COCOA GROWERS' BULLETIN

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Contents

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Editorial

The Work of the Plant Breeder

During the past 20 years much of the research on cocoa, particularly in West Africa, has been devoted to pests and diseases. With the crises due to swollen shoot virus and capsids this was inevitable, and the work is of vital importance, but it is in a sense a negative approach to save the trees or the crop from destruction but fail to make any improvement in the trees themselves. This is the field of the plant breeder and the agronomist. The agronomist can show the methods by which high yields can be obtained but it is the plant breeder who provides the potential, the planting material that will respond to the right conditions, or alternatively offers resistance to disease, better quality or the ability to thrive in marginal conditions.

When cocoa research began in Trinidad in 1930 an important section of the programme was concerned with a survey of the tree population which formed the basis of selection. The original aim was to produce trees of high-yielding capacity, and this resulted in 100 selections being made. Later it became clear that witches' broom disease—new to Trinidad when research started there—could only be countered by the use of resistant trees. The search for resistance took F. J. Pound to the Amazon valley. This search was not only successful in finding plants resistant to witches' broom but the material brought back has formed an essential part in breeding programmes all over the world. The breeding work in Ghana is described by D. R. Glendinning in his article on New Varieties of Cocoa at Tafo.

The next stage

It takes many years for the work of selection to result in improved material being distributed. The Amazon types taken from Trinidad to West Africa in 1943 were distributed to farmers 10 years later, and it has taken a further 10 years to develop and produce seed of the new varieties described by Glendinning.

This is only a beginning. The plant breeders are on to the next stage, testing varieties resistant to various diseases: witches' broom, black pod, swollen shoot. Some of these are already available, others will be in the future. Looking further ahead there will be varieties suited to different conditions—wetter or drier areas, for instance—and resistant to local diseases, but this is a long way off. However, the need for such specialised varieties emphasises the importance of widespread trials of new varieties.

This vital work depends on a very small number of plant breeders. Mr. Glendinning has now left Ghana and cocoa research and his post has not been filled. The cocoa industry can ill afford any gap in the continuity of this field of research.

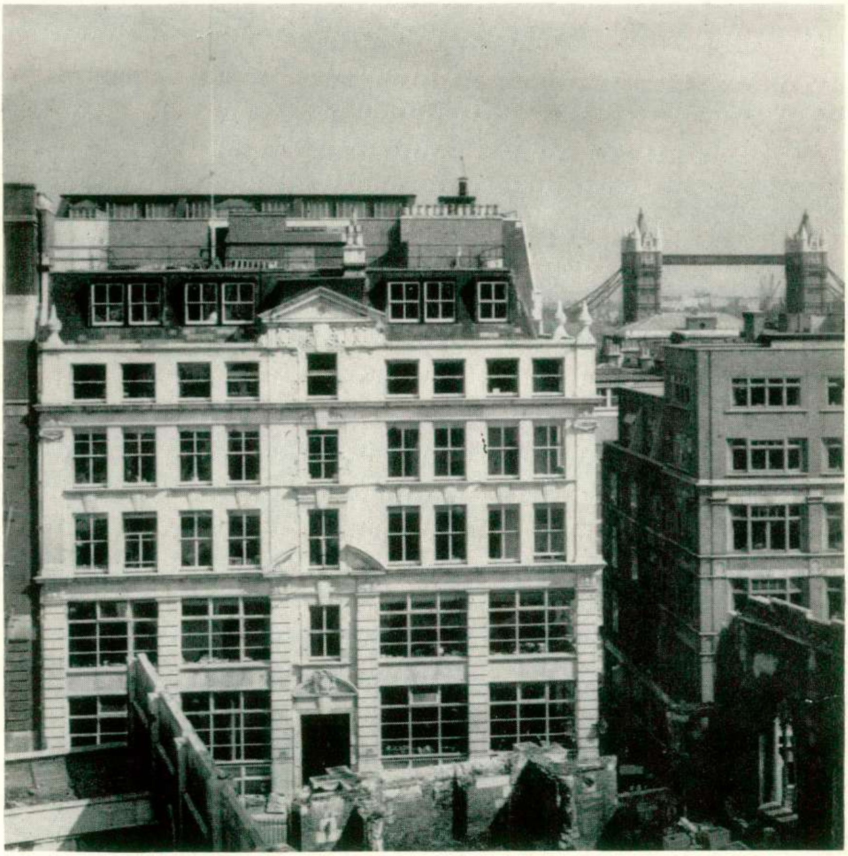
G. A. R. Wood.

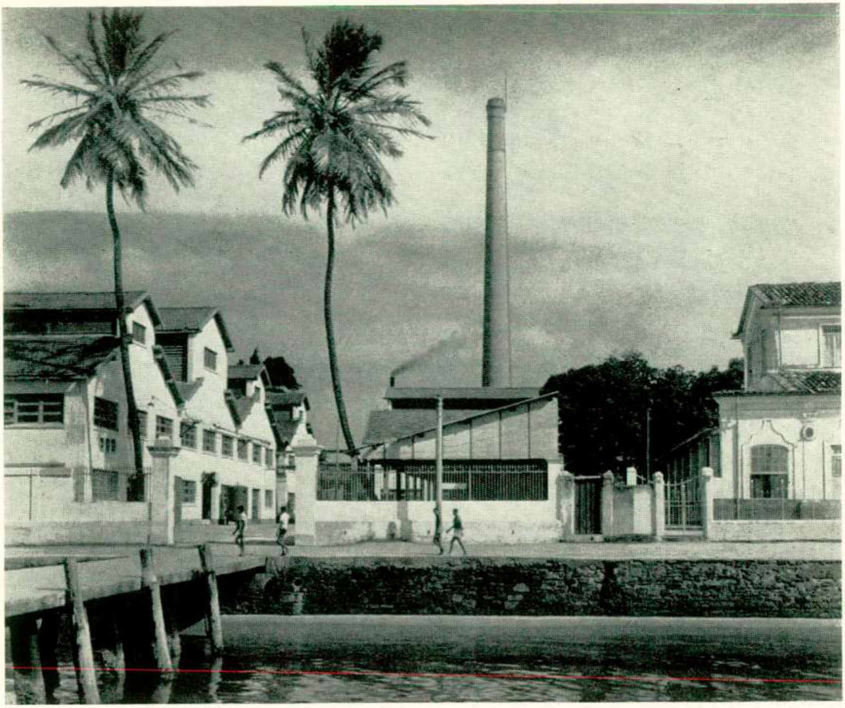
Gill & Duffus Ltd.

This is the sixth article in a series on the larger firms in the cocoa industry. Previous articles have dealt with Cadbury, Nestlé, Rowntree, Suchard and W. R. Grace.

The Gill & Duffus organisation provides a service to the growers of cocoa and to the chocolate and confectionery industry, both in the United Kingdom and throughout the world. In their role as cocoa merchants they are the largest dealers in cocoa beans and cocoa products in Europe and America, while in their capacity as manufacturers of semi-processed cocoa products, with factories in England, Ghana and Brazil, Gill & Duffus supply both the chocolate and bakery industries with cocoa butter, mass, powder and cake. At the same time, the general produce sector of the firm caters for the industry's requirements of

The headquarters of the Gill & Duffus Group in St. Dunstan's Hill.





The cocoa processing plant of Joanes Industrial, S.A., Salvador, Bahia.

most types of edible nuts and for various other items such as glacé cherries and wafer paper. Over the past 12 years the produce side has also pioneered research on the mechanical processing of Brazil nuts and cashew nuts. The successful development of these projects has resulted in the setting up of a Brazil nut-cracking factory in the north of England, at Hull, and a cashew-shelling plant in East Africa.

The history of Gill & Duffus dates back almost to the beginning of this century. In 1907 two young men, F. G. Gill and A. S. Duffus, joined forces and their small capital and formed a private partnership to carry on the business of general produce merchants dealing principally in edible nuts and oils. In the late 1920s, the firm started dealing in cocoa and the partnership became a limited company in 1929. Subsidiary companies were formed in Liverpool and Glasgow. In 1935 a separate company, Gill & Duffus (Cocoa) Ltd., was formed. It was from this nucleus that the present organisation was developed. Gill & Duffus became a public company in December 1949.

The headquarters of the Gill & Duffus Group is in the heart of the City of London, close by the Tower of London, and conveniently located near Mincing Lane, where the Cocoa Futures Market is situated and which is also the centre of the cocoa dealing market in London. The parent company's block of offices is opposite the famous Wren church of St. Dunstan's in the East, which is renowned for what is probably the finest example of Wren's flying buttress.

The church suffered severe damage during the last war and the nave was destroyed, but the spire and buttresses escaped and have since been rebuilt. The company have adopted their outline as a form of trademark.

Gill & Duffus have expanded rapidly over the last decade-and-a-half. In 1951 an office was opened in Toronto and in 1952 in New York. The New York company, Gill & Duffus Inc., in particular, has grown steadily and is now one of the largest cocoa dealing companies in the New York market. In 1961 Gill & Duffus acquired the share capital of the long-established and well-known London Merchant firm, Pacol Ltd., together with the Pacol subsidiary companies in Toronto and Paris. This enlargement of the organisation brought trading interests in other commodities within the structure of the Group, notably coffee, rubber and spices. The coffee business has been enlarged over the past few years and is now being carried on also in New York and on the continent of Europe. However, at the same time the cocoa trading departments of both Gill & Duffus and Pacol have retained their own individuality and have been trading in close competition with one another, and this has broadened the scope of the cocoa business even further. In 1961, when the Ghana Cocoa Marketing Company moved from London to Accra, offices were opened in Accra, and yet another overseas company, Gill & Duffus (Ghana) Ltd., was formed. To gain a second foothold in the Common Market, Gill & Duffus Continentaal N.V. was formed in Amsterdam in 1964. This company is owned jointly with the Dutch company, N.V. Continaf of Amsterdam.

The company's activities in cocoa manufacturing first started in the early years of the last war. In 1940 a close working relationship was formed with British Cocoa Mills (Hull) Ltd., and a joint venture, Southern Cocoa Mills, was started at Reading. Since the war B.C.M. have become wholly owned by Gill & Duffus and the manufacturing side has been concentrated at Hull.

The manufacture of cocoa products is an important part of the organisation. At the Hull factory a complete range of semi-processed cocoa products is made. One problem which arises in supplying cocoa products to a large industry, such as chocolate making, is the wide difference in the qualities required for these products, especially for cocoa butter. The chocolate industry in the U.K. is made up of many firms each using their own formulae and many require special blends and roasts in the manufacture of their cocoa butters. The factory prides itself that it can meet these requirements. In their endeavour to provide the best possible service to their customers, B.C.M. have for many years been using road tankers for bulk delivery of cocoa butter.

At the same time a wide range of cocoa powders is manufactured from the high-fat powders, used in drinking chocolate, down to the fat-free powders, which are occasionally required by the bakery trade. Here again, the individual requirements in flavour, fineness and colour vary enormously but the technical department can usually match customers' requirements. In the past the factory have even been called on to produce special red and black powders. Great importance is also attached to the export market and an increasingly important tonnage is being sold overseas.

Overseas cocoa processing factories are operated in Ghana and Brazil. The development of West African Mills at Takoradi in Ghana first began in 1947 and the factory went into operation in 1949. W.A.M., as it is known throughout the world, was the first cocoa-processing factory to be set up in West Africa and it is the largest cocoa-processing factory in Africa. In 1964 the Government of Ghana acquired a majority shareholding in West African Mills and the factory is now being run as a joint venture with the Ghana State Cocoa Marketing Board. The main products produced at West African Mills are cocoa butter and cocoa cake.

On the other side of the South Atlantic, at Salvador in the Brazilian State of Bahia, Gill & Duffus built the cocoa-processing factory of Joanes Industrial, S.A. in the late 1940s. A small processing industry had been in existence in Bahia since the early 1930s. This industry has been expanding in recent years and the Joanes's factory has grown along with the rest of the industry. As at the West African factory, the principal products manufactured are cocoa butter and cocoa cake for export, but the production of cocoa powder is being developed and cocoa mass is also manufactured, although this is not exported but sold to the chocolate industry in Brazil.

The general produce side of the organisation is based mainly in the U.K. It is concerned with trading in edible nut kernels, selling to the confectionery industry and also to the bakery, grocery and other allied trades. Almonds, Brazils, cashews, hazelnuts and walnuts, as well as the less important kernels such as pecans, pignolias, pistachios and apricot kernels, are imported. The Group own the general produce broking firm of Guedalla & Butcher Ltd., who have a close working relationship with the Californian Almond Growers Exchange. In the north of the country Gill & Duffus (Liverpool) and Gill & Duffus (Glasgow) have built up thriving businesses in canned goods and hold many important agencies, as well as dealing in edible nuts and kernels.

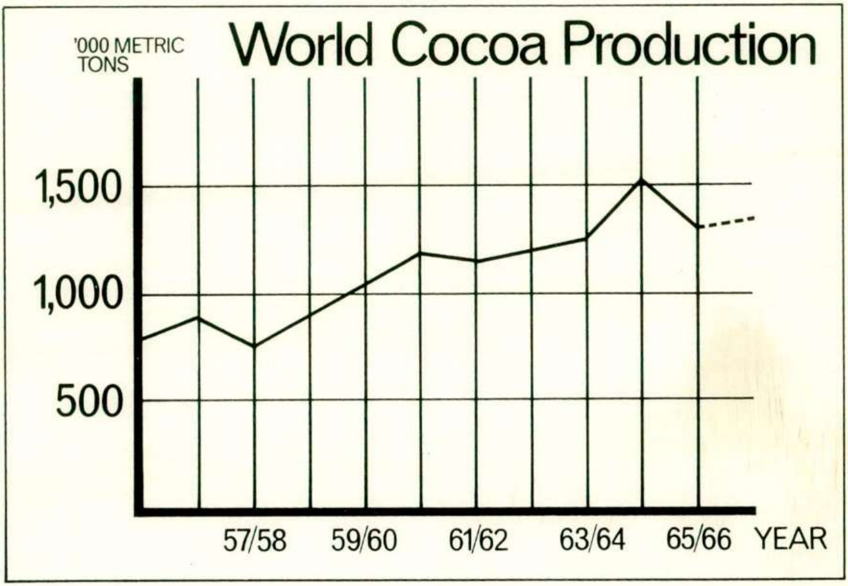
The Brazil nut-cracking plant at Hull is one of the few factories of its type in the world and was the first fully mechanised plant ever to be put into operation. In developing this process the company received much support and encouragement from Cadbury Brothers. As well as serving the U.K. industry, part of the production is exported. During the past few years research has also been taking place at the Hull plant into the mechanical shelling and blanching of the cashew nut. After a considerable amount of research a successful and economic method of obtaining the kernel was developed. In 1964 Gill & Duffus joined with Pierce Leslie & Co. Ltd. in a new venture in Portuguese East Africa that involved the expansion of Pierce Leslie's existing factory at Inhambane, which is situated about 250 miles north of Lourenço Marques, the capital of Mozambique. The factory should be fully operational by the end of this year.

Review of Production and Consumption

A. P. Williamson, Cadbury Brothers Limited

Production

The 1965-66 cocoa year has ended, and while a number of countries have still not declared their final figures it seems certain that the production will be very close to the F.A.O. March estimate of 1,260,000 tons which we published in our last Bulletin. Even though much lower than the 1964-65 total this was still the second largest crop on record, as is shown below:—



All the West African mid-crops were below average, but compensating for this was a bigger than usual temporao crop in Brazil of 1,195,000 bags or 72,000 tons.

It is still too early to make an accurate estimate of the 1966-67 crop although the F.A.O. has made a preliminary forecast of 1,316,000 tons. Small or moderate increases are forecast for all the West African producers, with the exception of Fernando Po. The Brazilian forecast shows a decrease of 35,000 tons, while other American producers are put at much the same level as last year. In the Pacific a large increase is forecast for New Guinea and Papua after their set-back last year.

Grindings

The third quarter's grinding figures for the major consumers were announced before the F.A.O. Cocoa Statistical Committee met in October, and it was able to put forward a fairly reliable estimate of 1,383,000 tons for 1966. This is 45,000 tons or 3·3 per cent up on 1965, which was itself an all-time record.

WORLD COCOA PRODUCTION AND GRINDING FIGURES

issued by the F.A.O. in October 1966

(Thousand metric tons)

PRODUCTION

	1964/65	1965/66	1966/67 (forecast)
Africa	1,196·1	893·5	970·6
South America	207·7	252·9	222·7
North and Central America ..	91·1	83·6	83·5
Oceania	25·0	22·6	31·7
Asia	7·8	8·0	8·0
World Total	1,528	1,261	1,316
Principal Countries:			
Ghana	580·4	415·6	437·0
Nigeria..	298·3	188·0	224·0
Ivory Coast	147·5	121·0	140·0
Cameroon	91·2	91·0	95·0
Fernando Po/Rio Muni	34·7	34·9	32·0
Brazil	118·5	170·8	135·0
Ecuador	48·2	38·0	43·0
Dominican Republic	38·0	34·0	35·0
Mexico	22·7	23·0	24·0
New Guinea and Papua	21·0	19·0	27·0

GRINDINGS

	1965	1966 (estimate)	1967 (forecast)
Western Europe	605·5	622·8	623·4
North America	302·0	313·2	324·0
Eastern Europe and U.S.S.R. ..	147·3	151·8	167·0
Australia and New Zealand ..	17·2	17·3	18·0
Central and South America ..	137·3	139·2	136·2
Asia	50·9	52·6	56·6
Africa	77·4	85·7	116·5
World Total	1,338	1,383	1,442
Principal Countries:			
United States	285·1	295·0	305·0
West Germany	155·0	159·0	162·0
Netherlands	119·0	120·0	114·0
United Kingdom	102·2	109·7	109·7
U.S.S.R.	80·0	85·0	95·0
France	63·1	63·0	64·0
SURPLUS/DEFICIT			
Production > Grindings ..	190	—	—
Grindings < Production ..	—	122	126

The general pattern has been for the fairly rapid expansion in cocoa usage to continue during the first part of the year but to fall away later. It must be remembered that because cocoa is usually bought and sold well forward, the low prices of June, July and August 1965 were still dominating the average U.S. and U.K. import prices as late as April 1966. The effects of the higher-priced landings since then can be seen from the percentage changes in the quarterly grinding figures for four major consumers compared with the same quarter of last year.

Country	First Qtr. per cent	Second Qtr. per cent	Third Qtr. per cent
United States	+ 3·9	+9·2	+1·4
United Kingdom	+22·4	+6·1	+6·7
Netherlands	+15·4	+0·9	—5·8
West Germany	+ 4·4	—6·8	—1·3

Over the whole year the F.A.O. forecasts that all the main consuming blocks will show an increase, with most individual countries slightly up but a few slightly down.

It is too early to make a realistic estimate of the 1967 usage, but assuming that present price levels continue, the F.A.O. has put out a provisional forecast of 1,442,000 tons. This is 59,000 tons or 4·3 per cent above the 1966 estimate. Again, mainly small increases are suggested in most traditional consuming areas but the grindings in West African producing countries are increased by nearly 38 per cent.

World Stocks and Price

The large surplus that followed the huge 1964-65 crop swelled world cocoa stocks to a record 600,000 tons or 5-6 months' supply. This compares with an immediate post-war level of 200,000 tons, or 3-4 months' supply at the time. Bearing in mind the seasonal nature of cocoa supplies, the latter stock level really indicated a "hand to mouth" existence for the chocolate manufacturers, and the continuation of stocks at this level was the principal cause of the high prices during the 1950s.

It seems certain that 1966 will see a deficit very close to the 122,000 tons estimated by the F.A.O., and if their forecast of a similar deficit in 1967 proves correct this would mean that nearly 250,000 tons would have been drawn from world stocks by the end of 1967 and their level would have fallen to 350,000 tons. On the basis of the forecast consumption this would be no more than three months' supply, or back to the "hand to mouth" level, and one would expect to see an appreciable hardening in cocoa prices.

Measurement of Consumption

In our last Bulletin it was shown that the production of intermediate cocoa products in cocoa-producing countries was growing very rapidly, and it was pointed out that as a result the use of grindings statistics to measure a country's consumption could be very misleading.

In this issue we have attempted to give an indication of the real extent of each country's consumption, taking into account not only the level of its grindings, but also its net imports, or exports, of intermediate cocoa products, such as cocoa butter, cocoa powder, cocoa mass and chocolate crumb and also of finished chocolate goods. To do this it has been necessary to reduce each different product back to the quantity of beans that it represents, or its "bean equivalent". There is a considerable amount of discussion at the present time as to the best factors to use for this purpose, but in this exercise we are using the factors proposed by the U.K. for use in an International Cocoa Agreement.

Below is a list of the principal consuming countries trading in intermediate cocoa products and finished chocolate goods. It indicates the 1965 level of their grindings, their imports or exports of intermediate products, their import or export of finished chocolate goods and finally their total consumption.

COMPARISONS OF GRINDINGS AND CONSUMPTION, 1965

Country	Grindings	Net Imports of Cocoa Products	Net Imports of Finished Chocolate Goods	Consumption
Austria	12·3	3·3	2·0	17·6
Belgium	18·0	14·3	—3·5	28·8
France	63·1	12·0	0·8	75·9
West Germany ..	155·0	—3·4	21·6	173·2
Ireland	10·5	—3·1	—4·4	3·0
Italy	41·6	—12·6	—1·3	27·7
Netherlands ..	119·0	—89·8	—19·5	9·7
Switzerland ..	14·4	15·9	—7·0	23·3
United Kingdom ..	102·2	63·4	—10·7	154·9
Scandinavia ..	18·7	17·6	1·2	37·5
United States ..	285·1	32·8	7·4	325·3
Canada	16·9	22·4	0·4	39·7
Japan	25·0	16·7	0·5	42·2
Australia/ New Zealand ..	17·2	10·0	—	27·2

Notes: (1) Exports marked negative.
(2) All figures in '000 metric tons of bean or bean equivalent.
(3) Factors used: Butter, 2·15; Powder, 0·3; Mass, 1·25; Crumb, 0·125; Chocolate, 0·6.
(4) All figures for 1965.

International Cocoa Agreement

Last May a full negotiating conference was summoned by the United Nations Conference on Trade and Development to try and reach agreement on an international scheme for cocoa. The meeting was held at the United Nations Headquarters in New York and lasted five weeks. The aim of the proposed scheme was to reduce the wide fluctuations in cocoa prices brought about by the sudden changes in annual production. The proposals involved the use of a quota system to restrict supplies on to the market in years of over production and this was to be backed up by a buffer stock scheme which would purchase and store all cocoa surplus to these quotas and then release it on to the market in those years when there was a shortage.

Unfortunately it proved impossible to get agreement on the price levels at which the quota and buffer stock systems would operate, although much useful work was done and the producing and importing countries were very much closer together than at the last full negotiating conference, in Geneva, in 1963. There was a real desire on the part of all participating Governments to get an agreement, and it was made clear that the momentum of the negotiations must not be allowed to wane.

It is hoped that it will be possible to reconvene the full negotiating conference in the middle of 1967, and towards this end there have been meetings of a working party in Geneva in September and also in New York in December.

THE WORLD'S COCOA ORGANIZATIONS:

4. The American Cocoa Research Institute

Ernest P. Imle, Director of Research

The chocolate-manufacturing industry of the United States has been encouraging and supporting research, training and dissemination of information concerning cocoa agriculture since 1947. This work is done through the American Cocoa Research Institute (hereafter referred to as ACRI), which is a non-profit affiliate of the Chocolate Manufacturers' Association (CMA) of the U.S.A. Funds for operations of ACRI come from contributions made by members of the industry based upon amounts of cocoa beans and semi-processed materials they import.

Recognising the technical complexities and the international character of cocoa production, ACRI has chosen from the beginning to work primarily through established U.S. and foreign institutions. Financial grants and technical advice are given for selected projects at established co-operating institutions, and ACRI has made no attempt to establish its own separate facilities for research and training.

This method of operating has given flexibility and good results. In the long run it is expected to strengthen existing institutions and to leave them with a residual experience and interest in cocoa.

ACRI operates from offices in Washington, D.C., with an Executive Director, a Director of Research, and a small office staff. A Board of Directors, whose members serve without compensation, determines policies and authorises projects. This Board is made up of representatives of the cocoa and chocolate industry of the U.S.A. (1).

The Director of Research has to maintain close liaison with pertinent public and private institutions in the tropics and elsewhere and has to keep abreast of cocoa problems and of pertinent research with other crops. He also serves as liaison officer between ACRI and the CMA Technical Committee and on advisory committees to other organizations which concern themselves with work on cocoa such as FAO, University of the West Indies and the International Office of Cocoa and Chocolate (IOCC). These connections help to keep ACRI abreast of over-all technical needs of cocoa agriculture. The ACRI office also serves in some degree as a clearing house or centre for technical cocoa problems of the western hemisphere.

For the period 1947 through 1965, expenditures by ACRI for the above purposes were in excess of $2,000,000.00 (U.S.). Recent annual budgets have been approximately $200,000.00 (U.S.). As of 30th September, 1966, ACRI was supporting or helping to support 14 separate projects. Over the past years 23 other projects have received support and are now either completed or terminated (2, 3).

Projects for support are selected on the basis of their potential for contribution to ACRI goals, as stated in our opening sentence. Support for on-going research and training has taken the major part of available funds but shorter-term special projects likewise are sponsored. By co-operating closely with organizations such as FAO, OAS, U.S. Department of Agriculture, USAID, IOCC and others, ACRI has been able to amplify the results of its own efforts on behalf of cocoa agriculture.

After noting the sizeable research and extension facilities which were being developed by organizations in West Africa following World War II, and being concerned over the steadily declining proportion of world production in the western hemisphere, ACRI at first confined its efforts to the western hemisphere (tropical Central and South America). More recently it has become ACRI's policy to show concern over the principal technical problems of cocoa production anywhere in the world and, within the limits of available resources, to collaborate in their solution. As an example of this collaboration ACRI became in 1964 a major contributor to the International Capsid Research Project in West Africa which is being conducted under the International Office of Cocoa and Chocolate.

A list and brief description of work currently receiving entire or partial support from ACRI funds follows.

Entomology Project—University of Wisconsin and IICA:

This project is for work on the insect problems of cocoa in tropical America. Problems investigated during the past nine years include *Xyleborus* species, Mirid problems and "Die-back", pollinating insects, and chemical control including systemics.

Cacao Program at the Instituto Inter-Americano de Ciencias Agricolas (IICA) at Turrialba, Costa Rica (4).

This project has been active since 1947. It is currently supported by matching funds from ACRI and the IICA. The Cocoa staff are all full members of the IICA staff and engage in research, training and advisory work at IICA and in OAS-member countries as requested. Research, training and dissemination of information are conducted in Cocoa Breeding, Pathology and Physiology. Over 220 specialists from 30 countries have been trained to some degree in cocoa technology, and about half of these are still in work related to cocoa in some way. Teaching is in Spanish and most of the students are from tropical Latin America. Research reports and technical papers are published and a quarterly bulletin, *Cacao*, is circulated in Spanish and English to more than 2,000 recipients. A one-hundred-hectare experimental farm, La Lola, Costa Rica, has been donated to the project by the United Fruit Company and is operated within the joint program.

Cocoa Germ-Plasm Collection—USDA—Mayaguez, Puerto Rico

About 164 clones are now in this collection. All have been introduced through safe quarantine procedures and indexed for and shown to be free from West African type viruses. These selections are carried by the U.S. Department of Agriculture as field-size trees in a tropical location away from commercial plantings. This constitutes a reserve collection of superior and potentially useful germ-plasm free from major cocoa diseases and pests.

Training Scholarships—Pichilingue, Ecuador

One or several scholarships are made available each year to Ecuadorean University students for research on cocoa problems of special importance to their country.

ACRI Technical Assistance

The ACRI Director of Research, in emergency situations, brings the special talent of various experts to particular cocoa problems.

Post-Harvest Bean Handling

A grant for a specialist in this field to work in the western hemisphere on improvements in cocoa bean quality through better fermentation and drying and through better handling between harvest and export.

Cocoa Gall Research

Grants have been made for eight years for specialists in this field, and ACRI still continues a consultantship for the services of a pathologist-gall specialist on this problem.

International Register of Cocoa Cultivars

A grant to IICA to develop and publish a system for accurately describing important cocoa cultivars. A book, entitled *International Register of Cocoa Cultivars*, will be published in early 1967 and will contain descriptions of 67 important cultivars. It will also explain the methodology developed by the authors. It is expected that other cocoa workers will use this method to describe additional important cultivars and it is hoped that a future expanded edition of this Register will thus contain all the world's known important cocoa selections.

Phytophthora—University of California, Riverside

A Research Fellowship for a graduate student for work with *Phytophthora palmivora* strains and problems of disease resistance.

Cocoa Seed Physiology—LSU—New Orleans

A grant to a biochemist for research into the possibility of developing dormancy in cocoa seeds through germination inhibitors or other means.

Cocoa Program, University of the West Indies, Trinidad

A grant for support of the general cocoa program at UWI. Other contributors are the British Cocoa, Chocolate and Confectionery Alliance, and the Regional Research Centre at UWI.

Unit Farm Study at La Lola (IICA), Costa Rica

A grant for study of replanting costs and methods, applicable to the small, under-capitalized farmer.

IOCC Capsid Research in West Africa

ACRI is a major contributor, through the IOCC, to this current three-year study in West Africa. Other members of the IOCC likewise contribute.

*Technical Co-operation with CEPLAC * in Brazil*

ACRI and CEPLAC have each made to the Inter-American Institute of Agricultural Sciences matching grants for a budget which provides, for three years, cocoa staff, student scholarships and consultantship services to the CEPLAC cocoa program at Itabuna, Bahia, Brazil.

Some examples of projects supported in the past but now completed are: cocoa seed storage, cocoa pollen storage and shipment, exchanges of technical personnel, assistance in publishing a Taxonomic Revision of the genus *Theobroma*, purchase of field vehicles and equipment for research and extension projects, a study of a new leaf disorder suspected of being a virus but proved by the investigation not to be so, assistance to plant-collecting expeditions and studies of cocoa pods for livestock feeding.

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*Comissao Executiva do Plano de Recuperacao
Economico — Rural da Lavoura Cacaueira

In spite of record-size world cocoa crops in recent years, several technical problems in cocoa agriculture continue as massive threats to world production. Cocoa production as it has been carried out historically is going to come under increasing question because of its traditional inefficiency. Research and experience soon will demonstrate other food and export crops which will give better returns per unit of land than the present average cocoa acre gives; therefore, cocoa research is all the more necessary and must receive continuing support if this important crop is to meet growing world demands.

Areas which depend preponderantly on cocoa exports must diversify their agriculture, but this need not be done at the expense of total cocoa production. Increases in production efficiency derived from research can, if properly applied, release large areas now in cocoa for diversification into other crops without reducing their total cocoa output or losing foreign exchange earnings therefrom.

Probably only through intensified research and its broader application for cocoa can this crop hold its fair share of the good tropical lands, labor and capital it must have if world production is to meet requirements. The available research dollars in developing countries are going to go mainly for urgent food-crop programs and for general agricultural improvement rather than for specific crops like cocoa. It looks more and more as if the chocolate-manufacturing industry in the developed countries will have to increasingly underwrite research for cocoa agriculture and will have to help find, encourage and finance the personnel to do it.

ACRI believes its efforts in this field over the past 19 years have been successful and rewarding for the whole industry, and would strongly urge any other industry or manufacturer groups not already engaged in similar work to consider doing so without delay. There is room for everyone. Technical collaboration with producing countries offers interesting opportunities for friendship, better understanding and improvements in productive efficiency of growers.

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Field Symptoms of Boron Deficiency in Cocoa

D. Tollenaar, Bilthoven, Holland

Introduction

Severe boron deficiency has eradicated large areas of Amazon hybrids recently introduced in Ecuador. Local Ecuadorian cocoa, although it is not killed by this deficiency, was found to suffer from it. This results in low yields and sensitivity to diseases such as witches' broom and *Ceratocystis*.

Boron deficiency has not been reported from any other cocoa area in the world but it seems unlikely that it will be limited to Ecuador. It may be overlooked due to unfamiliarity with the symptoms and for that reason a description of the symptoms of boron deficiency in cocoa and the conditions under which it can develop may be of interest to cocoa growers in many parts of the world.

Conditions which favour the outbreak of Boron deficiency

Experiments and research carried out on this subject have been described elsewhere (6) but in this article I will confine myself to the conditions that favour the outbreak of the trouble. They are:—

1. A low water-soluble boron content in the soil (less than 0·2 p.p.m.)
2. Eroded soils, where little humus is left in the top-soil
3. A high calcium content of the soil
4. Applications of N and P fertilisers
5. A light soil that is easily leached
6. Areas which do not get a supply of boron through rains
7. Heavy drought periods; especially when alternated with heavy rainy seasons
8. Planting cocoa types like Scavina 6 and 12 and their hybrids which have a high requirement for boron.
9. Seedling cocoa suffers earlier than the same cocoa planted as rooted cuttings because seedlings develop more roots in deeper soil layers where the B content is usually lower.

Areas close to the sea usually possess more than enough B from marine alluvia and from rain; therefore B-deficiency will not be a problem in coastal areas and islands.

In B-deficient areas the trouble will mostly start to develop at the time that the plantation is coming into production. At that time the demands of the developing tree increase, while the greater part of the root system is dependent on deeper soil layers where the B-content is lower than in the humus top-soil. Sometimes, on eroded soil for example, the trouble may start earlier, shortly after the jorquette develops.

The typical symptoms of B-deficiency in cocoa

Several authors have published the B-deficiency symptoms of young cocoa plants grown in pot trials when eliminating B as nutrient (1, 3, 4 and 5), but such studies only present the symptoms in young nursery plants. They have been a help in establishing the cause of the trouble in Ecuador, but they are not able to show what happens to the plant when it grows older and starts to flower.

The field symptoms of B-deficiency in three- to five-year-old cocoa plants are as follows:—

Leaves. They show typical twisting and curling (fig. 1); their colour often is pale, and in a somewhat more advanced stage there appear the brown dead leaf tips (fig. 2) that are very typical. Often these dead parts drop out, leaving a hole behind (fig. 1). The leaves feel rough and brittle; the midribs are often necrotic on their dorsal side. One shoot may have leaves with great differences in size (very large and very small leaves on one shoot).

Branches. The growing point often dies and axil shoots develop early (fig. 4), a process which repeats itself and leads to formation of brooms (figs. 3 and 6) and premature defoliation.

Flowering. Profuse flowering occurs on the branches as far as the youngest shoots (fig. 4). This excessive flowering in bunches and clusters leads to swelling of the flower cushions, but there is very little fruit-set of any importance (sterility phenomenon). Often parthenocarpic fruit are developed with no seeds or only a few (fig. 7).

Main Trunk. Profuse flowering and profuse chupon formation (fig. 5) combined with enormous swellings on the trunk. There is cracking and bleeding of bark and wood and the wounds often become infected by fungi (*Ceratocystis*, *Phytophthora*).

Root System. Root tips die when penetrating into deeper soil layers leading to the formation of side roots, etc. The wounds open possibilities of infection by root fungi.

General Behaviour

The first general symptoms are profuse flushing, branching and chupon formation, as well as profuse flowering without fruit-set of any importance. The tree develops dense foliage and branch system (fig. 5) but bears no fruit. Two years later the whole plantation may be dead, showing a broom-like branch system on a well-formed frame.

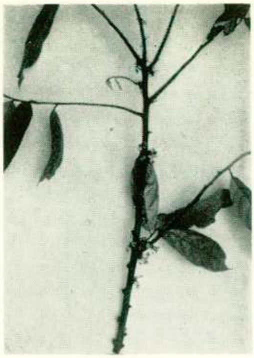
Dicotyledonous plants require more boron than Monocotyledons. For that reason, in cocoa areas where oil-palms suffer from B-deficiency, it seems advisable to watch for the symptoms in cocoa. Oil-palms suffer from B-deficiency in extensive areas in Malaya, in Colombia and in certain parts of Africa.

Measures to combat B-deficiency

It is not yet possible to give amounts and frequency of B-applications; this will depend on cocoa type, soil type and climate, and has to be assessed in every location, but a few important points may be stressed. B-applications should be given before the tissues become seriously affected. Once the tissues of trunk and branches are affected, the only effect of B-applications is that new flushes will be healthy, but the trunk and branches where the flowering and fruit-set take place cannot be cured; also secondary infection through wounds continues to take place.

There are two main methods of application: foliar application with Solubor, a highly soluble boron fertiliser containing 20 per cent B (Borax Consolidated Ltd., London) or soil application, using fertilisers containing boronsilicate (Ferro Enamels (Holland) N.V., Rotterdam). In trials both gave positive

1



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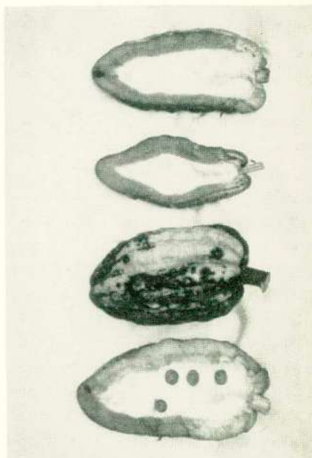
SYMPTOMS OF BORON DEFICIENCY



7

1. *Leaves showing curling and twisting.*
2. *Brown dead leaf tips and pale leaf colour.*
3. *Scavina 6 tree killed by B-deficiency. Broom-like branch sytem, 3 parthenocarpic fruit.*
4. *Branch showing defoliation, flowering and formation of side branches.*
5. *Tree suffering from B-deficiency, showing dense branching.*
6. *Repeated dying of growing points followed by side branching and formation of broom.*
7. *Parthenocarpic pods.*

responses. The advantage of boronsilicate is that rather large amounts can be given as a reserve without the risk of overdosing. It is advisable to try out amounts of 20 to 80 lb. per acre.

The water-soluble B-content of a soil is a good indication whether B-deficiency may be expected (the critical level is 0·20 p.p.m. in upper and lower soil layers). Leaf analyses have been shown to be irrelevant as there is not a simple correlation between B-content in the leaves and B-deficiency, exactly as Haarer (2) has stated for coffee.

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New Cocoa Varieties in Ghana

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The Tafo hybrid cocoa varieties are now reaching the farmer in Ghana. The product of many years' work at the Cocoa Research Institute, they were known during the development phase as the Series II varieties (2, 3).

The first test-plantings of these varieties, in the 8th and 9th progeny trials at Tafo, were made in 1952 and 1954. Their early growth was promising, and further Series II trials were planted in Ghana in 1956 and 1957. Nucleus stocks of the parent clones were also distributed at that time, as a first step towards the planting of seed gardens and subsequent issue of the varieties. Trials were also planted in Nigeria and in Sierra Leone.

These varieties were obtained by crossing Amazon cocoa either to Amelonado or to locally-found Trinitario selections. Of the seven issued varieties three are Amazon x Amelonado crosses and the other four are Amazon x local Trinitario crosses.

The Amazon parents were chosen from among many that were introduced, together with various other types of cocoa and related species, as seed from Trinidad in 1944. This was some of the first Amazon seed produced in Trinidad, for the original seed had been collected from the Amazon valley in the late 1930s (7, 8). The vigour of growth of the Amazon selections drew attention in Trinidad, and again in Ghana where many trees were in bearing by the late 1940s (4). Pods were distributed to the Department of Agriculture, and the resulting plantings supplied seed for an issue of Amazon cocoa from the mid-1950s onwards. This was considered an interim measure, pending development of still better varieties by breeding based upon the Amazons.

The Amelonado parents were selected from a collection built up at Tafo in the late 1930s from yield-recorded plots on three other Agricultural Stations in Ghana—Aburi, Asuansi, and Kpeve (5, 6). The Asuansi plot had been planted from the Aburi plot, which in turn derived from introductions from islands in the Gulf of Guinea in the early 1890s. The origins of the Kpeve cocoa, which was planted by the Germans (Kpeve being in the old German colony of Togoland), is not at present known. Much of the Amelonado cocoa grown in Ghana derives from these plantings, though also from earlier private introductions such as that of Tetteh Quarshie, which also were from islands in the Gulf of Guinea. Little variation has been found in Amelonado cocoa, but the best trees in this collection as regards pod size, yield, black-pod losses, etc. were chosen as parents of these varieties.

The local Trinitario parents were chosen from a collection built up in the early 1940s, partly from Agricultural Stations but mainly from farms (1). These local Trinitarios derive largely or perhaps entirely from introductions made through the Royal Botanic Gardens at Kew in England between 1905 and 1909. The first of these introductions was of "Cundeamor", later referred to as "Caracas white"; the second was of "Ocumare—from the celebrated Venezuelan estate"; and the third was "Criollo, from the West Indies". (An earlier, 1901, introduction of "Pentagona" seems to have been largely unsuccessful). These introductions were of living plants, and one may assume that very few plants were involved. The various types interbred to some extent while they were being multiplied on the Agricultural Stations, and may subsequently have crossed with Amelonado on the farms, so that few can now be firmly attributed to particular introductions. In building up the collection at Tafo preference was given to high-yielding large-podded large-beaned self-compatible trees, but in selecting within this collection for parents for the new varieties emphasis was placed on high yield together with the West African (i.e. Amelonado) type of flavour.

Three local Trinitario trees are parents of hybrid varieties now being issued, one of these being a parent of two hybrids. Of these three, two are individuals chosen from a progeny which had supposedly been obtained by self-pollinating the selection E1, which however is now known to be self-incompatible, so that the origin of this progeny remains a mystery. One of these parents derived from E1 is self-incompatible while the other is self-compatible. The other local Trinitario parent, W41, appeared probably incompatible from the start (though a small progeny was obtained, rather mysteriously, as a result of efforts at selfing), and in this case the original selection was used as the parent. Self-incompatibility of a parent is advantageous in relation to seed-garden design (see below), and it is fortunate, if rather odd, that in this collection of mainly self-compatible local Trinitarios, self-incompatible trees should have been chosen as parents.

Two things should perhaps be explained at this point. First, the flavour required for a variety to be grown in Ghana is that of Amelonado. This is for two reasons. Ghana is a major producer of cocoa, and as such she must seek to supply that which is wanted by the major producers of chocolate, which is the Amelonado type. Those types of cocoa which command premium prices probably do so largely because of their scarcity; they are bought mainly by the smaller manufacturers who have need to make their chocolate taste different from that made by the large manufacturing firms, to be able to sell it in competition with them. Such price-premiums would probably be lost were these cocoas produced in bulk. A related point is that the Amelonado flavour is relatively straightforward; one may perhaps say that Amelonado cocoa has the basic chocolate flavour without additional flavours, while most premium types have the basic flavour with other superimposed flavours—liquorice, fruity, or "floral" flavours, etc. (Some Criollo types are reported to be lacking in what I here term the basic chocolate flavour, which may therefore be the basic flavour of the Forastero group of cocoa varieties, rather than of cocoa as a whole). As it is always easier to add a distinct flavour than to remove one, it is clear that the flavour of Amelonado cocoa is the most useful basic type for chocolate manufacture. The second reason for the flavour requirement in Ghana being that of the Amelonado variety is that Ghana exports cocoa in bulk. The introduction of new varieties with markedly different flavours into the bulk export, in varying proportions from batch to batch, could only be damaging, causing manufacturers to look elsewhere for a more dependable product. Reorganisation to permit new varieties to be exported separately would require supervision right down to the level of the individual small farm, and would be exceedingly difficult and costly.

The Tafo hybrid varieties have been reported on by many manufacturers, and do conform fairly closely with the flavour of Amelonado.

The second point to be explained is that the Tafo hybrid varieties will be issued as pods of seed. This is far cheaper than rooting and distributing cuttings, and in other respects distribution of seed is much more satisfactory in Ghana. The farmer is used to planting seed. And also, his farms usually being scattered and many of them some distance from his house, and perhaps not close to streams, he would have great difficulty in keeping cuttings alive through their first dry season when, because of their initially shallow roots, they would need watering. But the seed-gardens, from which the pods of seed will be obtained, have been planted with cuttings taken from the parent trees. Technically speaking, each hybrid variety is not really a single hybrid but is a family of hybrids obtained by crossing two parent trees. Trees within a hybrid variety differ in some respects; thus in one variety (K/L) about half the trees have red pods while the others have green pods, ripening yellow.

A total of over 700 acres (320 ha.) of seed-garden is being established in Ghana; only the earliest-planted parts of some of the gardens are yet in bearing, but when all are in full bearing, in the early 1970s, there should be sufficient seed to plant over 40,000 acres a year, using traditional methods which require some 50 pods of seed per acre.

The minimum size of seed-garden that could be relied upon to give satisfactory results was thought to be about ten acres, but in practice it proved convenient to plant much larger gardens. The smallest planned was 22 acres, and the largest 190 acres. Each garden will produce only one variety, and is planted with cuttings of the two parents of that variety. The pollinations which gave the seed for the early test-plantings were done by hand, but in the seed-gardens ordinary pollination by insects will be relied upon. (Had only small quantities of seed been needed, hand pollination in very much smaller gardens may have been economic).

Dependence on natural pollination is possible because at least one parent of each variety is self-incompatible; that is, it will not set seed from its own pollen. In some varieties both parents are self-incompatible, and in seed-gardens for these varieties all the pods must arise from cross-fertilisation, thus giving the hybrid seed required. The design of such seed-gardens is straightforward, the two parents being planted in alternate double rows. Where, however, one of the parents is self-compatible, the pods on this parent could have arisen from self-pollination, and in such pods the seed will be of the wrong type, and much inferior. Therefore, pods for seed are taken only from the self-incompatible parent, and in these seed-gardens one tree of the self-compatible "Pollinator" parent is planted for every five of the self-incompatible "pod" parent.

In both cases there is a danger of pollen being brought in from trees outside the garden, and there is, therefore, a "discard area" from which pods are not issued as seed. This consists of the outer eight rows of trees, and in large gardens it forms a small proportion of the whole. In gardens containing a self-compatible parent the discard area is planted solely with this "Pollinator" parent, and in the outer edge of the seed-producing area the ratio of "Pollinator" to "pod" parents is 1 to 3 instead of 1 to 5.

The breeding and performance of the Tafo hybrid varieties is given in Tables 1 and 2. The detailed codes used for the varieties and for their individual parent trees are given in Table 1, together with simpler alternatives used when distributing them to the Ministry of Agriculture. Yields obtained in the two Tafo trials (planted in 1952 and 1954) and in the eight trials planted elsewhere in Ghana (1956 and 1957) are summarised in Table 2.

TABLE 1

Parentage of the Tafo Hybrid Varieties

Variety		Parentage								
Codes		Amazon parent				Other parent				
Series II	Alternative	Progeny	Stand number	'C' code	Compat-ibility	Type	Source reference	Tafo tree reference	'C' code	Compat-ibility
A	WAE 5	T63	971	74	SI	Amel.	P4/9	J114/5	18	SC
B	WBE 2	T63	967	75	SI	L. Trin.	E1	C43/291	25	SI
C	WBE 3	T63	971	74	SI	L. Trin.	E1	C43/270	23	SC
D	WBE 4	T16	613	73	SC	L. Trin.	E1	C43/291	25	SI
H/J	WAE 11/ WEA 3	T85	799	77	SI	Amel.	S84	E104/90	27	SC
K/L	WBE 6 WEB 3	T63	967	75	SI	L. Trin.	W41	—	14	SI
M	WEA 2	T79	467	69	SI	Amel.	S72	J114/49	20	SC

Variety codes: Series II; the code used in trials away from Tafo.
Alternative; an earlier code, used mainly at Tafo; W=W.A.C.R.I. (now C.R.I.G.) variety, A=Amelonado, B=Local Trinitario, and E=Amazon, with the female parent of the cross as tested given first, and crosses within a type numbered sequentially. Two crosses, H/J and K/L, were tested with either parent as female; little evidence of differences between such reciprocal crosses emerged.

Amazon parents: Progenies (from crosses made in Trinidad) were:
T16 : Iquitos selection No. 24, open pollinated.
T63 : Parinari No. 35 × Nanay No. 32.
T79 : Nanay No. 32 × Parinari No. 7.
T85 : Nanay No. 34 × Iquitos No. 60.
Nanay, Iquitos and Parinari were collection localities in the Amazon valley.

Amazon stand numbers: Reference numbers of individual trees in the Trinidad Introductions planting at Tafo.

"C" Code: A simple code used in distributing the parent clones. The seed-gardens are often referred to by the codes of the parent clones they contain; thus a garden to produce variety A would be referred to as a "C18 × C74" garden.

Compatibility: SC=Self-compatible; SI=Self-incompatible.
Other parents: Type: Amel.=Amelonado; L. Trin.=Local Trinitario.

Source references:
E1: Selection 1 from a farm at Effiduasi, near Koforidua.
P4/9: Row 4 Stand 9 from the Kpeve Agricultural Station.
S72 and S84: Selections 72 and 84 from the Asuansi Agricultural Station.
W41: Selection 41 from the Wiawso Agricultural Station.

Tafo tree reference: Reference to quarter-acre blocks in the "Old Station" at Tafo, and to stand numbers in those blocks.

E.g. Acre-row J, acre 11, quarter-acre block 4, stand 5.
Acre-row C, acre 4, quarter-acre block 3, stand 291.

TABLE 2

Performance of the Tafo Hybrid Varieties in Ghana

(Yields in lb. dry cocoa/acre)

Varieties in the 1952 Tafo trial	Trials at Tafo Potential yields Season*				Overall losses per cent	Series II trials Planted 1956 and 1957 Average of yields 1960 to 1962	
	1956	1957	1958	Later		Potential	Losses per cent
A	320	540	850	1810	29½	740	11
B	420	690	1150	1710	32	800	12
C	—	—	—	—	—	790	13
D	330	530	1000	1780	34	575	11
Amelonado	70	210	750	1420	28	—	—
Amazon WE 4	540	770	990	1355	33	610	12
Varieties in the 1954 Tafo trial	**Season**						
	1957	**1958**	**1959**	**Later**			
H/J	815	1175	1835	1610	22	900	10
K/L	505	1075	1630	1420	33	735	14½
M	740	1070	1450	1440	26	695	8
Local type TF 1	220	540	1030	1150	33	—	—
Amazon WE 6	650	990	1760	1400	19½	785	9

*Seasons: 1956 = April 1956 to March 1957, etc.
"Later": Averages for: 1952 trial; 1959 to 1964 inclusive.
1954 trial; 1960 to 1964 inclusive.

Note that the 1954 trial commenced bearing at an earlier age than the 1952 trial. Early performance in the 1952 trial was poor due to heavy shade, later much reduced; in contrast, conditions in the 1954 trial have deteriorated.

Potential yields are estimated assuming a 40 per cent conversion from weight of wet cocoa to dry marketable cocoa, and adjusting to include all pods harvested whether damaged or otherwise. Losses include all causes (disease, rodent damage, germination, etc.). A very strict view is taken in recording the Tafo trials, and many pods classed as discards might give commercially usable cocoa.

Varieties: A, B, C, D, H/J, K/L, M: See Table 1.

Amelonado: The standard West African variety.

TF 1: A local Trinitario known to be fractionally higher yielding than Amelonado.

Amazon WE 4: A progeny obtained by crossing two trees of the Amazon progeny T60 (T60 = Parinari 7 × Nanay 32).

Amazon WE 6: A progeny obtained by crossing a T85 tree to a T79 tree (See Table 1).

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Bulk Handling of Raw Cocoa

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Bulk handling facilities have long been used for the transport of grain and sugar, and in view of the big increase in raw cocoa production during the past 10 years and the possibility of further increases in the future, it is worth while considering whether bulk handling facilities can be adopted for the movement of this crop.

World production of sugar is approximately 70 million tons and of grain 1,000 million tons, and although a substantial quantity of each is consumed in countries of production, there is obviously a very large export trade. World production of raw cocoa in relation to sugar and grain is small, amounting to about 1½ million tons per year, but there is a possibility that this will increase to 2 million tons in the foreseeable future. The bulk of the world crop is grown in Ghana, Nigeria, Brazil, Ivory Coast and Cameroon Republic, and although industrialisation in these countries is increasing, the bulk of their crops is exported.

Within consuming countries there is a small number of large manufacturing companies whose yearly consumption of cocoa might be thought to justify the adoption of bulk handling facilities, but there are several important factors to be taken into account when considering this possibility, among them:—

(*a*) *Equipment*

Bulk handling would necessitate suitable facilities at ports in producing countries to load the ships; clean, dry holds during the voyage; unloading facilities at importing centres; bulk transport from these ports to the factories, and bulk storage facilities possibly at the ports as well as at the factories. Facilities at ports in producing countries need not be so complicated as at ports in receiving countries. Cocoa would have to be bagged by the cocoa farmer or by the organisation responsible for buying it from him. Bagged cocoa could be stored at the ports until required for shipment, but would then have to be opened so that the contents could be stowed in bulk in the ships.

(*b*) *Capital Cost*

The installation of bulk handling facilities would clearly entail a very heavy capital expenditure, particularly in the ports of consuming countries and by manufacturers at their plants. The capital needed by producing countries would be far less. However, to justify the outlay in consuming countries the adoption of bulk handling facilities must be shown to result in a worthwhile saving in handling costs and an improvement in efficiency.

(*c*) The carrying of cocoa in bulk from producing to consuming countries would inevitably put a greater responsibility on the producer to ensure that the beans were of good quality before loading. Special attention would have to be paid to the following points:—

(i) *Infestation*

This is likely to be more easily detected when the cocoa is in bags than when it is in bulk, and great care would have to be exercised to ensure that the cocoa was free from infestation when being loaded.

Storage bins at the Cadbury milk factory, Frampton-on-Severn. Bins of this type are used for the storage of milk, chocolate crumb, sugar, etc., and can be used for cocoa beans.

(ii) *Moisture Content*

The moisture content of beans would be more critical. The movement of moisture and the development of heat within a large bulk of beans have not been fully investigated, and it would seem wise at present to have facilities for passing cooling or drying air through the bulk if it was being stored for any lengthy period. With such facilities, however, control could be better than with bagged cocoa.

(*d*) *Breakages*

It is well known that once the cocoa shell has been broken the risks of infestation are increased and with bulk handling there would seem to be the possibility of an increased amount of broken beans and beans with broken shell.

It is recognised that infestation, moisture content, and breakages are problems which concern not only the producer, but also the manufacturer, and clearly a great deal of work has yet to be done on these and similar problems before large quantities of the world's cocoa crops are handled in bulk.

Meanwhile, experiments have been made with handling cocoa in large containers. These are made from glass fibre reinforced plastic material, are insulated and weatherproof. Those used in the experiments were capable of holding about 10 tons of cocoa, were filled in Nigeria, and unloaded at the chocolate factory. Among the advantages of using these containers it is claimed that there should be a reduction of loss, damage, and pilferage, a saving of export packing and marking, fast door-to-door delivery and lower insurance premiums. Such containers could, of course, be used for carrying goods to cocoa-producing countries as well as carrying commodities from them.

Container used for experiments in bulk transport of raw cocoa.

In some cases capital expenditure would be necessary to adapt existing factory arrangements to the use of these containers. A large manufacturer would obviously need the use of a large number of containers and would be faced with either paying demurrage charges if they were used for storing cocoa, or capital expenditure on setting up bulk storage facilities.

In the experiments mentioned above there were less broken beans in the containers than there were in the control bags received at the same time. The average moisture content in both containers and bags was normal.

It is possible that further experiments will be made with loose cocoa in containers, and this method of transporting beans could be the intermediate stage between the use of bags and bulk handling. It may be that while bulk handling facilities would be suitable for large manufacturers, the use of containers would be more suitable to smaller manufacturers. In either case, only a limited proportion of the world crop is likely to be moved by these methods, for several reasons including the fact that there is a large entrepot trade in cocoa which is much easier if the cocoa is transported in bags.

Letter to the Editor

Dear Sir,

I was very pleased to see the publication of extracts from de Chélus's book *The Natural History of Chocolate* of 1724 in the seventh issue of your *Cocoa Growers' Bulletin* on page 12. I have read the book myself and I found it a refreshing and sometimes exciting experience. You will permit me to make a few comments.

1. General: Having read de Chélus's book as a cocoa researcher I strongly recommend republication of the whole (small) book. It struck me as a remarkably sensible, well-balanced and well-written account of the author's 15 years' experience with the crop in the field and his apparently thorough knowledge of current ideas and the literature. This book presents a good summary of the total of accumulated knowledge on cocoa botany and cultivation. Moreover, some of the information is still valuable for research, there is important and reliable factual information about cocoa varieties, and the fact that it is "pre-blast" makes it the more interesting. I thoroughly enjoyed his most valuable advice about pruning (keep trees to the first jorquette so they stay handy) and how to plant seed—a pity you did not mention this.

2. Specific remarks on the published extracts:

I was most struck by de Chélus's recommendation of the establishment of a plantation and his ideas about shade. We would be describing his method of establishment as: complete felling and burning, leave the trash, plant cocoa seed at stake at five to ten feet spacing, preferably the wider spacings, plant cassava as a temporary shade, and *for weed control*, clean weed whenever necessary. The emphasis on weed control is striking and his advice to get the weeds out before they start fruiting is admirable. This concept of using temporary shade deliberately for weed control is one that was arrived at in Nigeria only recently after much experimentation and deliberation; starting off with such extreme measures as clear felling and planting seedlings without shade altogether, after which we experienced that weed control was impossibly difficult, that mulching and chemical and/or hand weed control were expensive. In fact the use of a temporary shade crop is a cheap method of weed control for which "tree cassava" (*Manihot glazoevii*) was used although it was not satisfactory. The use of cassava as a temporary shade would have been preferred but for its relatively slow growth and the widespread virus. A vigorous resistant cassava type would, however, renew interest in it.

So in a way it appears that after more than 200 years we are back to square one. It would have been of great assistance to us had we known of de Chélus's thoroughly practical remarks at an earlier stage.

The other striking thing is, as you point out in your editorial, the fact that permanent overhead shade is not mentioned at all in the book. However, I think that your explanation of the reasons for this is too shallow. De Chélus was aware of cocoa cultivation in other parts of America and he appears up to date with current ideas. I have a strong feeling that the need for overhead shade was not generally felt in those days. Here too, in a way, we are now back to where we were in de Chélus's time. There is need for an explanation and history of the tradition of the absolute need for overhead shade of which we have been trying to rid ourselves since the 1950s; we now know at least that the tradition did not exist in 1724.

Establishment method and shade are problems of cocoa cultivation which have never been subjected to the extensive and consistent experimentation necessary for such complex problems. Therefore, up to recently our conceptions were traditional and nobody knows where the tradition of overhead shade started, and how it came about; every cocoa researcher has his own private idea as to why the overhead shade was so necessary. As far as I know the only improvement in accepted establishment technique is the practice of planting out six-months'-old seedlings in the field. It seems to me that there is something wrong.

Yours sincerely,

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Graduated from Agricultural University at Wageningen (Holland), doctorate 1925. Worked from 1925-1950 in Indonesia; 1928-1934 as Director Tobacco Experimental Station, Klaten (Java), afterwards as superintendent and managing director of cocoa, tea, sisal, rubber, coffee and tobacco farms. After one year as Director, Rotterdam Zoo he has been a freelance consultant to many tropical countries (Angola, Cameroon, S. Tomé, Brazil, Costa Rica, Ecuador, Neth. Antilles) for many crops such as abaca, bananas, cocoa, coffee, rubber and tobacco.

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Born at Newcastle-upon-Tyne in 1931: studied at Durham 1949 to 1952 and post-graduate to 1954, continuing at the University of Neuchâtel, Switzerland, 1954-55. Subject: Botany, specialising (post-graduate) in experimental taxonomy of Polygala. Appointed to W.A.C.R.I. (now C.R.I.G.) in 1956 as Plant Breeder; received specialised training January to June 1956 at the Plant Breeding Institute, Cambridge, and commenced at Tafo in mid-1956. Came on final leave in December 1965. Since then temporarily employed at the Welsh Plant Breeding Station; transferring to a permanent post at the Scottish Plant Breeding Station.

Cocoa Abstracts

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May, 1966

Alvim, P. de T. A floraçáo do cacauerio na Bahia. (Flowering of the cocoa tree in Bahia). Cocoa Atualidades 2, 6, p. 71-2 (1965).

The author presents a graph showing the intensity of flowering of 100 cocoa trees at Uruçuca, State of Bahia (Brazil), during the period Jan. 1964-Sept. 1965, with fortnightly rainfall totals and temperature averages over the same period. Flowering practically ceased in the cool months of July-Sept., and rapidly increased after the onset of the rains to a maximum in the first months of the year. Graph. See also ibid. p. 72-3: Alvim, P. de T., Ciclo de fôlhas do cacaueiro (The leaf cycle of the cocoa tree). Graph.

Vello, F., and Medeiros, A. G. Expediçáo botânica à Amazônia brasileira. (Botanical expedition to the Brazilian part of the Amazon Basin). Cacau Atualidades 2, 4, p. 47-51 (1965).

As members of an expedition organized by the Bahia cocoa research centre (CEPEC), the authors in June-July 1965 visited 8 regions of the Amazon Basin between Belém and the Bolivian frontier in search of cocoa types valuable for future breeding work. Delegates of the Inter-American Institute of Agricultural Sciences in Costa Rica and of the Cocoa Research Institute of Ghana participated in the expedition. The time of the visit proved to be ill-chosen, wild-growing cocoa trees under dense forest shade producing nearly all their pods in Jan.-Apr. The Amazon forastero cocoa population was found to be highly variable in almost all characters. Material was collected from 55 trees; this is now being raised in quarantine at Belém and Santarém.

Bartley, B. G. D. Notes on the cocoa of Maracaibo and the relationship of pod and cotyledon colours. Cocoa; Inter-Am. Inst. Agr. Sci. 9, 1, p. 8-10 (1964; received 1966).

Criollo cocoa along the Catatumbo and Escalante Rivers in Venezuela is characterized by the absence of jorquetting in many trees and by an association of pod pigmentation with cotyledon colour, completely white seeds being only found in green pods. A review of literature and the author's observations indicate that the relationship between pod and cotyledon colours differs between varieties. In the Catatumbo area the porcelana type predominates, but other types do occur. The population of one farm was unique in consisting of 2 types, one with green pods and white seeds and the other with red pods and pale purple seeds, that had been found by the author in the higher parts of the watershed from which the Catatumbo and Escalante Rivers originate; these types also show affinities to Nicaragua criollo varieties. 8 refs.

Lems, G. Cocoa selection and breeding in Surinam. Bull. Landbouwproefstat. Suriname 82, p. 27-37 (1965).

Research on cocoa selection in Surinam is reviewed; lists are presented of the clones and progenies introduced from abroad and a few local clones available for a breeding programme, and of clone testing trials. Apart from a high yielding capacity and a good quality product, resistance to witchbroom and green-point cushion gall are the main criteria of selection. So far no clone has been found with an overall performance superior to that of ICS 95, which constitutes the bulk of the cocoa plantings established since 1948. The best prospects are offered by the Upper Amazon × Trinitario hybrids produced in Trinidad, for which the name triastero is proposed. One of the subjects discussed is whether a progeny received from Wageningen, The Netherlands, as SCA 12 × SCA 6 is really a cross between these 2 clones which are generally considered to be cross-incompatible. French summary. Tables. 20 refs.

Tests of a mechanical cocoa pod-breaker made at Turrialba, Costa Rica. Cocoa; Inter-Am. Inst. Agr. Sci. 9, 1, p. 10-2 (1964; received 1966).

A mechanical cocoa pod breaker was developed in Costa Rica by the proprietor of a machine shop; a patent has been applied for. During test runs supervised by the staff of the IICA Cocoa Centre the machine, which was driven by a 750 W (1 h.p.) electric motor, broke about 2,800 pods per hour; however, its capacity may be considerably increased by a better system of loading such as a conveyor belt. A normal performance of a man breaking the pods manually is 370 pods per hour. About 3 per cent of the seeds were lost because the machine ejected them with the pod shell fragments. Fermentation of the cocoa from mechanically broken pods was normal. Tables. Photos. 1 ref.

Maravalhas, N. Problemas de estocagem do cacau. (Problems of cocoa storage). Cocoa Atualidades 2, 6, p. 73-7 (1965).

Data from the literature concerning the relation between the moisture content of cocoa beans and the relative humidity of the ambient air are compared with the author's observations made in the State of Bahia (Brazil). The difference in moisture content of the shell and the cotyledons was found to be somewhat larger than that reported by others; extremes were 14 and 5 per cent, respectively. At a temperature of 20°C, cocoa could be stored indefinitely in air of 70 per cent r.h.; at a r.h. of 75 per cent only a slight increase of internal mouldiness was observed after 3 months. Under the usual storage conditions, i.e. at a r.h. of at least 80 per cent, external mouldiness became perceptible within 2 months, internal mould after 3 months. Most of the storage rooms in Bahia can be sufficiently improved by making walls and doors less penetrable for air and installing a simple domestic dehumidifier or air-conditioner. Tables. Graph. 8 refs.

Biehl, B. Probleme der Verbesserung der Rohkakao-Qualität in Bahia. (Problems of the improvement of raw cocoa quality in Bahia). Gordian 66, 1564, p. 3-6 (1966).

In the past few years the cocoa research centre in the State of Bahia (Brazil) has conducted investigations on improved fermentation methods and in particular on fermentation in rotating containers. Cocoa fermented by this method has been well received by local chocolate manufacturers because it is less acid than the usual product. It is, however, doubtful whether planters would profit much from the introduction of the new system as long as the cut test remains the only criterion for the grading of cocoa. The main defects of Bahia cocoa: acidity and off-flavours, will probably only disappear when a better grading system is developed which lays more stress on internal quality and less on the defects discernible by the cut test. 5 refs.

Helfenberger, A. A series of experiments on small-scale curing of cocoa. Cocoa; Inter-Am. Inst. Agr. Sci. 9, 1, p. 1-8 (1964; received 1966).

Good fermentations of cocoa samples with wet weights down to 0·75 kg was obtained in Costa Rica using a new method. A pile is made of 3 fermenting trays; the bottom tray is left empty, the middle tray is filled with ordinary cocoa serving as a control and as a source of heat; the top tray is divided into compartments holding the samples, and covered with banana leaves and bags. Several factors affecting fermentation and the quality of the product were studied; some results were: (1) fermentation does not affect the conversion factor from wet to dry cocoa; (2) the conversion factor is highest for ripe beans, very much lower for unripe beans; (3) flavour of the commercial cocoa decreases from unripe to overripe beans. Tables. Graphs. Refs (not quoted).

Newton, K. Cocoa drying with the Lister Moisture Extraction Unit. Addendum: drying trial on an 800 sq. ft. floor. Papua and New Guinea Agr. J. 17, 3, p. 109-16 (1965).

At Keravat, New Britain, the Lister dryer was used to dry 11·6 tons of wet cocoa (equivalent to 5·5 tons of dry beans) spread out in a layer 20 cm thick on a platform of 12×6 m covered by a roof. Drying was completed in 7 days at a cost of 162 l fuel and 2·5 l oil per ton of dry beans. This fuel consumption is considerably lower than that attained in previous trials (see Bulletin 5 p.32) with a smaller platform. However, drying was still too slow owing to the fact that the drying air was only about 3° C. warmer than the ambient air; some 90 hours elapsed before the beans became surface-dry and a disagreeable odour was detected during this period. The results indicate that the dryer can best be used for drying smaller loads of wet beans in shallow trays until they are surface-dry, completing the drying process in deep bins. Tables. Figs. Photos. 1 ref.

June, 1966

Bartley, B. G. Plant breeding. Ann. Rep. Cocoa Res. 1964, p. 11-34 (1965).

This report on cocoa breeding in Trinidad contains, inter alia, the 1963/64 yield data from various progeny trials. The characteristics are described of 16 progenies from material collected in Colombia in 1952-53; only few trees can be used in the breeding programme. Records of 17 mother trees selected in the progeny ICS 6 × SCA 6 showed a rather low correlation between yields in the first 3 years of bearing and those in the next 3 years, indicating that yields in these 2 periods constitute different bases for selection. The first results of a trial on seed size inheritance with clones ICS 40, 1 and 95 and clone SCA 6 indicated that the magnitude of the large seasonal effects on wet and dry bean weight and their ratio is partly determined by genetic factors, and that the dry weight of the cotyledons, being less variable than other characteristics, may provide the best estimate of genotypic differences for seed size. Tables.

Murray, D. B. Las Hermanas shade experiment. Ann. Rep. Cocoa Res. 1964, p. 40-8 (1965).

A cocoa shade × fertilizer trial was planted in 1958 on a heavy clay with severely impeded drainage at Las Hermanas Estate, Trinidad. Plots with light intensities 20, 50 and 70 per cent of full daylight, produced by means of plastic netting, were compared with unshaded plots. Increments in the trunk girth up to 1964 increased with the light intensity, especially in the wet season. Mean yields in the first 2 years of bearing were highest at 50 per cent light, but the optimum had shifted to 70 per cent in the 4th year. Application of fertilizers increased the yield of all treatments; in the first 3 crop years the fertilizer had no effect on the optimum light intensity, but in the next 2 years trees to which fertilizer had been applied produced most in full daylight whereas the control trees showed an optimum at 70 per cent of full daylight. Table. Graphs.

Getzendaner, M. E. Bromide residues from methyl bromide fumigations of cocoa beans, and processed fractions from fumigated beans. J. Agr. Food Chem. 14, 1, p. 56-8 (1966).

A study to determine the residual levels of methyl bromide in cocoa beans and in their fractions after milling was conducted in the U.S.A. Bromide residues in cocoa beans did not exceed the tolerance of 50 p.p.m. after fumigation 5 times with 24 g methyl bromide per m^3 for 24 hrs, with 120 g/m^3 in 1 fumigation, or with 72 g/m^3 for 24 plus 12 hrs. The shells from fumigated beans contained 4-6 times the amount of residue in the whole bean. Cocoa had a residue level about the same as the fumigated beans, and the other fractions all had lower residues. Reducing the chamber load from 75 to 15 per cent did not affect the residue deposition. Author's summary. Tables. 6 refs. See also ibid. p. 59-62: Getzendaner, M. E., and Richardson, H. H. Bromide residues from methyl bromide fumigations of fruits and vegetables subjected to quarantine schedules. Tables. 19 refs.

Maliphant, G. K. Fertiliser, shade, spacing experiment. Ann. Rep. Cocoa Res. 1964, p. 48-53 (1965).

A fertilizer × shade × spacing trial with cocoa was planted at River Estate, Trinidad, in 1949. Results are presented over the 10-year period 1954-64, adding 6 years' data to those of the previous report. When no fertilizers were applied, average yields of unshaded plots with a spacing of 3·6 × 3·6 m were 30 per cent lower than those of shaded plots at the same spacing or those of unshaded and shaded plots with a spacing of 2·4 × 2·4 m. The effect of fertilizers on yield changed with the age of the plants; the need for split applications of the higher fertilizer dosages diminished. Since shaded cocoa showed only a small response to N fertilizer, the best results were generally obtained with PK fertilizers in the shaded plots and with NPK fertilizers in the unshaded plots. Tables.

Murray, D. B., and Maliphant, G. K. Mulching and trenching experiment. Ann. Rep. Cocoa Res. 1964, p. 35-40 (1965).

Results are presented of a trial conducted in a cocoa field at River Estate, Trinidad, from 1949 to 1961. Application of 27 t/ha of a grass mulch twice annually consistently increased the yield, the mean increase over 1955-60 being 41 per cent. The mean yield increase over this period due to a bagasse mulch, applied at a rate of 34 t/ha twice annually and supplemented with fertilizer, was only 17·5 per cent and varied considerably between years, probably because it enhanced waterlogging in wet periods. The bagasse mulch increased the organic matter content and C/N ratio of the soil more than did the grass mulch; both mulches increased the level of available P and K. Trenches dug once every 5 years and filled with 36 t of cattle manure plus 36 t of cut bush per ha had a similar average effect as the bagasse mulch but tended to reduce yields in the years following trench digging on account of the damage inflicted to the roots. Tables. Graph.

July, 1966

The longer-term outlook for cocoa production and consumption. Monthly Bull. Agr. Econ. Statist., FAO 15, 3, p. 10-7 (1966).

An analysis of the factors which brought about the increases of cocoa production in the past 7 years is followed by a cautious estimate of annual cocoa production in the period from 1970 to 1972. World cocoa consumption at the manufacturing level increased from 820,000 tons in 1956 to an estimated 1,332,000 tons in 1965, equivalent to an annual rate of growth of 5·6 per cent. Projections of world cocoa grindings in 1970 and 1975 are presented on the basis of alternative assumptions as to the world market price of beans at the end of the projection period. For 1970 the estimates are 1·45 million tons, 1·53 million tons, and 1·62 million tons on the basis of price levels of £200, £160, and £120 per long ton (of 1,016 kg), respectively. World grindings will probably expand at a lesser rate than in recent years, unless consumption is stimulated. Tables.

Glendinning, D. R. Further observations on the relationship between growth and yield in cocoa varieties. Euphytica 15, 1, p. 116-27 (1966).

Studies conducted in Ghana showed that yields of cocoa varieties are positively correlated with the rate of trunk diameter increase prior to bearing. However, yields seem to be more closely correlated, over early and intermediate years, with the difference between the rate of trunk diameter increase while in bearing and that in the pre-bearing period. Over these years there is a negative relationship between yield and the current rates of trunk diameter increase. Once varieties are well into bearing, current trunk diameters have little influence on yield. A difference between varieties of 1·2 cm per annum in the pre-bearing rate of trunk diameter increase seems to be roughly equivalent to a difference in yielding capacity of 1,800 kg dry cocoa per ha per annum. From author's summary. Tables. 2 refs.

Nichols, R., and Walmsley, D. Translocation of phosphorus-32 into wilting and healthy fruits of cocoa (Theobroma cacao). Plant and Soil 23, 2, p. 149-60 (1965).

In Trinidad, the uptake of P by 2½-year-old cocoa plants growing in tins was studied by applying P^{32}-labelled phosphate to the soil in the tins. Uptake and translocation of P into the cocoa pod was linear and continued at the same rate for about 3 days after the pod ceased to grow as a first sign of wilting; P uptake then suddenly ceased while no P moved out of the wilting pod. Uptake of P into the leaf steadily increased during the 5-week period of counting and was not affected by flushing of the terminal bud during the 2nd week. The total P content was always higher in the seeds than in the pericarp both in wilting and healthy pods; it remained nearly constant in pods with lengths increasing from 3 to 10 cm. The results obtained support the hypothesis that cherelle wilt of cocoa is a fruit-thinning mechanism. Tables. Graphs. Photo. 11 refs.

Jordan, D., and Opoku, A. A. The effect of selected soil covers on the establishment of cocoa. Trop. Agr., Trinidad 43, 2, p. 155-66 (1966).

The effect of 6 types of soil cover on the development of young cocoa plants and on the nutrient and moisture contents of the soil was studied in a forest clearing at Kade, Ghana. By far the best growth of the cocoa and the highest yield in the 1st complete crop year were obtained from mulched plots; next in order came plots with *Calopogonium* or *Pueraria* covers, plots with *Mimosa invisa* or *Centrosema* covers, and plots with natural regrowth. The temporary shade of *Manihot glaziovii* grew best in the plots with natural regrowth and mulch, least satisfactory in the *Mimosa* plots. Weeding costs increased in the order: natural regrowth, mulch, *Mimosa*, *Calopogonium*, *Centrosema*, *Pueraria*. The leaf N content of cocoa in plots with natural regrowth was significantly lower than that in the other plots. Differences in the effect of the covers on soil properties were relatively unimportant. Tables. Graphs. 15 refs.

Attafuah, A. Occurrence of cocoa viruses in wild plant species in Ghana. Ghana J. Sci. 5, 2, p. 97-101 (1965).

Transmission trials were conducted in Ghana to determine the incidence of the cocoa swollen shoot virus (CSSV) and the cocoa mottle-leaf virus (CMLV) in wild-growing trees of 5 species known to be susceptible to these viruses. CMLV was found in some trees of *Adansonia digitata* in savanna areas but not in the forest area. CSSV was found in some trees of *Ceiba pentandra* growing on farms and in some trees of *Cola chlamydantha* growing on farms and in forests of cocoa-growing areas. No virus was found in *Sterculia rhinopetala* and *S. tracagantha* growing on farms. Availability of the virus from artificially infected trees of the 2 *Sterculia* spp. appeared to decrease with time, whereas that in *C. chlamydantha*, *A. digitata* and *C. pentandra* remained fully infective during several years. The 2 main virus-transmitting mealybugs were found to occur on all 5 tree species. Table. 8 refs.

August, 1966

Alvim, P. de T. O problema do sombreamento do cacaueiro. (The cocoa shade problem). Cacau Atualidades 3, 2, p. 2-5 (1966).

Trials conducted in the State of Bahia (Brazil) confirmed the conclusion from experiments carried out in other countries, that cocoa yields can be greatly improved by removing all shade coupled with generous fertilizer applications. However, shade is always necessary in young fields, and the protection against various adverse conditions afforded by shade cannot be missed when growing conditions are marginal. For the time being cocoa planters in Bahia are only advised to apply fertilizers and to reduce the shade to 25-35 trees per ha. Graphs.

Rosand, F. P. C., et al. Adubaçáo do cacaueiro. (Manuring of the cocoa tree). Cacau Atualidades 3, 1, p. 8-9; 3, 2, p. 6-7 (1966).

Cocoa planters in the State of Bahia (Brazil) are recommended, when planting a new field, to mix the soil to be returned to the top 20 cm of the planting hole with 120 g ammonium sulphate, 44 g superphosphate and 8 g KC1 plus 60 g dolomitic limestone; the soil of the lower 20 cm receives only dolomitic limestone. Twice these fertilizer doses plus 30 g dolomitic limestone should be applied in the 1st and 2nd years, in 30 cm broad rings, 25 and 50 cm from the trunk, respectively. Old fields are only worth manuring when the cocoa is vigorous, the soil rather deep and the shade not excessive; advice for local conditions is to be asked from the research station. Fertilizers should be applied at times of vigorous flushing, in a circular band whose distance from the tree is 1 and 1·3 m in alternate years; on sloping land a half-circle is better. Figs.

Maravalhas, N. Novos tipos de secadores. (New types of dryers). Cacau Atualidades 3, 1, p. 2-7 (1966).

The 2 types of dryers that have been in use on most cocoa estates in the State of Bahia (Brazil) during the last 50 years have a high fuel consumption and require much labour. More economical drying is possible with a modification of the Ferraz types originally designed for coffee and cereals, in which the beans are dried on a rotating cone of perforated metal sheet through which hot air is forced. The large Ferraz 75 dries 2·5-4·9 tons of commercial cocoa in 24-36 hours, the smaller Ferraz 25 has a capacity of 1·2 tons. A new and simpler type of dryer has recently been developed for smaller quantities of cocoa. Beans pre-dried in the open are dried on a horizontal table through which hot air is forced while the beans are constantly stirred. When air of 60°C. is used, this type will dry 200-1,300 kg of commercial cocoa in 12-15 hours; it can be attended by 1 man, consumes only 1·2 tons of firewood for a full load, and is driven by a 3 h.p. motor. Photos.

September, 1966

Cabanilla, H. L., and King, J. R. The extension of viability of cocoa (Theobroma cacoa L.) pollen by the freeze-drying method. Trop. Agr., Trinidad 43, 3, p. 187-98 (1966).

At Pichilingue, Ecuador, pollen of cocoa pre-dried for 1-4 hours over $CaC1_2$ or at 32° C., freeze-dried for 1 hour, and sealed in vacuo has maintained viability in the storage ampoules for as long as 248 days in an environment with uncontrolled atmosphere. Normal fruits with good complements of viable seeds have been produced from this type of stored pollen. However, the percentage of harvested fruits is, thus far, low as compared to that from pollinations with fresh pollen. Authors' summary. Tables. Photos. 22 refs.

Tollenaar, D. Boron deficiency in cocoa, bananas and other crops on volcanic soils of Ecuador. Neth. J. Agr. Sci. 14, 2, p. 138-51 (1966).

Detailed evidence is given that boron deficiency affects imported cocoa varieties in Ecuador, which are destroyed at the beginning of their productive stage. The local varieties usually survive, but B-deficiency affects their production and makes them susceptible to such diseases as *Marasmius* and *Ceratocystis*. The first evidence is given that bananas in the field are affected by B-deficiency. B-deficiency in cocoa and bananas has so far not been reported from any other country. A survey showed that on young volcanic soils coffee, avocado, mango, Chinese cabbage, lucerne, potato, clovers and apple are affected as well. Its occurrence is apparently of a general and persistent kind and is promoted by the prevailing soil and climatic conditions. From author's summary. Tables. Photos. 21 refs.

Jiménez Sáenz, E., and Diaz Romeu, R. Efecto del nitrógeno, fósforo y potasio en el crecimiento de la buba de puntos verdes en cacao. (Effect of nitrogen, phosphorus and potash on the growth of green-point galls of cocoa). Turrialba, Rev. Interam. Ciencias Agr. 16, 1, p. 44-7 (1966).

The effect of N, P and K, alone and in combination, upon the growth of green-point galls of cocoa (caused by fungi of the genus *Fusarium*) and of the cocoa plant was studied under greenhouse conditions in Costa Rica. It was found that N increased the weight of the galls whereas P and K had no effect on it. Nitrogen and K also stimulated the growth of the cocoa whereas P had no effect on the fresh weight of the plants. None of the possible interactions between N, P and K was statistically significant. From authors' English summary. Tables. Graph. 8 refs.

Leather, R. I. Studies on the reaction of some cocoa varieties to Phytophthora palmivora (Butl.) in Jamaica. Exp. Agr. 2, 2, p. 107-12 (1966).

In Jamaica, cuttings and pods of several cocoa clones were inoculated with 2 isolates of *Phytophthora palmivora* from cocoa. All clones were susceptible to strain A, but some (including SCA 6 and SCA 12) were resistant to strain B. Inoculation of detached pods from various clones, suspended in a closed bin, with the more virulent strain A revealed large differences in susceptibility, SCA 6 and SCA 12 being among the most susceptible clones. Field observations also demonstrated large differences in susceptibility to black pod disease, a very high incidence of the disease being observed in clones ICS 98, SCA 6, and SCA 12. The results indicate that susceptibility to black pod cannot be deduced from the results of artificial inoculation with 1 strain of the fungus, and that an assessment should be based on the field reaction to the local strains. Tables. Photo. 8 refs.

Schulten, G. G. M., and Kuyken, W. Dichlorvos resin strips for control of cocoa moth, Ephestia elutella. Int. Pest Control 8, 3, p. 18-9, 21, 23 (1966).

A 2,200 m^3 storage room in The Netherlands was half filled with bags of cocoa beans infested with larvae of the cocoa moth (*Ephestia elutella*). Three days after the first adults emerged, 46 strips of $6{\cdot}25 \times 25 \times 0{\cdot}5$ cm containing 20 per cent dichlorvos were suspended from the ceiling. The adult moths were all killed, and no re-infestation of the cocoa was observed afterwards. The insecticide had no or little direct effect on the larvae and pupae. The dichlorvos concentration in the air of the room was determined at 0·04-0·05 mg/m^3. Residues in the cocoa beans were negligible. Laboratory trials indicated that the lepidopterous storage pests *Cadra cautella*, *Anagasta kuhniella* and *Plodia interpunctella* are equally susceptible to dichlorvos as is *E. elutella*. Tables. Photo. 1 ref.

October, 1966

Green, R. H., and Hymer, S. H. Investment in the Ghana cocoa industry: some problems of structure and policy. Econ. Bull. Ghana 9, 1, p. 16-23 (1965).

Cocoa trees are the most important single productive asset in Ghana. A long-term policy to increase cocoa output requires knowledge of the factors controlling cocoa investment and supply in Ghana, and of cocoa prices and demand levels on the world market. An adequate policy with regard to world demand and prices requires a new type of action by the governments of cocoa producing countries; it should concern itself with the entire chocolate-cocoa industry including the manufacturing, advertising, and distribution stages.

World cocoa bean crop smaller in 1965-66, grindings increase. Foreign Agr. Circ., U.S. Dep. Agr., FCB 1-66, p. 1-18 (1966).

This review of production, trade, and prices of cocoa and cocoa products estimates the 1965/66 world production at 1·28 million tons or 15 per cent less than the record 1964/65 crop of 1·51 million tons. Production of Ghana, Nigeria, the Ivory Coast and Cameroon fell from a total of 1,066 million tons in 1964/65 to one of 841,000 tons in 1965/66 as the result of unfavourable weather, in the case of Ghana also of neglect of swollen-shoot control since 1962 and the curtailment of insecticide imports for capsid control. On the other hand, the Brazilian crop increased to 159,000 tons, a level not attained since 1959/60. Cocoa bean exports in 1965 reached record levels. Grindings in 1965/66 are expected to exceed world production, resulting in a decrease of stocks held in consumer countries. Tables.

Thomas, C. Y. Projections of cocoa output in Grenada, Trinidad and Jamaica, 1960-75. Social Econ. Stud., Jamaica 13, 1, p. 94-117 (1964; received 1966).

Projections of cocoa output in Grenada, on the basis of an assessment of the Rehabilitation Scheme, suggest that a declining production will find its low in 1963. Subsequently, a rapid increase will occur, so that by 1975 a production of about 5,300 tons or 4 times the 1963 figure will have been reached. In Trinidad, where a Cocoa Subsidy Scheme is gathering momentum, supply figures of 9,400, 11,000 and 13,200 tons are projected for 1965, 1970 and 1975 respectively, on the basis of the output capacity of the nurseries, the ratio of partial to complete replanting, and yield estimates. It is envisaged that the cocoa subsidy scheme of Jamaica will lead to an output of 4,450 tons in 1965, 8,520 tons in 1970, and 12,500 tons in 1975. Appendices. Tables. Graphs.

Ascenso, J. C., and Bartley, B. G. D. Varietal relationship of growth factors of young cocoa seedlings. Euphytica 15, 2, p. 211-23 (1966).

Studies of the early development of diallel crosses of 3 Amazon forastero, 2 trinitario and 1 *pentagona* type of cocoa, conducted in Trinidad, showed that post-germination growth was largely determined by seed weight. Subsequent development was influenced partly by initial growth; differences due to seed weight tended to disappear with age. Plant height, diameter and fresh weight after 14 weeks were positively correlated to a degree determined by the origin of the parents. Most hybrids were larger, grew at a faster rate, and were less variable than inbreds of the same parents. Seed size was determined principally by the female parent but in some cases the male parent exerted a specific influence. Inter-varietal variability for plant height appeared to be sufficiently large for this character to be used in selection provided it is associated with factors controlling yield. From authors' summary. Tables. Graphs. 16 refs.

Naundorf, G., and Müller, R. Werkzeuge und Maschinen in der Kakaokultur. (Implements and machines in cocoa cultivation). Gordian 66, 1571-72, p. 5-9; 1573, p. 10-5 (1966).

This is the conclusion of the article referred to in Trop. Abstr. n301. Its main part consists of a description of the construction and operation of various types of spraying and dusting apparatus for the control of pests, diseases, and weeds in cocoa fields. In Colombia the Swingfog type of mistblower has given excellent results, for example in the control of *Monilia* disease. The remainder of the paper briefly describes hoes for manual weed control, a manually operated soil cultivator for nurseries, propagator bins for cuttings, and implements for pruning the trees and for harvesting and opening the pods. A mechanical pod-breaker constructed in Colombia was not very satisfactory. Photos.

Hardy, F. Soils and ecology of the cocoa belt of Ecuador. Cocoa; Inter-Am. Inst. Agr. Sci. 9, 2, p. 1-23 (1964; received 1966).

A detailed account is presented of the topographical, climatic, and edaphic conditions under which cocoa is grown in the Riverine Belt of the Pacific Coastal Lowlands of Ecuador, between latitudes $1\frac{1}{2}°$ N and 4° S. Soils are classified according to the U.S. system of classification, and properties of the principal soil groups are described. Prevailing climatic and edaphic factors are discussed and compared with generally accepted environmental requirements of the cocoa crop. An appendix discusses the necessity and prospects of the rehabilitation of old cocoa fields, whose yields have deminished to uneconomic levels, in the light of experience gained in Trinidad. Tables. Graphs. Figs. Map. 14 refs.

Rocha, H. M. Cocoa varieties resistant to Phytophthora palmivora (Butl.) Butl.; a literature review. Cocoa; Inter-Am. Inst. Agr. Sci. 10, 1, p. 1-9 (1965).

A review is presented of literature on the resistance of cocoa cultivars to diseases caused by *Phytophthora palmivora*, in particular to black pod, on methods of testing for resistance, and on the correlation of resistance with the presence of certain phenolic compounds. A list of clones which have been found resistant, tolerant or susceptible in various countries is appended. Attempts to find resistant cultivars have not been very successful; methods to detect resistance are not wholly satisfactory, in part because of lack of knowledge about the resistance mechanism. Moreover, the degree of resistance of a clone may not be equal in different countries owing to the existence of local strains of the fungus that differ in virulence. Table. 67 refs.

Bourret, J. A., and Ford, E. J. Distribution of Calonectria rigidiuscula and other Fusarium species in relation to cushion gall of cocoa. Cocoa; Inter-Am. Inst. Agr. Sci. 10, 1, p. 13-5 (1965).

In Central America, perithecia of *Calonectria rigidiuscula* were found on decaying pods, twigs and branches of cocoa, but only in a humid climate; none were found in adjacent fields of coffee, rubber, and bananas. They may be important in spreading cushion gall disease because large numbers of ascospores were found floating in the air. The imperfect form of the fungus, *Fusarium rigidiuscula* (= *F. decemcellulare*) was repeatedly isolated from greenpoint galls and also from flowery galls; other *Fusarium* spp. associated with cushion gall were found as well. 3 refs. See also ibid, p. 15-6: Alexander J. V., and Cook, R. J. *Fusarium* species and *Calonectria* associated with cushion gall of cocoa in Central America. 4 refs.

Mitchell, J. W., et al. Growth-regulating substances in greenpoint gall extracts and the effect of some regulating substances on bud growth of cocoa. Cocoa; Inter-Am. Inst. Agr. Sci. 10, 1, p. 10-3 (1965).

At Beltsville, Maryland (U.S.A.), cocoa plants raised from seeds inoculated with the fungus *Calonectria rigidiuscula* developed greenpoint cushion galls within 1-2 months, usually at the cotyledonary node. An extract of the galls in lanolin, applied to leaf axils of healthy cocoa seedlings, had some stimulating affect on bud development. Among 7 growth regulators tested, 2,3,5-triiodobenzoic acid greatly increased branching when it was applied (in lanolin) to the apical portion of the stem of young cocoa seedlings; this effect was much smaller when it was applied to the soil, absent when it was applied to leaves or to lower portions of the stem. Gibberellic acid applied to the upper part of the stem did not stimulate bud growth but increased xylem development in the treated portion of the stem. Photos. 2 refs.

Liabeuf, J. Le cacaoyer en Ouganda. (The cocoa tree in Uganda). Café, Cacao, Thé 10, 2, p. 103-25 (1966).

Possibilities for the cultivation of cocoa in Uganda exist only in 3 small regions with an annual rainfall of at least 1,250 mm. Even here the conditions are marginal since the area on the N. bank of Lake Victoria and that in Bunyoro (E. of Lake Albert) are situated at an altitude of 1,200-1,400 m, that in the Semliki Valley S.W. of Lake Albert at 800-900 m. Efforts made by the administration since 1956 have resulted in cocoa of the Upper Amazon type being grown on some 600 ha; an expansion to 1,400 ha by 1968 is planned and a few central fermentaries have been established. The author discusses the condition of the existing plantations, methods of cultivation, and prevailing pests and diseases, as well as the work of the small cocoa research station comprising investigations into agronomic problems, breeding and selection, clonal propagation, and distribution of seedlings. English, German and Spanish summaries. Tables. Photos. Maps. 9 refs.

INDEX of First Eight Issues

AUTHOR INDEX

SUBJECT INDEX

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