expressed on the basis of soluble nitrogenous compounds – suggesting a direct or indirect relationship.

Maintenance is of potential practical importance in that it may represent a waste which might be reduced to bring about increased dry matter production. If maintenance could be reduced to the minimum necessary for normal functioning of the plant, the energy needed for replacing proteins and other maintenance processes could be used more profitably in further growth. There are substantial differences in maintenance respiration between species, and there are genetic variations in maintenance respiration within a species which may be partly responsible for observed differences in productivity between genotypes – e.g. Wilson (6). Variations in the maintenance requirement offer opportunities to the plant breeder but, as with photorespiration, it is not an easy process to measure on an extensive scale. The value of photorespiration or maintenance respiration as selection criteria depends on how closely these processes are correlated with productivity.

The rate of maintenance processes increases with temperature, the Q_{10} over the normal range being 2–3. High temperature has a beneficial effect on many physiological processes in the cocoa tree but an undesirable effect on maintenance respiration.

There is rather limited scope for reducing maintenance in field agronomy. Tissue not serving a useful function – e.g. leaves exposed to light intensities below the photosynthetic compensation point, branches supporting only a few leaves, etc. – is a liability to the energy and dry matter economy of the tree and should be removed.

No measurements of maintenance respiration are available for cocoa so those of Muller and Nielsen (discussed by Evans (1)) for some tropical trees in the Ivory Coast may be mentioned. Maintenance respiration was found to be a large part of the dry matter budget. There were marked differences between species in the rate of maintenance respiration, and the total CO_2 loss by a length of stem seemed to be approximately proportional to the stem circumference. If the same pattern is true of cocoa then maintenance expenditure will increase as the trees increase in size. Maintenance respiration is shown as 25% of apparent photosynthesis in the diagram but the proportion may well vary with the age and size of the tree. The net productivity of a stand of cocoa should be at its highest soon after the canopy has fully formed and total CO_2 fixation by the canopy is maximal. Beyond this point of time, the rate of production of dry matter may fall gradually as the photosynthesis/respiration ratio declines with growth of the trees.

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THE RECENT ROLE OF THE ROYAL BOTANIC GARDENS, KEW, IN DISTRIBUTION OF COCOA

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For 200 years, Kew has been responsible for the distribution of economic plants all over the world. From 1772, when Francis Masson was sent out from Kew to collect plants in South Africa, to the present day, there has been an uninterrupted tradition of service to agriculture and horticulture in plant introduction and dissemination.

Masson introduced a large number of plants into European horticulture, including many present-day garden favourites, for instance a large proportion of the South African bulbs which we now commonly grow. The genus *Massonia* (Liliaceae), perhaps not very beautiful, is named after him.

Kew's active part in the introduction of quinine (1860) and rubber (1877) from South America to the East is too well known to need re-telling here. It is worth remembering, nevertheless, that these two commodities have perhaps contributed more to the complexion of our present civilisation than any of the other things which have been done at Kew. The introduction of quinine made life in the malarial tropics tenable for Europeans, and the large-scale production of rubber brought the benefits of the motorcar to the roads of the world.

Theobroma cacao was first cultivated at Kew between 1768 and 1785, probably for the first time in Europe, and, like other plants, was distributed to various parts of the British Empire, including West Africa. Through the nineteenth century many consignments of cocoa planting material left Kew for the tropics, going both to West Africa and other parts where cocoa production is not at the moment so important. In the latter countries present day plantations would probably be directly traceable to these original importations but in West Africa, Kew's early part in the introduction of cocoa is too involved to be discussed in the present article.

With the discovery, shortly after the end of the Second World War, of the value of Upper Amazon cocoa types in West Africa and elsewhere, there came a demand for a greater variety of material on which breeding programmes could be based, and in 1954 and the years immediately following, ICS clones and Amazon Forasteros were sent to Ghana, the Cameroons, Peninsular Malaysia, Sri Lanka, Fiji and the Solomon Islands. Not all distributions were from the Americas to other parts of the tropics. The cocoa cultivar Lafi 7, believed to be resistant to *Phytophthora palmivora*, was distributed to Trinidad, Jamaica, U.S.A., Ghana, Nigeria and Uganda and via Wageningen to New Guinea from its original home in Samoa, and cv. Inus 1, again supposed to be resistant to black pod, was distributed from Bougainville to Trinidad and elsewhere.

These distributions were all made through the Quarantine Station at Kew which had been set up a few years previously to handle introductions of rubber to Malaysia. Unfortunately, except as outlined above, details of the earlier activities of the Station are rather fragmentary but between 1961 and 1968, 170 clones of cocoa mostly Nanay and Parinari but also including Scavinas, Pound selections, etc., were sent to Ibadan for use in the breeding programme of the Cocoa Research Institute of Nigeria. As a result of the splitting of WACRI into two separate institutions, the programme of introductions was begun again in 1970, financed by what is now the British Ministry of Overseas Development, to transfer these same clones and many others to Ghana where they have been used in recent breeding programmes. This operation is still in progress. One of the needs of the plant breeder which is being met at the moment is the distribution to Ghana and elsewhere of Oriente clones, originating in Ecuador, which are needed, not only in the general sense of providing a more widely based plant breeding programme, but in particular for their pericarp characters, which it is hoped will provide resistance to pod diseases and insect damage.

Immediately on arrival at Kew, cocoa budwood which comes from approved sources, is patch-budded on to Amelonado seedlings grown in the Quarantine Station from West African seed. These rootstocks are known to be highly susceptible to cocoa virus diseases and are allowed to produce at least one flush before their height is gradually reduced by pruning. This often has the unfortunate effect of delaying the shooting of the clonal bud, but is intended to allow virus symptoms to express themselves in the Amelonado seedling. The seedlings and clonal material are inspected virtually every working day for symptoms of any disease, including virus.

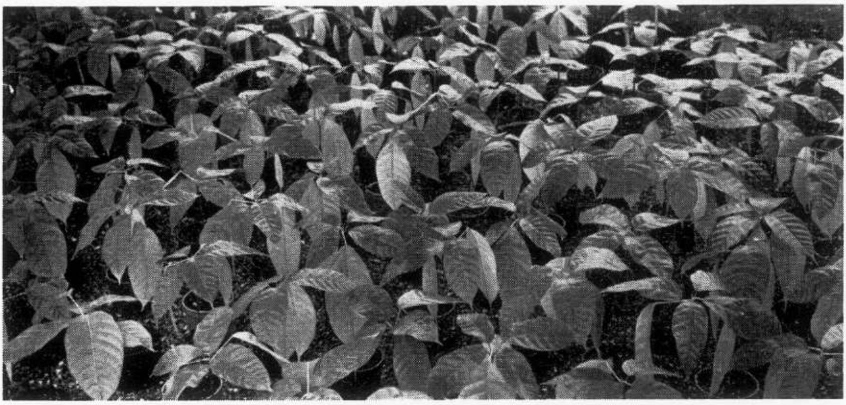
After budwood from the clonal material has been sent to the country for which it is destined, the original plant is kept in the Quarantine Station for as long as space will permit, usually for at least a further season, still under close daily observation for virus symptoms. Selected clones are top-worked with Amelonado budwood, again in an attempt to reveal any symptoms of virus infection. At the moment about 200 clones are in cultivation and are being sent to Ghana and Sabah.

Until recently, the quarantine station has also been regularly handling banana and sugar-cane planting material though financial stringency has caused quarantine of these crops to be temporarily discontinued. However, it is planned to reopen the service, at least to the sugar industry, as soon as possible. In anticipation of this, preliminary experiments have begun to perfect a method of micropropagation of sugar cane from meristem tissue has been developed. In combination with regular virus screening this should provide material whose freedom from infectious disease can be guaranteed. It would also have the advantage that the growing area devoted to this rather bulky crop could be considerably reduced, and a stock of the more useful varieties maintained. Unfortunately, the use of this method will, in the case of sugar cane, probably be limited to subclones, since most of the clonal material at present in use consists of genetic mosaics, not all segments of which are present in a single meristem-derived plant. It is hoped to extend the micropropagation method to other crops in the quarantine station, including cocoa, as soon as possible.

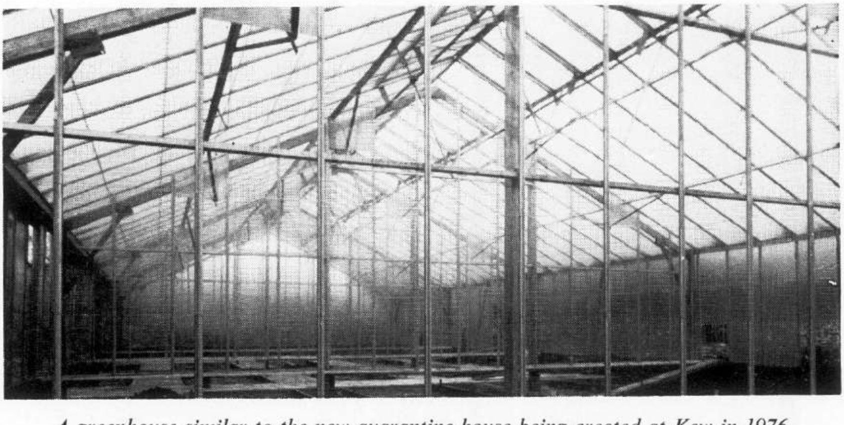
In addition to work on growing plants, the quarantine station also treats seed by fumigation, seed-dressing or dipping. During 1974 large quantities of oil-palm seed, 1½ tons of seed coconut and 200 kg of *Pinus caribaea* seed were treated and inspected at Kew *en route* from various parts of the tropics to Malaysia and there have been similar quantities of oil-palm and *Pinus caribaea* seed, together with *Gmelina arborea* fruits in 1975.

To continue to run the quarantine service costs a fairly substantial annual sum and as Kew's financial resources are limited a number of approaches have been made to outside bodies for assistance. As a result of this appeal, the British cocoa and chocolate industry has kindly donated the funds necessary for construction of a new quarantine house to replace the old and outmoded buildings at present in use. Contracts have been placed for the construction of an insect-proof 20×100 ft. tropical greenhouse with built-in laboratory accommodation, automatic watering, misting and ventilation control, and work has already begun on the building. This new house will be much more secure from a quarantine point of view as well as being very much more efficient in terms of labour and fuel costs.

It is hoped that other bodies will find it worthwhile to provide a continuing income for the quarantine station, and indeed a number of promises have been received, none of which has materialised up to the time of writing. All are agreed that this is a worthwhile activity and it would certainly be to everyone's advantage that the service should not be allowed to fail through lack of funds.



Amelonado seedlings for use as rootstocks.



A greenhouse similar to the new quarantine house being erected at Kew in 1976.

Fifth International Cocoa Research Conference

The Fifth International Cocoa Research Conference was held at Ibadan, Nigeria, in September, 1975. The previous conferences were held at Abidjan in 1965, Salvador in 1967, Accra in 1969 and Trinidad in 1972. The proceedings of all these conferences have been published, the proceedings of the Trinidad conference having been issued quite recently.

The latest conference was well attended and a very large number of papers were presented. The following notes deal with some of the more important points raised in them.

Breeding

There were 16 papers on plant breeding dealing with the research being done in the four main producing countries in West Africa, together with one paper from South America. Inevitably most of these papers were progress reports on breeding programmes and useful reports of this nature came from Ghana, Nigeria and Ivory Coast. Much more attention is now being paid to resistance to disease – swollen shoot virus and black pod in particular.

In Ghana the aim of the breeding programme is to produce progeny with some resistance to virus. Some of the Amazon parents, those from Iquitos, have some resistance and many new hybrids are being tested. It is hoped that new varieties will be released to farmers in 1978. There have also been detailed studies of cropping and losses to black pod in Ghana which indicate considerable differences of losses which may be due to crop pattern or to susceptibility.

Similar studies of crop pattern were reported from Nigeria. The third Nigerian breeding programme aims to combine black pod resistance or escape with the yield and establishment ability of the varieties developed earlier. This programme has several years to run.

Breeding work in the Ivory Coast has been founded on Amelonado selections and Amazon types introduced from Ghana. Twelve hybrids, which have yielded about 2 tons dry beans per hectare in field trials, have been selected for general distribution.

Hand pollination has lead to increases in yield in seed gardens and consideration has been given to extending these results to commercial plantings. A trial in Costa Rica compared hand pollination and other methods of artificial pollination with natural pollination. Hand pollination was the most effective by a considerable margin; the other artificial methods were only effective with self compatible trees.

Pathology

Several important papers on black pod disease provided detailed evidence of the two morpho types of *Phytophthora palmivora*, the discovery of which was reported in "Nature" earlier in 1975. This takes the earlier classification of two types a stage further and helps to explain the differences between Ghana and Nigeria in the way that the disease attacks the tree. MF1 which predominates in Ghana, penetrates the flower cushion while MF2 spreads more easily from pod to pod. The latter type occurs in Nigeria and Cameroon where pod losses are higher but there is little infection from flower cushions.

The detailed work on mapping infected pods on a small group of trees in Nigeria should lead to greater knowledge of how the disease spreads and the sources of the disease. Work in Jamaica has shown that black pod on trees, the soil and cankers are the main source of infection in that country.

Economics

About 10 papers were presented on the economics of cocoa and allied subjects like land tenure and credit. This is far more than at any previous conference of this nature and reflects the attention that is rightly being paid to this subject. It is now being appreciated that we need to know more about the cocoa farmer as well as the cocoa tree.

One of the significant features of cocoa areas in West Africa is the system of land tenure. In general land is held communally but farmers have individual rights where tree crops are grown. Areas of individual farms are small and there are barriers to the development of larger continuous farms on which enterprising farmers could adopt better techniques with advantage. A study of land tenure in Western Nigeria has shown that customs are changing but not in such a way as "to give positive support to agricultural development".

Physiology

This fundamental subject rarely receives the attention it deserves. Finding out how the cocoa tree works, which environmental factors exert the greatest effect and what influences the tree to flower and fruit rather than to put on vegetative growth are surely vital subjects in striving for higher yields. Two papers gather together the information available, together with the results of recent research, on photosynthesis in the cocoa tree and on the factors affecting the partition between reproduction and vegetative growth. There was another interesting paper reviewing the effect of light on cocoa production.

Agronomy

The ill defined subject of rehabilitation is one of obvious importance to West Africa with its ageing cocoa areas. Encouraging results were obtained by coppicing old Amelonado trees and subsequently budding or grafting Amazon material onto them. In trials these methods work well but there would be many problems in using them on a large scale.

Papers on fertilizers include a report from Ghana and Nigeria on trials with Amazon cocoa. In Nigeria fertilizers appear to arrest the decline in yield which sets in with Amazon cocoa at an earlier age than with Amelonado. It follows that higher levels are likely to be needed as the trees age further. The results of a trial in Ghana indicate rather small responses to fertilizer though the effect of shade was shown once again. Another paper from Nigeria gave further evidence of the susceptibility of Amazon cocoa to boron deficiency.

None of these papers consider the economics of fertilizers, an aspect which must be examined closely in future.

Pests

There are several papers on capsids and their control. Resistance to BHC was first reported in 1961 from one cocoa station in Eastern region of Ghana. It has taken several years to develop throughout the country and it is probable that the difficulties over insecticides supplies have delayed this development. A survey in 1974 showed that resistance was fairly general throughout Ghana.

Trials of insecticides in Nigeria have shown that two carbonates Etrofolan and Orthobux are effective in controlling capsids. As far as Orthobux is concerned, this confirms the findings made earlier in Ghana.

On other pests *Bathycoelia thalassina* has not yet become as serious a pest as was feared at one time. It is normally well controlled by its own enemies but can be controlled by Azodrin or Thiodan when necessary. Similarly the Pod Husk Borer, *Characoma stictigrapta,* is controlled by its parasites and predators.

Chemistry and by-products

While few papers were presented on processing or quality, there were several on by-products which reflected the considerable attention devoted to this field, particularly in Nigeria, during the past few years. To some extent this work goes over old ground but there are some novel ideas on new products which might perhaps lead to something in this overwise barren field. One new suggestion was that pod husks could be used as a fertilizer and as a nematicide, some evidence being produced on their effect on nematode populations.

G. A. R. Wood

Book Review

C. A. Thorold. *Diseases of cocoa.* Clarendon Press: Oxford. x and 423 pp. 1975. Price: £11·00.

The last few years have seen a bumper crop of books on cocoa: cocoa in general (Braudeau, 1969; Wood, 1975); cocoa in West Africa (Are, 1974); insect pests (Entwistle, 1972); Phytophthora disease (Edited: Gregory, 1974); and now a general account of cocoa diseases in this long-awaited and scholarly work by C. A. Thorold.

The author gained practical knowledge of cocoa and its diseases during nearly 30 years of government agricultural service in the tropics, including the Caribbean region, Ghana and Nigeria, and on visits to Cameroon, Angola and the islands of the Gulf of Guinea. Later, while in charge of the Woburn Experimental Station, he had access to the extensive library facilities at Rothamsted and Kew.

Publications on cocoa diseases are scattered in a wide variety of reports and journals, many of them hard to obtain. But in preparing this compendium few of even the most obscure papers on the topic can have escaped the author's scrutiny, to be incorporated in this book or rejected.

The first chapter on the history and geography of cocoa sets the scene. Then follow chapters on individual economically important troubles: witches' broom, Monilia pod rot, black pod, other pod rots following vertebrate damage, and cherelle wilt. The important chapter on virus diseases includes an account of vectors, and a key by Dr. D. J. Williams to identification of species of mealy-bugs associated with cocoa. A chapter discussing die-back associated with mirid attack and fungal infection is followed by a chapter on cushion gall diseases: in both of which contexts the fungus *Calonectria rigidiuscula* appears in varied roles that still need explaining. Root diseases, including "collar crack" are dealt with in Chapter 11. Then follows a long chapter with a 55-page list showing distribution of organisms regarded as parasites, saprophytes and epiphytes of the cocoa tree. A useful addition to the description of individual diseases would have been general accounts of breeding cocoa for resistance to disease, and quarantine measures restricting spread of races and species of pathogens across and within political frontiers.

Two chapters discussing nematodes and nutritional disorders are followed by a bibliography of some 2,000 literature references.

After this work on the troubles of the living tree comes an Appendix discussing mouldiness and other defects of raw cocoa beans. The Appendix has its own bibliography of some 250 references. After a set of maps, the work ends with excellent subject and author indexes, and a list of organisms mentioned in the text, which combine to make the very considerable resources of this book easy to use.

A number of fungicides for the control of black pod disease (Phytophthora palmivora) on cocoa (Theobroma cacao) have been tested on the Klatakan Estate, Jember (Indonesia). The fungicides used were copper oxychloride (Cobox 50 WP), metiram (Polyram Combi), mancozeb (Dithane-M 45), and copper oxychloride (Vitigran Blue) and copper oxychloride (Cacaobre Sandoz) with a spraying interval of two weeks. The results of the experiment indicated that the percentage of dry pods was not affected by the fungicide spraying. It also appeared that spraying with Vitigran Blue at 0·3% of formulation reduced the percentage of infected pods significantly as compared with control (untreated). The other fungicides did not show significant differences with the control. Authors' summary.

Massaux, F.; Gestin, A. J.; Misse, C. (Ecole nationale supérieure agronomique, Université de Yaoundé, Yaoundé, Cameroon. **Étude de l'absorption radiculaire du cacaoyer á l'aide d'un traceur radio-actif dans les conditions écologiques du sud-Cameroun.** (Study of radicular absorption of the cocoa tree using a radio-active tracer under South-Cameroon ecological conditions). Café, Cacao. Thé (France) v. 18(4), pp. 225–236 (October 1974).

Since phosphates do not move in the soil, P. fertilizers should be placed within the immediate reach of the roots of the cocoa tree. Results of placing P. at various distances and depths showed, on the basis of foliar analysis, that the uptake of P. is optimum when supplied at a depth of 5 cm and a distance of 80 cm from the trunk. Leaf P. contents vary with physiological age of leaves. As a result of this study, surface spreading of fertilizer can be recommended in a circle mulch but should not be buried.

Alencar, M. H.; Mandarino, E. P. Custo da secagem do cacau em diversos tipos de instalações. (Cost of cocoa drying). Cacau Atualidades (Brazil) v. 10(3), pp. 7–10 (July 1973).

Data are presented on the various systems of cost of cocoa drying in Brazil, for the year of 1971.

Decazy, B. (Station de Recherches, Institut Français du Café et du Cacao (IFCC), llake-Est, Malagasy). **Les variations saisonnières des populations de Boxiopsis madagascariensis Lavabre, miride ravageur du cacaoyer á Madagascar (note préliminaire).** (Seasonal variations of populations of Boxiopsis madagascariensis Lavabre, a devastating Madagascar cacao mirid (preliminary note)). Café, Cacao, Thé (France) v. 18(4), pp. 255–262 (October 1974).

A preliminary study on the biology of the Madagascar cocoa mirid and on the seasonal changes in its populations indicated that cocoa should be correctly shaded and the chupon shoots eliminated. Apart from that, adequate chemical control is necessary.

July 1975

Emechebe, A. M.; Leakey, C. L. A.; Banage, E. B.; (Makerere University, Kampala, Uganda). **Verticillium wilt of cacao in Uganda: wilt induction by mechanical vessel blockage and mode of recovery of diseased plants.** East African Agricultural and Forestry Journal (Kenya) v. 39(4), pp. 337–343 (April 1974).

Examination of the xylem vessels of stems of Verticillium wilted and Verticillium-free cocoa showed 57–87, 45–47, and 6–8% partial or complete occlusion of the vessels by either tyloses, gum deposits or fungal mycelium in root-inoculated, stem-inoculated, and control plants, respectively. Cocoa plants remained turgid when 75% of their vessels were artificially blocked by polythene films blocking 50% of the stem cross-section at two levels 3 cm apart. Plants with artificial blocks at two levels placed in such a way that the proportion of vessels not blocked at one level were blocked at the other wilted level within seven days. Long-term recovery of plants from the disease was associated with formation of new Verticillium-free xylem vessels and with the confinement of the fungus to discoloured inner vessels. Difficulty in isolating the fungus from discoloured wood increased with time after host recovery.

Dakwa, J. T. (Cocoa Research Inst., Tafo, Ghana). **The development of black-pod disease (Phytophthora palmivora) in Ghana.** Turrialba (IICA) v. 24(4), pp. 367–372 (October 1974).

Counts of numbers of diseased pods over a certain period of time indicate, that the disease developed rapidly between May and September. The pattern of development was influenced by location and fungicide application but was similar from year to year on different cocoa varieties and under different shade regimes; the effects of these factors on disease incidence were, however, different Blackpod developed faster under shade than without shade, and also in years and areas with frequent heavy rainfalls than with occasional light rains. Disease development was slow on cocoa varieties known to be resistant to the disease but fast on those known to be susceptible. Fungicides reduced the rate at which the disease increased during the epiphytotic period.

Annual report on cocoa research, 1973. University of the West Indies, St. Augustine, Trinidad and Tobago. Annual Report – Cocoa Research University of the West Indies (West Indies). 52 p. 1974.

The annual report on research activities of the University of the West Indies, Trinidad, includes breeding, physiology, plant pathology, biochemistry and processing. So far no relationship was found between pod phenols and resistance to Phytophthora. Results of study on factors affecting appearance and quality of cocoa are discussed comprehensively.

August 1975

Naime, R. M. J. (Laboratorio de Entomologia, Colegio Superior de Agricultura Tropical, Cárdenas, Tabasco, Mexico). **Cuatro especies de tripes en el cacao de Tabasco, México.** (Four species of thrips on cocoa in Tabasco, Mexico). Revista Theobroma (Brazil) v. 4(1), pp. 29–38 (January 1974).

It is often said that only the thrips Selenothrips rubrocinctus (Giard) is responsible for damage in the cocoa plantations of Mexico. However, it was found that the thrips Frankliniella parvula Hood, Sericothrips inversus Hood and Leucothrips piercei var. theobromae Priesner are also pests of cocoa. This is the first time that these three species have been reported on cocoa in Mexico. Habits, life cycles and distribution of all the four thrips species are mentioned. Author's summary.

Illustrations are few, because the reader in view is the trained agronomist, extension worker or plant pathologist. This very useful book is the key to an extensive literature, and will be essential to individual specialists, and to all libraries in teaching and research institutes with interests in tropical agriculture.

P. H. GREGORY

Notes on Contributors

Dring, D. M.

Born in Peterborough, 1932. B.Sc. (Lond.), Ph.D. (Lond.). University of Exeter, Plant Pathologist to Gold Coast/Ghana Government, five years working on several tropical crops including cocoa, and FAO for two years working on Maladie de Kaincopé of Coconut in the Republic of Togo. Since 1967 Quarantine Officer, Royal Botanic Gardens, Kew.

Hutcheon, W. V.

Born in Aberdeen, 1945. Received B.Sc. (Agriculture) (Hons.) from Aberdeen University in 1968 and appointed lecturer in agriculture. Seconded to C.R.I.G. in 1969 as physiologist in the British Research Team, Ministry of Overseas Development.

Cocoa Abstracts

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

June 1975

Pastrana, S. O. (Federación Nacional de Cacaoteros, Guatemala City, Guatemala). **Situación del cacao en el pais** (The cocoa situation in Colombia). Revista Nacional de Agricultura (Colombia) v. 35–38.

A review presented of the cocoa situation in Colombia, and of the activities of national cocoa federation, dealing particularly with agricultural credit and extension.

Maravalhas, N.; Berbert, P. R. F.; Esquivel, T. F. (Divisão de Bioengenharia, Centro de Pesquisas do Cacau (CEPEC), Itabuna, Bahia, Brazil). **Um método fácil para a determinação do cheiro de fumaça.** (A simple method of determination of a smoky smell of cocoa). Cacau Atualidades (Brazil) v. 10(4) pp. 2–4; (October 1973).

One of the main defects of Brazilian cocoa is a smoky smell. A very simple method for the detection of smoky smelling cocoa is presented, based on the discoloration of an alcoholic extract of the beans when they have been exposed to smoke.

Costa A. Da S. Implantação de lavoura de cacau em área de pimental decadente. (Establishment of cocoa plantations in areas where the pepper growing is declining). Cacau Atualidades (Brazil) v. 10(4) pp. 5–9 (October 1973).

The State of Para produces 80% of the national pepper production. Old age and especially fungus diseases are causes of deterioration of the pepper plantations. Most of the pepper has been grown on acid latosols. It has been found that the growing of cocoa on these soils is feasible when soil pH is corrected. But there is always a danger of contaminating cocoa with diseases that also affect pepper, such as Corticium salmonicolor and C. koleroga. A cost calculation is presented on the establishment of 1 ha of cocoa plantation.

Anon. CEPLAC: um modelo de trabalho voltado para a agricultura. (CEPLAC: a model of work dedicated to agriculture). Cacau Atualidades (Brazil) v. 10(4) pp. 10–23 (October 1973).

A discussion on the works of the executive commission of the rural-economic rehabilitation programme of cocoa growing in Brazil. Statistical data are presented on the application of various improved techniques as a result of CEPLAC activities. An expansion of the cocoa producing area of 500,000 ha in 10 years is programmed.

Situmorang, S.; Soeyatno (Balai Penelitian Perkebunan Bogor, Jember, Indonesia). **Percobaan pemberantasan penyakit busuk buah (Phytophthora palmivora) pada tanaman kakao dengan fungisida.** (An experiment on the control of black pod disease (Phytophthora palmivora) in cacao with fungicides). Menara Perkebunan (Indonesia) v. 42(5), pp. 251–254 (October 1974).

Ajayi, S. I.; Oyejide, T. A. (Department of Economics, University of Ibadan, Ibadan, Nigeria). **The role of cocoa in Nigeria's economic development.** In: Economics of cocoa production and marketing. pp. 225–235 (1974).

The role of cocoa is assessed in terms of its contribution in transforming the structure of the society, by providing income for farmers, foreign exchange and government revenue, raw material for agro-based industries and by stimulating the development of infrastructure.

Olatunbasun, D. (Nigerian Inst. Social and Economic Research, University of Ibadan, Ibadan, Nigeria). **Pricing policy and supply response in cocoa production: the Nigerian case.** In: Economics of cocoa production and marketing. pp. 236–250 (1974).

Thsi is a study of the pricing policy and supply response in cocoa production to examine the effect of the actual level of producer prices on the farmers' response behaviour. It is concluded inter alia, that a relationship exists between price response and pricing policy. If producers are positively responsive to price changes, an increase in producer prices constitutes an incentive to increase production and vice versa. However, many other factors besides the producers actually determine the rate of acreage expansion or output growth. But as a policy variable, producer price is the most amenable to control to channel the development of the cocoa economy in desired directions. Here lies the strategic significance of prices as a policy variable. Recommendations are given for stimulating greater investment in cocoa production.

Elliott, H. (Center for Research on Economic Development, University of Michigan, Ann Arbor, Michigan, U.S.A.). **Cocoa production prospects in Ivory Coast.** In: Economics of cocoa production and marketing. pp. 251–264 (1974).

Faced with limits on the amount of coffee it can sell in quota markets and with strong competition in the non-quota countries, Ivory Coast is turning to its other traditional export crop, cocoa, as a major part of its diversification effort. Historically, domestic producers have alternated between coffee and cocoa as relative producer prices have changed in response to world market conditions. This paper assesses the role which cocoa has played in the economy of the country and of the effects which can be expected from the planned increase in output. The paper discusses the following topics: (1) history of cocoa in the country; (2) cocoa in 1970 and planned expansion; and (3) cocoa in the world market.

Leão, A. C.; Gramacho, I. da C. P. (Divisão de Geociências, Centro de Pesquisas do Cacau (CEPEC), Ilhéus, Bahia, Brazil). **Aplicação da fotografia aéria em planejamento agricola na região cacaueira da Bahia.** Cacau atualidades (Brazi.l) v. 11(4). pp. 8–17 (October 1974).

The article shows the principles of aerial photography and how photointerpretation can be used for agricultural planning with reference to an existing cassava growing and processing industry in Bahia, Brazil.

Figueroa, G. E. S. (Estação Experimental Filogônio Peixoto, Linhares, Espírito Santo, Brazil). **Informe de uma nova praga do cacaueiro no estado do Espírito**

Santo. (Note on a new pest of cocoa in the Espírito Santo Estate). Cacau Actualidades (Brazil). v. 11(4). pp. 18–19 (October 1974).

A new pest, the bug Eocader vegrandis, of cocoa in Brazil is described (occurrence, symptoms).

Medeiros, A. G. (Divisão de Fitoparasitologia, Centro de Pesquisas do Cacau (CEPEC), Ilhéus, Bahia, Brazil). **Novos conceitos sobre a podridão parda do cacau.** (New concepts on black pod of cocoa). Cacau Atualidades (Brazil) v. 11(4). pp. 20–26 (October 1974).

Several aspects of black pod of cocoa caused by Phytophthora palmivora are discussed including losses, sources of infestation and dispersion, the effects of the environment, the development of new races and control measures. Spraying calendars are presented.

Oni, S. A.; Adubi, J. (Department of Agricultural Economics and Extension, University of Ibadan, Ibadan, Nigeria). **Economics of fertilizer use in cocoa production: a case study of Western Nigeria.** In: Economics of cocoa production and marketing. pp. 86–95 (1974).

The objective of this study was to analyse the costs and returns derived from fertilizer use. Since the study involved the use of both cross sectional and time series data, a brief explanation was given on the fertilizer experiments and other sources of data utilized. The analysis indicated that it is profitable to use fertilizer at the current producer price of £155 per ton. Even when the present subsidy on fertilizer is set aside, fertilizer application was still profitable at the present product price. However, a decline in the product price to £50 per ton would make fertilizer application irrational even if the subsidy were still operative.

Boaten, K. (Department of Geography, University of Ghana, Legon, Ghana). **Problems facing cocoa farmers in Mampong, an old cocoa growing district in Ashanti.** In: Economics of cocoa production and marketing. pp. 196–203 (1974).

A discussion is presented of the efforts and problems of the farmers in Mampong District. The problems are: food shortage, low yields from mature and old cocoa farms, fragmentation of land holdings and conflicting interests between old and new farms.

Barnes, J. S. (West African Mills Ltd., Takoradi, Ghana). **Some aspects of processing cocoa in a producer country.** In: Economics of cocoa production and marketing. pp. 503–511 (1974).

A gradual but significant change is taking place in the pattern of the processing of raw cocoa, in that the tonnage turned into primary products in the producer countries is becoming an important factor in the trade. If continued, this change will have a substantial impact on the trading and marketing of cocoa, linked as it must be by a consequential effect on the manufacturing industry in the consumer countries. This article deals with: (1) development of cocoa processing in producer countries; (2) technical problems in cocoa processing; (3) economic considerations in processing cocoa in producer countries and; (4) concluding observations.

Sharma, R. D.; Loof, P. A. A. (Divisão de Entomologia, Centro de Pesquisas do Cacau (CEPEC), Itabuna, Bahia, Brazil). **Nematodes of the cocoa region of Bahia, Brazil III – Plant parasitic and free-living nematodes in the rhizospheres of six different plant species.** Revista Theobroma (Brazil) v. 4(1), pp. 39–43 (January 1974).

Further to earlier studies of nematodes occurring on crops in the cocoa region of Bahia, Brazil, this article presents information on plant species hitherto unsampled, viz. Theobroma grandiflora, T. bicolor, Erythrina glauca, Momordica charantia, Psidium guajava and Gladiolus sp.

Segunda reunião regional Americana do grupo de Phytophthora palmivora Guayaquil, Equador, 8 a 23 de junha de 1973. (Second American regional meeting of Phytophthora palmivora group Guayaquil-Equador, June 8–23, 1973). Centro de Pesquisas do Cacau (CEPEC), Itabuna, Bahia, Brazil. Revista Theobroma (Brazil) v. 4(1), pp. 44–52 (January 1974).

The papers delivered at the above-mentioned deal with canker and black pod of cocoa and more specifically with a new species of Phytophthora (Phytophthora megasperma), P. species isolated from pods, infection from trunk canker, inoculation tests and black pod epidemiology and control in Bahia, Brazil. Further studies on cocoa diseases including Monilia black pod and witches broom caused by Marasmius perniciosus are needed.

Soria, S. de J.; Wirth, W. W. (Divisão de Entomologia, Centro de Pesquisas do Cacau (CEPEC), Itabuna, Bahia, Brazil). **Identidade e caracterização taxonômica preliminar das mosquinhas Forcipomyia (Diptera, Ceratopogonidae) associadas com a polinização do cacaueiro na Bahia.** (Identification and preliminary taxonomic characterization of Forcipomyia midges (Diptera, Ceratopogonidae) related to the pollination of cacao in Bahia). Revista Theobroma (Brazil) v. 4(1), pp. 3–12 (January 1974).

It is concluded that the Forcipomyia midges are mainly responsible for the pollination of cocoa in Bahia, Brazil.

Silva, L. F. da; Mariano, A. H.; Dias, A. C. da C. P. (Divisão de Solos, Centro de Pesquisas do Cacau (CEPEC), Itabuna, Bahia, Brazil). **Zoneamento agricola da região cacaueira Baiana.** (Agricultural zoning of the Bahian cacao region). Revista Theobroma (Brazil) v. 4(1). pp. 13–28 (January 1974).

The Bahia cocoa region in Brazil is divided into micro-regions and agricultural area on the basis of climatic, pedologic and topographic data. For each zone the most favourable agricultural utilization is discussed. The following zones are particularly dealt with: (1) the present cocoa zone, (2) the grassland zone and the humid lowland plateau zone in the south. Thanks to advanced infrastructure and good soil and climatic conditions the overall region has favourable possibilities.

Chalmers, W. S.; Murray, D. B. (Cocoa Research Unit, University of the West Indies, St. Augustine, Trinidad and Tobago). **The role of the cocoa industry in the economy of Trinidad and Tobago.** In: Proceedings of the West Indies Agricultural Economics Conference No. 8, pp. 78–83, (1973).

This historical review shows the role of the cocoa industry in the economy of

Trinidad and Tobago. Although the industry experienced continual crisis during recent years, the authors are of the opinion that there are several important reasons for revitalizing the industry. One of the reasons is that existing cocoa and coffee estates are the ideal base on which to build an integrated agricultural economy including food production which will provide employment for the rural population and stem the exodus to already overcrowded urban centres.

Okali, C. (Institute of Statistical, Social and Economic Research, University of Ghana, Legon, Ghana). **Labour inputs on cocoa farms.** In: Economics of cocoa production and marketing. pp. 3–19 (1974).

Labour inputs and labour arrangement on a number of cocoa farms of different ages are presented with the aim of studying the factors affecting intensity and type of labour used in these farms. A description of the area to which the data refer is given. Total labour inputs on farms of different ages and the contribution of different types of labour are discussed. The distribution of labour inputs between various activities on farms are presented and the implications of possible changes in techniques are indicated. Where data are available, comparisons are made with previous estimates given.

Rourke, B. E. (Institute of Statistical, Social and Economic Research, University of Ghana, Legon, Ghana). **Profitability of cocoa and alternative crops in Eastern Region, Ghana.** In: Economics of cocoa production and marketing. pp. 20–31 (1974).

This paper gives some provisional estimates of costs and returns of various alternative crop enterprises which might be grown in areas suitable for cocoa production. These crop enterprises are: mixed plantain and cocoyam, cocoa pure stand, cocoa intercropped with plantain and cocoyam, mixed maize and cassava, oil palm pure stand and oil palm intercropped with maize and cassava. These estimates suggest that the return on investments in the establishment of cocoa, particularly when returns from the intercrops are included are still high. However, both mixed plantain and cocoyam enterprise and an oil palm enterprise are of a similar profitability.

Olayemi, J. K. (Nigerian Inst. of Social and Economic Research, University of Ibadan, Ibadan, Nigeria). **Cost and returns to cocoa and alternative crops in Western Nigeria.** In: Economics of cocoa production and marketing. pp. 47–58 (1974).

Adoption of cocoa cultivation was stimulated by the fact that the farmers did not have to give up the cultivation of their traditional crops (rice, cocoyam, yam, orange, cassava, maize, coffee, oil palm, cola and rubber). This paper studies the relative importance of these crops vis-a-vis cocoa, gives the approximate rates of returns from these crops and examines the extent to which expected net returns from crops influence the choice of crops grown by farmers. The results showed a weak relation between acreage allocation and expected net returns, more so for food crops than for cash crops. Food crops were grown primarily for subsistence. Most of the cash crops were poor alternatives to cocoa. Most farmers considered these crops as complements. Besides the expected net returns the choice of crops and their acreage were based on how complementary they were in terms of the efficient use of family labour, effective weed control and maintenance of soil fertility.

Haessel, W. W. (Department of Economics, University of Ghana, Legon, Ghana), **Payoffs to alternative cocoa producers' coalitions.** In: Economics of cocoa production and marketing. pp. 512–532 (1974).

The possibility is examined of solving the problem of unstable prices and that of raising the price for cocoa by means of inducing a small group of large producers voluntarily withholding a portion of the cocoa crop from the market in years of excessive production. The profitability of various groups of producers withholding cocoa from the market in an effort to increase the world price and hence their total revenue is assessed. Certain problems in the currently proposed International Cocoa Agreement are outlined.

Leston, D. (Department of Zoology, University of Ghana, Legon, Ghana). **The diseconomy of insecticides in cocoa production in Ghana.** In: Economics of cocoa production and marketing. pp. 96–104 (1974).

This article examines the contention that routine application of insecticides was largely responsible for the marked increase in cocoa production which took place in the late fifties and early sixties. Production of cocoa from 1945/50 to 1972/73 is briefly discussed. All the beneficial effects obtained from the control of capsids, swollen-shoot virus disease and the black-pod fungus disease were of short term nature. Evidence is presented to indicate that routine application of pesticides is harmful to cocoa yield in the long term. It is concluded that the current recommendations for the control of capsids and the present method of swollen-shoot control are ecologically wrong and economically disadvantageous.

Akwabi-Ameyaw, K. (Department of Geography, University of Ghana, Legon, Ghana). **The development of the cocoa industry in Eastern Ashanti.** In: Economics of cocoa production and marketing. pp. 183–195 (1974).

Eastern Ashanti was one of the first important cocoa-growing areas in Ghana. At present, however, the area plays a much less important role as a producer of cocoa. This paper examines the growth of the cocoa industry in Eastern Ashanti and assesses some of the problems currently confronting cocoa farmers in the area.

Kumar, H. (Commodity Market Specialist, London, U.K.). **Institutional arrangements in the world cocoa market.** In: Economics of cocoa production and marketing. pp. 419–431 (1974).

This paper discusses the major institutional characteristics which reflect the basic structure of the world cocoa market as it exists today. It covers: (1) basis for cocoa prices; (2) the terminal markets; (3) the mechanics of price change in the terminal market; (4) causes of price change on the terminal market; (5) the actual cocoa market; and (6) some related observations.

Weymar, F. H. The effects of cocoa inventories on price forecasting. In: Economics of cocoa production and marketing. pp. 432–449 (1974).

A brief note on short- and long-term price movements is followed by a discussion on the economic system which generates intermediate-term price movements with special reference to the effect of inventory and inventory expectations on cocoa price.

Kofi, T. A. (Food Research Inst., Stanford University, Stanford, California, U.S.A.). **Vertical price relations in the international cocoa market and implications for Ghana's marketing policies.** In: Economics of cocoa production and marketing. pp. 450–490 (1974).

This paper investigates empirically the vertical price relations in the marketing channels in international trade and analyses the effects of imperfect competition in determining price levels and the distributive share of the profit margins. It covers: (1) history of cocoa marketing as it relates to Ghana; (2) empirical analysis of the marketing margins in the vertical channels; (3) empirical analysis of post World War II cocoa price determination mechanism; (4) use of cocoa future markets and implications for optimal pricing. It is concluded that policies should be enacted to create more competition in the cocoa market, especially on the buying side and policies should be taken to increase optimal producer use of the cocoa future markets. Implications of these policies are given.

Ajayi, S. I.; Oyejide, T. A. (Department of Economics, University of Ibadan, Ibadan, Nigeria). **A market share analysis of cocoa exports in Nigeria.** In: Economics of cocoa production and marketing. pp. 491–502 (1974).

This paper evaluates Nigeria's cocoa export performance on the basis of the country's relative share in major world markets or groups of markets from 1960 to 1970. On the basis of the analysis, some suggestions are made as to possible measures to improve the country's export position.

Kotey, R. A. (Institute of Statistical, Social and Economic Research, University of Ghana, Legon, Ghana.) **The organization of the internal marketing of cocoa in Ghana; The search for an efficient buying system.** In: Economics of cocoa production and marketing. pp. 381–392 (1974).

This paper examines the following two main problems in the internal cocoa marketing: (1) the economic performance of the existing Licensed Buying Agents (LBAs) and the reasons that stopped the activities of many of these LBAs in the 1972/73 season; (2) the search for an efficient marketing system, namely the choice between a competitive market with many LBAs operating and monopoly market with only one LBA operating. It is concluded inter alia, that a competitive market is most suitable provided that the LBAs satisfy the conditions laid down by the Cocoa Marketing Board, operate in a geographical area with a radius not exceeding about 80 km and are able to buy not less than 50 tons a year.

Gyekye, L. O. (Institute of Statistical, Social and Economic Research, University of Ghana, Legon, Ghana). **Transportation and storage problems in internal marketing of cocoa in Ghana.** In: Economics of cocoa production and marketing. pp. 393–402 (1974).

The transportation and storage problems in the internal marketing of cocoa are briefly outlined. The transportation costs involved when sending cocoa from the farms to the buying centres by farmers are specified. Expenses paid by produce clerks to transport owners as inducement to evacuate cocoa from remote areas in addition to the normal freight charges are given. It is concluded that it might be beneficial in certain cases to refund to the produce clerks expenses incurred to avoid the temptation of taking the money, meant for buying cocoa, to pay for these expenses. Insufficient roads, poor maintenance and inadequate freight vehicles appear to be the most important transportation problems facing produce clerks.

Addo, N. O. (Population Dynamics Programme, University of Ghana, Legon, Ghana). **Some employment and labour conditions on Ghana's cocoa farms.** In: Economics of cocoa production and marketing. pp. 204–218 (1974).

The overall pattern of employment on cocoa farms suggests that employment is related to many factors. A number of these are discussed including the extent to which the farmer can effectively mobilize family labour, the stage of development of the farms, the number and size of farms, the financial position of the farmer and the availability of effective labour for permanent employment.

Bateman, M. J. (Mars Confectionery Div. Ltd., Slough, U.K.) **An econometric analysis of Ghanaian cocoa supply.** In: Economics of cocoa production and marketing. pp. 286–326 (1974).

The econometric analysis of cocoa supply presented in this paper differs from earlier work in that two different equations have been used to estimate the effects of price and weather on production. The first equation is an average capacity equation which is additive in form because the variables employed in the equation have an additive effect on output. On the other hand the short-run equation which measures deviations from capacity due to short term prices and weather effects is multiplicative in nature. The parameter estimates in both equations are highly reasonable and significant except for the current rainfall variables. The conclusions derived from the model are given.

Blomqvist, A. G. (Department of Economics, University of Ghana, Legon, Ghana). **An approach to an optimal cocoa policy for Ghana.** In: Economics of cocoa production and marketing. pp. 327–346 (1974).

The main objective of this paper is to formulate a consistent dynamic model which would make it possible to find an optimal cocoa policy of planting and output over time. The paper covers: (1) formulation of an algebraic model of the optimal policy problem; (2) a discussion of the choice of parameters and of initial conditions; (3) a summary of the numerical experiments that have been carried out to date; and (4) some concluding comments.

Graft-Johnson, J. C. de (Department of Economics, University of Ghana, Legon, Ghana). **Co-operative marketing of cocoa in Ghana 1929-72.** In: Economics of cocoa production and marketing. pp. 351–366 (1974).

The history of co-operative marketing of cocoa is outlined. Some factors that have either inhibited or stimulated growth of co-operatives are discussed.

Okali, C.; Owusuansah, M.; Rourke, B. E. (Institute of Statistical, Social and Economic Research, University of Ghana, Legon, Ghana). **The development pattern of large cocoa holdings in Ghana: some case studies.** In: Economics of cocoa production and marketing. pp. 173–182 (1974).

Five large-scale cocoa farmers (two native and three migrants) were interviewed to study the pattern of their farm developments. Land acquirement was not a constraint on investment activities, but finance was the most crucial constraint. All the farmers were willing to take risks, the native one to the extent of borrowing money even at the prevailing high interest rates until the land was fully developed. The farmers did not develop their farms on small dispersed areas to spread risks, a practice claimed to be followed by small-holders. Labour for farm establishment and maintenance is discussed.

Manu, J. E. A. (Department of Economics, University of Ghana, Legon, Ghana). **Cocoa in Ghana economy.** In: Economics of cocoa production and marketing. pp. 265–276 (1974).

The main objective of this paper is to study the factors that have prevented the country from maximizing her earnings from cocoa exports in the period from 1960 to 1970. The study covers: (1) the significance of the cocoa industry to the economy of the country; (2) assessment of domestic policies towards the industry within the context of developments in the world market (the objective here is to analyse the reasons for the low output of cocoa to demonstrate the role of economic policy in promoting development of the industry); and (3) some suggestions to induce farmers to increase their output of cocoa as an alternative to the present pricing policy.

Beckman, B. (Department of Political Science, University of Uppsala, Uppsala, Sweden). **Government policy and the distribution of cocoa income in Ghana, 1951-1966.** In: Economics of cocoa production and marketing. pp. 277–285 (1974).

This paper deals with the large-scale redistribution of cocoa income which was brought about by the producer price and tax policies of the government and the administration of the surplus of the Cocoa Marketing Board. It covers: (1) factors responsible for changes in rates of accumulation; (2) redistribution of income among the factors of production; and (3) implications of the redistribution of cocoa income.

Wood, G. A. R. (Cadbury-Schweppes Ltd., Bournville, U.K.). **Some aspects of cocoa production costs on plantations.** In: Economics of cocoa production and marketing. pp. 59–67 (1974).

Some aspects of production costs of mature cocoa at Ikiliwindi estate in Cameroon and at an estate in Malaysia are discussed and compared. It is concluded inter alia, that the cost of production on these two estates is high in relation to the prices paid to farmers in West Africa. This does not mean that estates will be unprofitable, as this will depend on the actual price received. Where heavy deductions from world market prices are made, as in Cameroon, profits will be made only, when prices are unusually high.

Bonaparte, E. E. N. A. (Cocoa Research Inst., Tafo, Ghana). **An agronomist's assessment of recent research findings and their implications for cocoa production.** In: Economics of cocoa production and marketing. pp. 73–85 (1974).

Research conducted on breeding and selection, and agronomy of cocoa is reviewed. Implications of research findings for cocoa production are discussed.

Blomqvist, A. G.; Haessel, W. The price elasticity of demand for Ghana's cocoa: some estimates and policy implications. Economic Bulletin of Ghana (Ghana). v. 2(3), pp. 15–29 (1972).

One frequently hears the claim that an expansion of the output of cocoa is not a profitable course of action for Ghana because of the low price elasticity of demand for this produce. This paper investigates whether the pessimism in this respect is correct by attempting to estimate the marginal social revenue and cost of cocoa production.

September 1975

Soria, S. de J. (Divisão de Fitoparasitologia, Centro de Pesquisas do Cacau (CEPEC), Ilhéus, Bahia, Brazil). **Indução da produção em cacaueiro com uso de atomizador motorizado portatil na Bahia, Brasil.** (Induced production in cocoa by the use of a portable motorised knapsack sprayer in Bahia, Brazil). Revista Theobroma (Brazil). v. 4(2). pp. 3–13 (April 1974).

In the Bahia cocoa region the harvest in the first half of the year is small, due to low levels of insect pollinations. Blowing air using a knapsack sprayer induced mechanical pollination and tripled the yield compared to the untreated control. However, the net profit computed of the six month period was equivalent to only 8% of the treatment costs.

Berbert, P. R. F.; Esquivel, T. F. (Divisão de Fitologia, Centro de Pesquisas do Cacau (CEPEC), Itabuna, Bahia, Brazil). **Um método colorimétrico simples para determinação da intensidade de contaminação com fumaça em améndoas de cacau.** (A colorimetric method for determining the intensity of smoke contamination in cocoa beans). Revista Theobroma (Brazil). v. 4(2), pp. 14–20 (April 1974).

A simple method, found in Brazil, is to dissolve the tar compounds associated with smoke in ethyl alcohol and to assess the colour produced either visually or spectrophotometrically.

Menezes, J. A. de S.; Paniago, E.; Ladeira, H. P.; Bandeira, A. L. (Divisão de Socio-Economia, Centro de Pesquisas do Cacau (CEPEC), Itabuna, Bahia, Brazil). **Economicidade dos insumos modernos em fazendas de cacau.** (Economic aspects of modern inputs in Bahian cocoa farms). Revista Theobroma (Brazil). v. 4(2). pp. 21–33 (April 1974).

The results suggest that modern inputs such as fertilizers, pesticides, etc. are profitable. It is shown that profitability can be increased more rapidly for modern inputs than for other inputs. Detailed data are presented on costs and returns.

Olayemi, J. K. (University of Ibadan, Ibadan, Nigeria). **Technology in the western Nigerian cocoa industry: an empirical study.** Economic Bulletin of Ghana (Ghana). v. 2(2). pp. 47–60 (1972).

The economic impact of the adoption of improved cocoa seedlings and of black pod fungicides is analysed. It was concluded that although each of the two new technologies was basically profitable to adopt, the incremental rate of return on invested capital from the use of black pod fungicides was probably about three times that expected from the use of improved seedlings. It was found that while almost 95% of the farmers interviewed had used the spray chemicals, only about 22% has used the improved seedlings.

Menezes, J. A. de S. (Divisão de Socio-Economia, Centro de Pesquisas do Cacau (CEPEC), Ilhéus, Bahia, Brazil). **Resultado econômico de renovação de cacauis: um estudo de caso.** (Economic results of renovation of cocoa plantations: a case study). Cacau Atualidades (Brazil). v. 11(3). pp. 2–7 (July 1974).

Detailed cost figures are presented for the renovation of a cocoa plantation in Brazil. The yields of cocoa and banana, used for shading, are given, together with the returns. Conditions under which renovation is profitable or not are compared.

Silva, P. (Divisão de Fitoparasitoligia, Centro de Pesquisas do Cacau (CEPEC), Ilhéus, Bahia, Brazil). **Combate aos insetos do cacau armazenado na Bahia.** (Insect control of stored cocoa in Bahia). Cacau Atualidades (Brazil). v. 11(3). pp. 8–12 (July 1974).

All the noxious insects of cocoa in storage in Brazil are described and measures of control are discussed.

Garcia, J. de J. da S. (Centro de Pesquisas do Cacau (CEPEC), Ilhéus, Bahia, Brazil). **Evolução do projete cacau no baixo e médio Tocatins.** (Development of the cocoa project in the lowland and upland areas of the Tocatins region). Cacau Atualidades (Brazil) v. 11(3). pp. 21–25 (July 1974).

Developments in cocoa cultivation in the Tocatins area of Amazonia, Brazil, are discussed with special emphasis on climate and soils. Expansion tends to be in the upland areas rather than in the lowland areas.

Ahenkorah, Y. (Cocoa Research Inst., Tafo, Ghana). **Use of radio-active phosphorus in determining the efficiency of fertilizer utilization by cacao plantation.** Plant and Soil (Netherlands). v. 42(2). pp. 429–439 (April 1975).

In Ghana uptake of P^{32} was greatest during the wet season and root activity highest within the upper 3 cm soil layer in both wet and dry season. Highest P^{32} activity occurred at a distance of 120–160 cm and lowest at 91 cm from the tree base. In a 20 year old cocoa plantation planted at 240 cm $\times$ 240 cm, the fertilizer should be broadcast during the wet season. Under low soil moisture conditions the placement of P^{32} labelled superphosphate provides information on relative availability of the fertilizer or soil P. Active roots of cocoa tend to be more extensive and are capable of exploring a much larger area than hitherto expected.

Kotey, R. A. (ed); Okali, C. (ed); Rourke, B. E. (ed). (Institute Statistical, Social and Economic Research Legon (Ghana). **Economics of cocoa production and marketing.** 560 p. (1974).

This volume contains papers presented at the Cocoa Economics Research Conference organized by the Institute of Statistical, Social and Economic Research of the University of Ghana from 9th to 12th April, 1973. The papers presented deal with the following topics: (1) costs and returns from coçoa farms (4 papers); (2) research findings and improved practices (4 papers); (3) land and labour problems (6 problems); (4) production policy (7 papers); (5) internal marketing (4 papers); (6) international marketing and manufacturing (6 papers). Discussions following each session are given.

Elliott, H. (Center for Research on Economic Development, University of Michigan, Ann Arbor, Michigan, U.S.A.). **A benefit/cost analysis of cocoa development programs in Ivory Coast.** In: Economics of cocoa production and marketing. pp. 105–152 (1974).

The economic benefits of two programmes for the improvement of cocoa production are discussed. These programmes are: (1) the anti-capsid campaign which started in 1959; and (2) the regeneration of traditional plantation. The economics of traditional cocoa cultivation are discussed so as to provide a basis for comparison with a regenerated plantation.

October 1975

Kaufmann, T. (Cocoa Research Inst., Tafo, Ghana). **An efficient new cocoa pollinator, Lasioglossum sp. (Hymenoptera: Halicitdae) in Ghana, West Africa.** Turrialba (Costa Rica). v. 25(1). pp. 90–91 (January 1975).

The sun-loving Lasioglossum sp. visits cocoa flowers (Theobroma cacao) blooming at the canopy level to gather pollen. During this process, the bee's zigzag movement in and out of petal hoods makes the insect brush against pistil five times in each flower, resulting in a characteristic distribution of pollen grains around the style. The pollination efficiency of Lasioglossum spp. proved more than twice as effective as some of the commonest ceratopogonids in Ghana. This advantage is further enhanced by the bee's longer active hours and much greater flying distances. The importance of this cocoa pollinator for future studies is stressed. Authors' summary.

Lee, N. R. (Makanga Agricultural Experiment Station, Chiromo, Malawi). **Irrigated Upper Amazon cacao in the lower Shire Valley of Malawi. II – A water rates trial.** Tropical Agriculture (Trinidad and Tobago). v. 52(2). pp. 179–182 (April 1975).

Three different irrigation factors of 0·6, 0·8 and 1·0 of the evaporation from a Kenya type pan, together with two irrigation deficits of 5·2 cm and 10·4 cm, were compared in a factorial trial on Upper Amazon cocoa. The 0·8 factor gave the higher yield of both pods and wet beans, but the differences were not significant. Irrigation at a deficit of 5·2 cm significantly increased the yield of wet beans compared with the 10·4 cm treatment. The periodicity of the harvest built up to a maximum in March during both seasons, but was not affected by any of the treatments. Author's summary.

Seng, T. G. (Faculty of Agriculture, University of Malaya, Kuala Lumpur, Malaysia). **Helopeltis theivora theobromae on cocoa in Malaysia. I. Biology and population fluctuations.** Malaysian Agricultural Research (Malaysia). v. 3(2). pp. 127–132 (August 1974).

Descriptions of life-cycle and habits of this mirid are given. The seasonal population curve is monomodal with the peak in October and the lowest numbers in April–May.

Gutérreq, C. H. Instructivo para el cultivo de cacao en Colombia. (Instructions for the growing of cocoa in Colombia). Chocolatería LUKER Manizales (Colombia). 52 pp. (1974).

Recommendations are given on the cultivation of cocoa with special reference to Colombia, including a cost calculation on cocoa production.

Raj, H. G.; Kee, C. K. (Faculty of Agriculture, University of Malaya, Kuala Lumpur, Malaysia). **Effects of nitrogen on growth of seedling cocoa (Theobroma cacao L.)** Malaysian Agricultural Research (Malaysia). v. 3(2). pp. 153–161 (August 1974).

The effect of nitrate nitrogen on the growth of Amelonado cocoa are reported. N was applied to seedlings in sand culture at three levels, namely, 35 ppm (N_1), 70 ppm (N_2) and 140 ppm (N_3) The investigation was carried out for four months. In the first three months no significant differences in growth, except for leaf number, were observed among the three N levels. In the fourth month, highly significant differences were found in all the growth characters studied, namely, number and area of leaf, height and girth of stem and dry weight per plant. The best performance was noted in level N_3 and the poorest in N_1. The latter plants were uniformly pale and stunted.

Lee, B. S.; Varghese, G. (Faculty of Agriculture, University of Malaya, Kuala Lumpur, Malaysia). **Studies on the genus Phytophthora in Malaysia II. Reproduction and sexuality.** Malaysian Agricultural Journal (Malaysia). v. 3(2). pp. 137–144 (August 1974).

Studies on the reproduction and sexuality of Phytophthora palmivora, P. heveae, P. nicotianae var. parasitica, P. capsici and P. melongenae indicated that generally sporangia were produced in cultures on a variety of nutrient media and at pH levels ranging from 4–9, although variations in the degree of sporulation were observed among species.

Adebayo, A. A. (Cocoa Research Inst. of Nigeria (CRIN), Ibadan, Nigeria). **The neglected side of black-pod control.** East African Agricultural and Forestry Journal (Kenya). v. 40(1). pp. 72–76 (July 1974).

Observations on the spread of the Phytophthora pod rot disease in cocoa in Nigeria during the rainy season and investigations on the mode of survival of the fungus P. palmivora through the dry season indicate that diseased pods are important in the initiation and spread of the disease. Diseased pods which were not harvested were found to be sources of infection leading to a rapid spread during the rains whereas pod and husk heaps became sources of fresh outbreaks at the beginning of the rainy season.

November 1975

Nguyen Ban, J. (Centre de Recherches, Institut Français du Cafe et du Cacao (IFCC), Bingerville, Abidjan, Ivory Coast). **Dinamique d'une population d'Earias**

biplaga (Wlk) – Lépidoptére, Noctuidae – dans l'écosystème du cacaoyer cultivé en basse Côte d'Ivoire. (Dynamics of an Earias biplaga (Wlk) population – Lepidoptera, Noctuidae – in the ecosystem of the cocoa tree cultivated in the Lower Ivory Coast). Café, Cacao, Thé (France). v. 19(1). pp. 5–18 (January 1975).

The dynamics of Earias and the various factors involved are discussed comprehensively on the basis of laboratory and field studies. The rapid development of the insect in the ecosystem of cocoa coincides each year with a period of stress in the tree, resulting from optimum climatic conditions and favourable nutritional status of the substrate.

Soenarjo. (Balai Penelitian Perkebunan Bogor, Jember, Indonesia). **Akar bengkok pada bibit kopi dan cokelat laporan dari lapangan.** (Bent tap-roots of coffee and cocoa seedlings). Menara Perkebunan (Indonesia). v. 42(6). pp. 305–307 (1974).

Investigations carried out in the nursery bed at Kaliwining experiment station in E. Java, Indonesia, have shown that stunted growth of the coffee and cocoa seedlings is frequently accompanied by bent or abnormal tap roots. It is therefore recommended not to use such seedlings.

(Ministerio de Agricultura y Cria, Caracas, Venezuela). **Manual de cacao Venezolano** (Handbook on cocoa in Venezuela). Ministerio de Agricultura y Cria Caracas (Venezuela). 35 pp. (December 1974).

Recommendations, based on the latest research findings for the rehabilitation of the cocoa cultivation in Venezuela, are presented.

Wessel, M.; Giesberger, G. (International Agricultural Centre, Wageningen, Netherlands). **Necrotic tissue in beans of cacao (Theobroma cacoa L.).** Tropical Agriculture (Trinidad and Tobago). v. 52(3). pp. 259–268 (July 1975).

Recently, necrotic tissue was found in beans of cocoa in N. Sumatra, Indonesia. The disorder is described and possible causes are discussed. The symptoms and the pattern of occurrence suggest that mainly nutritional factors are involved. The results of foliar and bean analyses have been studied concerning a possible relationship between nutritional factors and the disorder. Authors' summary.

Carvalho, A. M. F. de. Análise dos fatores produtivos na exploração de cacau. (Analysis of production factors in cocoa farming). Cacau Atualidades (Brazil). v. 10(1). pp. 12–16 (January 1973).

Four size classes of cocoa farms in the Ilhéus district were compared with respect to their land use, labour, and capital, and to the type of management.

Omotoso, T. I. (Cocoa Research Inst. of Nigeria (CRIN), Ibadan, Nigeria). **Technical and research aspects of soil fertility and fertilizer use in Nigeria with special reference to cocoa.** Phosphorus in Agriculture (U.K.). v. 29(64). pp. 37–42 (March 1975).

This paper summarizes some of the research work on cocoa. The results showed: (1) yield decline was partly due to selection of bad sites and lack of fertilizer use; (2) the crop generally responded well to N and P fertilizers; responses to K being limited to soils on sedimentary rocks with low K contents and to leached soils; (3) Amazon cocoa was more sensitive to soil boron deficiency than amelonado; (4) soil organic P contributed to the P nutrition of the crop; (5) in some soils about 54·4% of applied **P** (over a 5-year period) remained fixed; (6) beans, testa and husks analyses showed amelonado cocoa to remove 38·9, 6·3 and 20·4 kg of N, **P** and K, respectively, from the soil in a ton of harvested dry cocoa; and (7) 296, 152 and 118 kg/ha of urea, triple superphosphate and potassium sulphate, increased yield of amelonado cocoa. Also published in a French edition; pp. 37–43.

Olofinboba, M. O. (Department of Botany, University of Ibadan, Ibadan, Nigeria). **Studies on seedlings of Theobroma cacao L., variety F_3 Amazon. I. Role of cotyledons in seedling development.** Turrialba (IICA). v. 25(2). pp. 121–127 (April 1975).

This study showed that removal of the cotyledons from above cocoa variety, before the formation of four fully expanded leaves results in growth retardation. The cotyledons are not important photosynthesising organs, but they store food reserves for the development of the seedling. The importance of these reserves for growth decreases with the age of the seedling. Application of herbicides on the cotyledons caused swelling of the hypocotyl, suppression of growth, and rapid proliferation of lateral root primordia.

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