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COCOA GROWERS' BULLETIN

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Editorial

Grading Standards

There has been a shortage of cocoa for the past 18 months—a shortage which may well continue—and such a time may not seem the most appropriate for considering quality standards. This, however, is a slow-moving matter, and the standards agreed at the F.A.O. Working Party on Cocoa Grading are unlikely to be fully implemented in the near future. The important aspect of this meeting, which was held in Paris in May 1969, is that agreement was reached between producers and consumers. International Cocoa Standards in the form of a Model Ordinance and a Code of Practice have been formulated, and these documents are printed in this issue.

The new grade standards are very similar to the draft standards put forward by the previous meeting of the Working Party in 1963. These standards have been adopted by several producing countries during the intervening period. They differ, however, from the standards in use in the trade, which has retained the limit of 5 per cent slate, 5 per cent mould and other defects for "Good Fermented" cocoa. This contrasts with 3 per cent slate, 3 per cent mould and 3 per cent other defects for Grade I cocoa in the F.A.O. standards.

One new feature is a limit on moisture content. This must not exceed 7·5 per cent as determined at first port of destination. The bulk of the world's cocoa has moisture content well within this limit, but there may be countries where more attention will have to be paid to this aspect of quality. As moisture content is to be determined at port of destination, so consideration will have to be given to change during shipment. This aspect has not been studied in detail. During the journey from West Africa to Europe there is a tendency for cocoa to lose moisture rather than gain it, but there must be instances where longer journeys through the tropics could lead to different results. The need for this limit is to prevent the development of mould. In the first place the presence of mould affects flavour, but there is another aspect, namely the possible presence of mycotoxins. As information is gathered on this subject, it points to the need for close attention to proper drying and storage.

Following the agreement reached at Paris, the Director-General of F.A.O. will submit the standards to member governments for adoption. When they have been adopted more generally by producing countries, the trade will then use these standards in their contracts.

G. A. R. WOOD.

Review of Production and Consumption

November 1969

A. P. Williamson, Cadbury Limited

Production

Gill and Duffus have put their first forecast of total 1969-70 production at 1,279,000 tons, or approximately mid-way between last year's level and the more normal level of 1966-67 and 1967-68.

The forecast confirms the earlier pessimistic reports from some parts of West Africa. Only very small increases over last year's disastrous levels are predicted in Ghana and Nigeria. On the other hand, record crops are predicted in the Ivory Coast and Cameroon, and another good year is expected in Bahia.

Consumption

Higher cocoa prices are causing a reduction in consumption, and world grindings in 1970 are forecast at 1,286,000 tons, 4 per cent less than in 1969, which in turn was 4 per cent less than in 1968. The main fall is expected to be in Western Europe and North America. In Eastern Europe usage is expected to be similar to last year's.

Stocks

While the nominal production deficit in 1970 is expected to be only 7,000 tons, after allowing for the normal 1 per cent loss in weight, this is equivalent to a true deficit of 20,000 tons.

If this forecast proves correct, it will be the fourth consecutive year in which consumption will have exceeded production, and stocks of old-crop cocoa carried over into 1971 will be even lower than those carried over into 1970. This carry-over into 1970 is itself the lowest, in terms of monthly usage, since the end of the war.

Prices

The price for 1969-70 Ghana shipment cocoa rose from £400 to £440 per ton during September and October and then fell back to £390 during November.

WORLD COCOA PRODUCTION AND GRINDING DATA

Reproduced from Gill and Duffus Market Report dated November 24 1969
(Thousand long tons)

Production

	1967–68	1968–69 (estimate)	1969–70 (forecast)
Africa	963	853	884
America	292	301	306
West Indies	49	37	47
Asia and Oceania	37	40	42
World Total	1,341	1,231	1,279
Principal Countries			
Ghana	415	334	340
Nigeria	235	187	200
Ivory Coast	144	142	155
Cameroon	90	101	108
Guinea (Spanish)	33	37	30
Brazil	141	163	165
Ecuador	68	53	55
Dominican Republic	30	22	30
Mexico	27	26	24
New Guinea	24	27	29

Grindings

	1968	1969 (estimate)	1970 (forecast)
Western Europe	546	514	494
Eastern Europe and U.S.S.R.	185	186	182
North America	304	278	265
Australia and New Zealand	17	17	17
Central and South America	157	152	147
Asia	50	50	46
Africa	137	141	135
World Total	1,396	1,338	1,286
Principal Countries			
United States	286	262	250
Germany (Federal Republic)	137	124	120
Netherlands	110	109	105
United Kingdom	92	91	86
U.S.S.R.	95	106	112
France	49	44	42
NOMINAL DEFICIT	–55	–107	–7

The Royal Tropical Institute, Amsterdam

Ir. H. Ph. Huffnagel, Director, Department of Agricultural Research

The Royal Tropical Institute was founded in 1910 as a private organisation, and still functions as such, but is nowadays subsidised to a considerable extent by the Netherlands Government in order to contribute in development co-operation, research and education. In earlier days the Institute was more academic, its staff studying anthropology, agriculture, or health in the tropics. Amongst the better-known members of staff was Dr. C. J. J. van Hall, who was in charge of the advisory and documentation activities of the Institute's Trade Museum in pre-war years and whose biography appeared in the last issue of this *Bulletin*. Nowadays the Institute's functions are more practical and its tasks are carried out by three scientific departments: the Department of Tropical Hygiene, the Department of Social Research and the Department of Agricultural Research, while the Department of General Affairs includes a Central Library and an Education Division responsible amongst others for the training of all Dutch Young Volunteers. The well-known Tropical Museum takes a central place in the Institute, as all departments are involved in explaining to the public the aspects of the third world and of development co-operation.

The staff of the Institute has increased from 260 to nearly 400 over the past five years. The scientific staff rose from 50 to 80, all university graduates and many with long experience in the tropics. The combination of many disciplines in one Institute is unusual and provides many opportunities for the Institute's staff to implement the interdisciplinary approach to development planning.

Fortunately the present need for sociological and socio-economic research in integrated planning is sufficiently understood. The staff of the Department of Social Research therefore take part in technical as well as in educational projects. The former main interest in physical and cultural anthropology has now developed into applied research in sociology, rural economy and community development.

The staff of the Department of Tropical Hygiene are particularly involved in medical research and health planning in the tropics. This Department operates a Medical Research Centre at Nairobi, which is part of the Royal Tropical Institute. Epidemiological research carried out in close co-operation with the Nairobi Centre is the basis of health planning research within the framework of socio-economic opportunities of the developing countries. The Department takes care of medical training courses at Amsterdam and of a number of field projects on family planning and medical training.

By explaining first of all the work of the Institute on sociology and health related to the tropics, it has been made clear that the Royal Tropical Institute is not involved solely in the field of tropical agriculture. However, it is presumed that the reader of the *Cocoa Growers' Bulletin* will be particularly interested in the activities of the Department of Agricultural Research.

Department of Agricultural Research

Whereas the Institute as a whole has as its threefold task: development co-operation, education and research, the emphasis on each of these tasks may differ slightly from one Department to another. Development co-operation in the Agricultural Research Department means in the first place helping developing countries in the improvement of their agriculture, livestock and forestry through technical assistance missions and by making use of various extension and information media.

The staff members, who carry out these activities, are all senior specialists with at least ten years' experience in tropical regions. Their long-standing experience covers either specific food or industrial crops, or subjects such as irrigation and drainage, economics, extension, education, and tropical weed control.

While at the Home Office, the staff members handle requests on agro-technical advice, study the world literature on tropical agriculture and related fields and supply monthly over a thousand research stations, institutes and libraries, mainly in the tropics and subtropics, with summaries of their studies. The cocoa abstracts, published regularly in the *Cocoa Growers' Bulletin*, are reprinted from the monthly periodical *Tropical Abstracts*. Each issue contains about 260 carefully selected abstracts in English from original publications on tropical and subtropical agriculture, as well as book reviews and "review articles", summarised information on specific subjects of current interest.

The extensive documentation, built up in this way by means of official documents and internal reports, and abstracts, gives the Institute an excellent opportunity to provide its own agricultural staff with considerable backstopping facilities. These facilities are also appreciated by national and international institutions concerned with agricultural development planning.

Besides the Advisory and Documentation Bureau, the Department consists of a number of laboratories. The Chemical and Biological Laboratories have played an active part in the chemical analyses and quality tests of tropical products since the establishment of the Royal Tropical Institute nearly sixty years ago. In the course of the years, analyses on cocoa were regularly carried out. The active, former head of the laboratories, Mr. W. Spoon, may still be well known to the reader. Today the long-term research projects of the Chemical Laboratory concern in particular food processing, with emphasis on soybean products.

In the biological section of the sub-department, work is done amongst others on forestry, entomology, fibre research and botanical identification. The collection of tropical timber specimens of the Wood Section covers approximately 10,000 different species coming from 49 tropical countries. This collection is used, for instance, in arbitration. Since 1938 the Wood Section has tested different tropical species for their resistance to shipworm attack. An important activity started in 1967 with the introduction of lesser-known tropical species. The Institute has asked potential producer countries to supply full documentation and one cubic metre of timber of those species which have good physical properties and are abundant in the forest. The Institute acts only as an intermediary by supplying samples and information to interested traders and industries. A new activity by the Wood Section concerns the promotion of research programmes about the complete exploitation of left-over timber after selective commercial cutting in forests in the tropics.

Preparation of industrial wood samples for experimental purposes.

Mr. J. G. Ohler, of the Royal Tropical Institute, examining a disease in a young coconut palm, Surinam.

The work of the entomological section may interest the cocoa trade in particular as this section is concerned with the nature and extent of insect damage. The entomologists are often called to report on damage caused by storage insects in shipped tropical products.

A sub-department, which has not been mentioned yet, and which forms an integral part of the programme of activities of the Department of Agricultural Research, is the Tropical Soils Laboratory. Formerly a laboratory for routine analyses only, it recently developed into a well-equipped research laboratory to serve the Department's staff members in their field work and to carry out specialized soil research. Survey missions often need quick control checks, whereas consulting firms carrying out development projects often face specific soil problems which need thorough investigation. For both types of request a thorough knowledge is needed and fortunately is available in this part of the Institute.

One further activity of the Institute should be mentioned. In 1942, on the occasion of the 125th anniversary of the establishment of the Hortus Botanicus at Bogor (then: Buitenzorg), Indonesia, the Royal Tropical Institute founded a chair of tropical botany at the University of Amsterdam. The lectures are focused on aspects of applied research on major food and industrial crops, with special emphasis on the increase of agricultural production in the tropics and subtropics. In 1968 Dr. G. Giesberger, with long experience of cocoa research in Indonesia, and a staff member of the Institute, was appointed to this chair.

All separate activites within the Institute are integrated as far as possible. The experience gained during pre-investment surveys, evaluation missions and the execution of projects, can be pooled and used to increase the knowledge of interdisciplinary approach. It is a far from easy task and much has still to be learned. This was demonstrated at the "International Seminar on Change in Agriculture" held at Reading University in 1968. At this Seminar 67 case studies were presented. They described attempts to change the agricultural structure in certain countries, and showed that it is very difficult to develop strict guidelines for sound development. Nevertheless, the Royal Tropical Institute is confident that through its activities on development co-operation, research and training, the contribution to improvement in the developing countries is worth the effort.

Cocoa in Ecuador

R. A. Lass, Cadbury Limited

Historical

During much of the 19th century Ecuador was the world's leading cocoa producer, a position held until 1910 when her production was surpassed by Ghana and Brazil. Production of cocoa increased from about 5,000 tons in 1840 to an average of 23,000 tons by 1900 and then rose rapidly to a peak of 47,000 tons in 1914. The ravages of two fungus diseases—Monilia and Witches' Broom—caused a substantial decline in yields and total production. Over the next twenty years cocoa exports fell back to 11,000 tons in 1933, but subsequently there has been a continuous rise to the record level of 64,000 tons in 1968.

When Ecuador was the foremost producer, cocoa was the only export crop of any significance and it brought much prosperity to the cocoa areas. The arrival of disease brought hard times for the growers and gradual diversification of the agriculture ensued, first by plantings of coffee and latterly bananas. Bananas have become the most valuable export crop, though all banana sales from Ecuador are on the open market with no guaranteed outlets. The 1968 banana exports of 1·2 m tons were valued at £42 m and export potential is considered to be 2·2 m tons (5). The cocoa exports were valued at only £16 m

Unloading wet beans at the roadside for transport to the drying houses.

in 1968—a year of very high prices (6). An unexpected improvement in banana prospects has occurred during the latter half of 1969, following the impact of hurricanes in Central America, and it now seems likely that banana exports in 1969 will achieve a total value similar to that in 1968 (7). The fortunes of cocoa and bananas tend to work in apposition, and quite extensive plantings of cocoa seem to occur when the banana industry is unprofitable, as in the period from 1960 to 1963.

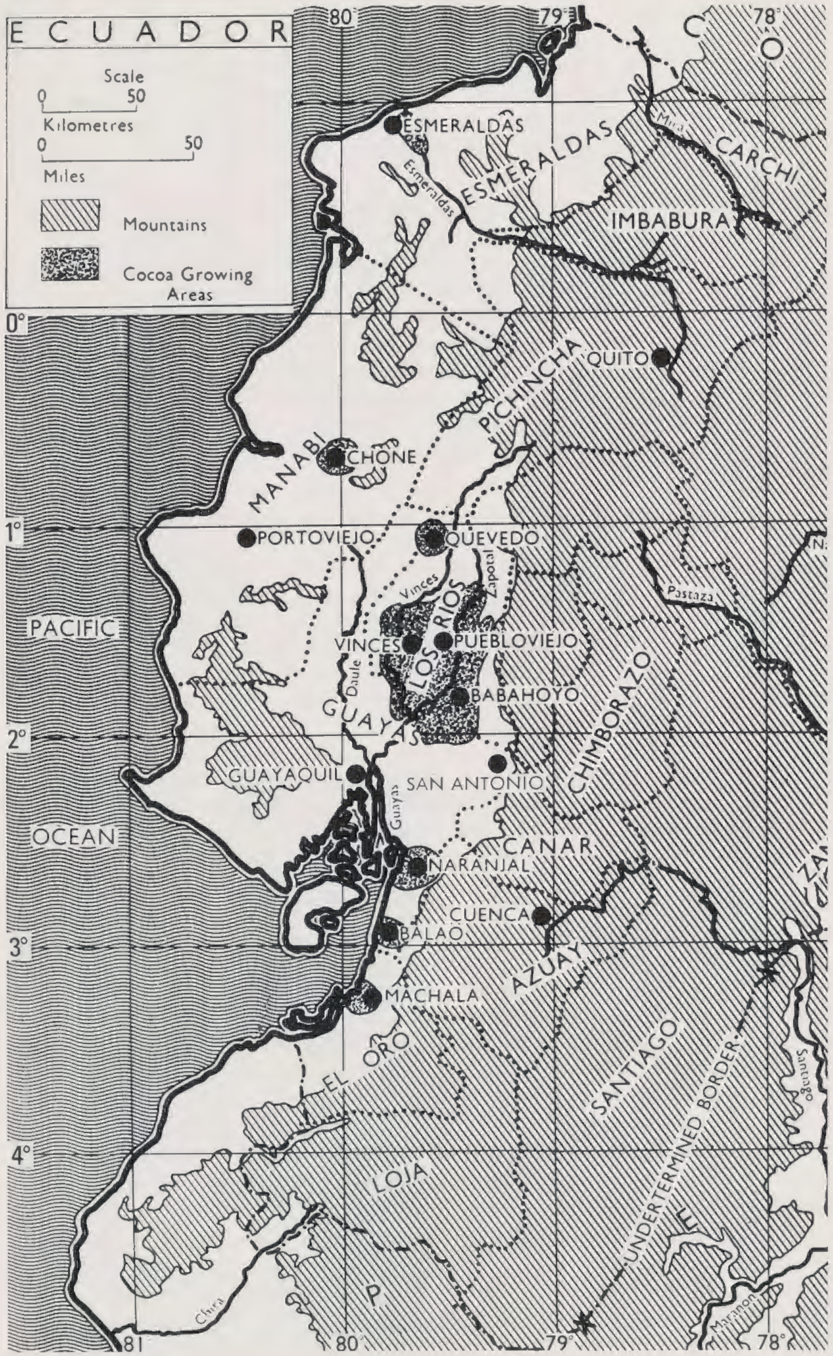
At the present time, bananas are less profitable than cocoa due to a higher export tax on them combined with low world price. Government policy is to stimulate new crops—oil palm, rice and sugar—and reduce dependence on bananas, and to this end a grant is made for the removal of bananas. In addition credit will be available at about £80 per hectare for planting cocoa. The recent plantings of cocoa stem from private rather than public initiative and are a direct result of increased profit from cocoa when compared with bananas. By tradition cocoa is treated as a low investment—low cost crop and it is indeed strange to observe the high investment in irrigation schemes, aerial roadways and packing sheds for bananas, but by contrast almost no investment in cocoa cultivation.

Cocoa Industry

Cocoa is grown in several areas in the Provinces of Esmeraldas, Manabi, Guayas, Los Rios and El Oro. The main area is along the many tributaries of the river Guayas, and this cocoa is referred to as Arriba as it lies upstream from Guayaquil (Arriba in Spanish means "above"). Traditionally all the cocoa from the Arriba district was forastero from trees of 'Nacional' variety giving the flavour associated with Ecuador. 'Nacional' cocoa was grown exclusively until 1890, but the low-yield potential of this variety meant that extensive plantings of more vigorous Trinitario and Venezolano materials have occurred since the first introduction in 1890. Arriba cocoa usually receives a premium over West African on the world market and is widely described as a flavour cocoa. Depending on the supply and demand for flavour cocoas the percentage sales of true Arriba cocoa (considered as the two best grades A.S.S.P.S.—Arriba Superior Summer Plantation Selected and S.S.S.—Superior Summer Selected) is estimated to vary from 10—35 per cent of the total season's crop. The grading was traditionally by size and external appearance of the bean, but standards for the degree of fermentation were introduced in 1962 and are being widely adopted by the exporters. On the world market, demand for Arriba cocoa and flavour cocoas in general has not increased in step with the world demand for cocoa and so the premium currently received is not as substantial as in the recent past.

The introduction of Trinitario material to Ecuador from the turn of the century, and more recently of other hybrid forastero material, has meant that holdings entirely of 'Nacional' cocoa are now extremely rare and the cocoa from farms in the Arriba district never contains 100 per cent 'Nacional' beans.

Nearly all the cocoa produced in Ecuador is sent to Guayaquil by road or river, and until 1965, 90 per cent of the country's total cocoa exports were brought into Guayaquil unsold. However, in 1965 a programme to develop a network of 37 Local Buying Stations was introduced by one of the old-established exporting companies. Considerable investment by them in purchasing and credit facilities has meant that this one company now purchases 50 per



cent of the country's cocoa through these stations. The buying stations are generally run by small merchants, who appear ready to offer credit in cash or kind to known customers. The cocoa purchase and sale price are fixed by the exporting company twice a week and they pay expenses and transport costs, while the station buyer receives a guaranteed commission of 2 per cent. On arrival in Guayaquil much of the cocoa requires further drying, and all is usually hand picked to select Arriba cocoa for sale under A.S.S.P.S. or S.S.S. grades.

The traditional outlet for the better grades of Ecuador cocoa has been Europe, with poorer quality beans being sold to U.S.A.; however, interest has recently arisen from U.S.S.R and other consumers in the Eastern Bloc. During 1968, 37 per cent of the cocoa exported was sold to U.S.S.R., 28 per cent to U.S.A. and 12 per cent to Colombia. It is worth noting that there were no sales to Russia prior to 1967.

There are several local consumers of raw cocoa, who used over 5,000 tons in 1968. A cocoa butter plant was scheduled to open in September 1969 under private ownership, and when fully operational will increase local consumption to an estimated 10,000 tons per annum. It is suggested that smuggling into Colombia may account for an appreciable quantity of raw beans.

There has been no recent Agricultural Census from Ecuador but an estimate of current acreage under cocoa suggests it may be 500,000 acres, though the F.A.O. estimate (3) for the 1966-7 season is 125,000 acres higher. A further estimate suggests that average holding size is $2\frac{1}{2}$-5 acres, with holdings under 75 acres producing 85-90 per cent of the crop; there are a few estates of over 3,000 acres. A Danish company is developing an estate (Hacienda San Antonio in Guayas Province) with 3,500 acres of cocoa planted since 1965, but there is no other major foreign investment in cocoa.

Environmental conditions

The climate is unusual for a cocoa-growing country and much information on the climate of Ecuador is given by Wood (10), while Hardy (8) discusses in detail the soils of the Riverine Belt which includes much of the cocoa areas. The wet season lasts from December or January to May and is hot and sunny in comparison to the six or seven months of the dry season, when the days are cool with an overcast sky for much of the time and considerable early morning mist and dew. This climatic pattern is due to the Humboldt current—a cold stream which flows north along the coast. The rainfall in much of the Guayas basin is in the range 55-100 inches per annum and decreases towards the coast. The high humidity of the dry months reduces the desiccating effect of the long dry season in many areas. Many soils are immature volcanic ashes, though alluvial deposits are widespread, especially in Los Rios province, where they occur on river levées with waterlogged humic gleys in the low-lying areas. This unusual situation means that cocoa planted on the levée will never suffer from dry-season desiccation.

Method of establishment

Traditionally, much of the cocoa was established by the contract system as used in Trinidad. This is now impossible due to the Land Reform Law 1964 which specifies that anyone who crops land for over three years becomes the legal owner. Establishment is now usually under bananas as temporary shade (both crops at 12-foot square spacing) and permanent shade as *Erythrina glauca* or *Inga* sp. The bananas would be removed in the third year.

There is a shortage of planting material which has led to the planting of unsuitable material on many farms. Numerous farmers are forced to make their own selections from trees which when assessed visually appear to be high yielding. A State Company E.R.C.A. (Empresa para Renovacion de Cacao) was established in 1950 to distribute rooted cuttings as a commercial venture. It did this profitably for some years but ceased operations in the early 'sixties. There are more clonal trees than seedlings in the country.

Cultivation

The only cultivation is the process described locally as "cleaning", which is carried out twice per annum and combines weed control with removal of chupons. Any other cultivation, even on the largest haciendas, is very rare. Bamboo supports are universally used for all clonal material from a young age even on the smallest farms. Essentially cocoa is operated as a low-cost enterprise by the farmers of Ecuador, and in view of the very serious and unresolved disease problems of cocoa this may well be the most economically viable approach.

Processing

Traditionally, pods are cracked in the field, carried to a central area (Plate 1) and fermented on the drying platform in a heap under a canvas for one or two nights (Plate 2) before being dried in the sun for 8-10 days. Much cocoa used to be dried on oblong cambered concrete floors (tendals) (Plate 3), but many of the larger haciendas are now using sliding platforms. Arriba types ferment adequately in 24 hours, whereas Trinitario material needs several days. Mixtures of these types in proportions varying from field to field give rise to fermentation problems, resulting in a high proportion of underfermented Trinitario beans. Allison (1) carried out some trials from 1964 and showed a higher percentage of fully fermented beans with longer periods of fermentation in trays, but this method has not received widespread acceptance. In fields with mixed stands of cocoa varieties it is hard at the moment to see a practical solution to this problem.

Diseases

The fungus diseases, Witches' Broom (*Marasmius perniciosus*), Monilia Pod rot (*Monilia roreri*) and Ceratostomella Wilt (*Ceratocystis fimbriata*) have had very serious economic effects on the cocoa industry of Ecuador.

Witches' Broom (or Escoba de Bruja) first appeared at Balao in 1921 and spread to all other areas within five years (10). The disease is well described by Holliday (9). It is not unusual to see 100-200 brooms per tree in areas of high infection as is seen in and around the Experimental Station at Pichilingue. So far no immune planting material has been developed in spite of much research effort, and over 200 introductions of planting material from many parts of South and Central America (4). The well-known SCA 6 clone appears to offer a high degree of tolerance to Witches' Broom but is not immune under Ecuador conditions. The TSH series of clones from Trinidad also offers some

Fermentation technique under a canvas sheet.

Cocoa drying on "tendal" with mobile polythene covers.

tolerance in Ecuador although the standard tests suggest a high degree of resistance under Trinidad conditions. There is no estimate of the percentage of pods infected with the fungus as this effect tends to be masked by the very high infection of Monilia.

Ceratostomella Wilt (or mal de machete) has killed nearly all the ICS 1 and ICS 45 trees in Ecuador. Losses of 40,000 trees of these clones were recorded at the well-known Hacienda Clementina, and caused the estate to abandon cocoa culture. When Ceratostomella disease was first studied in Trinidad, farmers were recommended to remove diseased trees by cutting out. Further research now suggests that it is undesirable to cut the wood, as the spores are spread in the sawdust, but unfortunately some Ecuador farmers are still cutting out infected trees. Some local clones when crossed with IMC 67 are showing a very high degree of resistance to 12 months of age and these are now being planted in field trials at Pichilingue. Most trees of the highly susceptible clones have now died and so the disease is not currently inflicting severe losses in Ecuador.

Monilia Pod rot is suggested to infect annually and render useless a large part of the potential cocoa crop. The low infection and dry weather in 1968 coincided with a record crop, and the poor crop in 1969 may well be due to high rainfall and humidity causing ideal conditions for the spread of Monilia. It is suggested by Delgado (pers. comm. 1969) that 10 applications of Zineb in a year of high infection might reduce the percentage infection from 80 per cent to 30 per cent. In a year of low prices or low infection this is probably not profitable and as far as is known no farmers are currently spraying against Monilia Pod rot.

One large hacienda collects the Monilia infected pods prior to the main harvest and dips them into an agricultural oil before permitting contact with healthy pods. The oil is of the type needed to control leaf spot of bananas. This seems a sound procedure, especially for cocoa in a new area, and this hacienda showed a very low percentage infection. Beans from Monilia infected pods may be only partially destroyed, if infected at a late stage. These beans will be blackened and of poor flavour, but are currently being sold to U.S.A. buyers at a considerable discount. The disease is peculiar to Ecuador and Colombia, where it is also of major importance, thus the research into control would seem to be the responsibility of these countries. A helpful discussion of Monilia is provided by Ampuero (2).

Research

Cocoa research was initiated in Ecuador in 1943 by the U.S. and Ecuador governments, but now all agricultural research is carried out by a government agency, Instituto Nacional de Investigaciones Agropecuarias (I.N.I.A.P.), with additional finance from various overseas foundations. A considerable volume of cocoa research is in progress at the research station at Pichilingue, near Quevedo, and is directed mainly at resistance to the three major diseases.

Future prosects

The Ecuador cocoa farmer is faced with many problems, of which the control of disease is probably the most frustrating and serious. It is perhaps unfair to encourage the use of high-cost inputs in labour or fertilisers when such high losses from disease are to be expected. Therefore, until such time as adequate

control for the major diseases is available, the Ecuador farmers' policy of remaining a low-cost producer is probably justified. The farmer has further difficulties due to shortage of long-term credit for development, lack of planting material and the absence of an effective extension service. There is little hope for resolution of the problem of fermentation of the various cocoa types or the consistency of Arriba cocoa until an effective extension service is operating. There is some awareness of these problems but at the moment finance is limiting any dramatic progress.

The environmental conditions suggest Ecuador to be well suited for cocoa, and cocoa in Ecuador should have an excellent future, especially if Monilia could be effectively controlled. The discovery of substantial oilfields in the Andes must have far-reaching effects on the economy and more gradually on the agricultural sector. It is difficult to estimate the effect on the cocoa industry until the full potential of the discoveries is realised.

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Some Aspects of The Management of Young Cocoa

L. J. Foster and Lim Hong Kee, BAL Estates, Sendirian Berhad, Tawau, Sabah.

In the early stages of an estate development programme for cocoa on BAL Estates in Sabah several technical problems arose in the nursery and after transplanting to the field. Investigations were therefore undertaken on the estate in connection with the production of suitable planting material, the control of leaf-eating insects and weed control on planting out. This paper summarizes the results of these investigations.

1. Production of Seedlings in the Nursery

It was required that plants should be sufficiently well grown, say 10-12 in. (25-30 cm.) high, with a stem diameter of about 4 mm., for transplanting to the field at three months. It was assumed that factors influencing the quality of seedling material would be the type of the soil for the nursery, the application of fertilisers and the size of the polythene pot or polybag. The cocoa was to be planted in basaltic soil, and soil samples were taken from two areas scheduled for planting to cocoa, one of virgin jungle and another from a field which had grown abaca for some years. Although chemical analysis of these particular soils showed no deficiency of phosphorus, it had been customary to use phosphate in the nursery and in the field at transplanting. The soils were slightly acid, pH 5·5 to 6·2 (1). Thus, two carriers of phosphorus, Christmas Island rock phosphate (CIRP) and double superphosphate (supers), calcium in the form of Limbux and a compound fertiliser of the formulation 12:12:17:2 with a third of the phosphate available in a water soluble form, were included in the experimental treatments by mixing in the soil. Double superphosphate and CIRP was tried at $\frac{1}{2}$, 1, 2, 3, 4 oz. per $3\frac{1}{2}$ lb. of soil, Limbux at 1 and 2 oz. and 12:12:17:2 compound at $\frac{1}{2}$ and 2 oz. per $3\frac{1}{2}$ lb. of soil.

Cocoa seedlings 18 days from sowing in 6″ × 9″ polythene bags.

No doubt the polybag has come to stay (4) but different views prevail as to the optimum size. (Plates 1 and 2). Three types were investigated, two of black perforated polythene 6 x 9 in., laid flat, and 7 x 12 in., the former containing about $3\frac{1}{2}$ lb. of soil and the latter about $6\frac{1}{2}$ lb. The third type, as used by the Agricultural Department, was a transparent polythene tube, 5 x 10 in. in size, and contained about $2\frac{1}{2}$ lb. of soil.

The three treatments, soil, fertiliser and polybag, were incorporated in a series of three formal trials. Germination beds are not considered necessary and the seeds were sown direct in the bags. It is normal estate practice to sow a single seed to each polybag but the experimental plots were sown at two seeds per bag which were singled at three weeks when germination was recorded. Measurements of diameter just above the cotyledon scar were recorded at five weeks and three months and the number of mature leaves and leaf length at three months.

Basaltic soil which had grown a crop of abaca was evidently as suitable as

Cocoa seedlings at three weeks.

Typical three-month seedling ready for planting out.

virgin jungle soil provided topsoil was used. Simazine, used as a pre-emergent herbicide, did not adversely affect germination but subsequent growth was retarded.

The phosphatic fertilisers, the compound fertiliser and lime were not beneficial at the high rates used in the trials. Both rates of the 12:12:17:2 fertiliser and the two highest rates of double superphosphate impaired germination and subsequent growth. There was, however, some benefit to be obtained from low rates of phosphate, i.e. ½ oz. double superphosphate or 2 to 4 oz. of CIRP, a slowly available form of phosphate; of these treatments CIRP gave the best results and is undoubtedly the safest to use in commercial practice.

There was little to choose between the sizes of polybag. For three-month-old material there was nothing to be gained by using the largest bag. The smallest bags were satisfactory but, as the small diameter meant closer spacing, the bags most conveniently being arranged pot tight, i.e. touching each other, this size would not be suitable if there was to be any delay in planting. Thus, for commercial practice the 6 x 9 in. polybag was recommended (Plate 3).

2. The Control of Leaf-Eating Insects

Cocoa suffers from continuous attacks by leaf-eating insects, mostly night-flying beetles of the cockchafer (Melolonthidae) and the grasshopper type, both in the nursery and in the early stages in the field (Plate 4). Lead arsenate has been used as stomach poison but it has the disadvantage of needing frequent application if the plants are to be adequately protected and it is easily washed off by rain. Cocoa leaves are also susceptible to scorching by lead arsenate.

Two observation trials were therefore laid down to screen a series of insecticides for their efficacy and their phytotoxicity on young hybrid cocoa seedlings. There were 100 seedlings to each treatment. All chemicals were sprayed at the strengths recommended by the makers to run-off point. A spreader (Teepol 710) was added to the sprays at the standard rate, 2 fl. oz. in 20 gallons of water.

In the first trial the first spraying was necessary five weeks after sowing the seed; two further applications were made at fortnightly intervals. In the second trial, which included a higher rate of bidrin and formulations of dimethoate and trichlorphon from a local supplier, treatment was necessary at three weeks after sowing; a second spraying was made a month later. The number of chewed leaves was counted a fortnight after the spray applications in the first trial and a month later in the second. All chewed leaves were removed after recording so that fresh attacks could be counted.

Endosulfan was most outstanding and is a relatively safe insecticide to handle. Bidrin and dimethoate are systemic and partly systemic respectively in action and would therefore still be effective after heavy rain. They can be used to protect nursery material prior to transplanting to the field at a time when labour might not be available to apply a prophylactic spray in the field. Bidrin has a high mammalian toxicity level and would have to show other advantages such as superior persistence and low cost to justify its use on a field scale.* In another trial with bidrin, not reported here, it was found that when applied to mature trees its effect persisted for about a month; this was about twice as long as could be expected for dimethoate or endosulfan.

Both formulations of trichlorphon (Dipterex 80 and T.95 both at 0·30 per cent commercial material) were not outstandingly effective at the strength and frequency employed and induced a blistering and chlorosis of the foliage resulting in a marked reduction in the growth rate. The remaining chemicals formothion (Anthio 25 per cent E.C. at 0·20 per cent commercial material), gardona (S.D. 8447, 24 per cent E.C. at 0·20 per cent) and malathion (M. 5F 60 per cent E.C. at 0·25 per cent) were not effective.

Thus, at least three insecticides as efficacious as lead arsenate are available for the control of leaf-eating insects on cocoa with the added advantages of not inducing phytotoxic effects, being safer to handle in two cases and more persistent. The first choice for commercial use depends to some extent upon their comparative costs but this is not so important a consideration in the small area of a nursery as in a field. Thus, for nurseries a sequential spray of bidrin/lead arsenate has been adopted.

3. Weed Control on Planting Out

Kasasian and Seeyave (2, 3) recommended the use of paraquat followed by pre-emergent sprays of the substituted urea, diuron, and of the triazines, atrazine or simazine, as suitable herbicidal treatments for young cocoa with the proviso that the sprays should not come in contact with the cocoa foliage and growing points and that diuron should not be used on light soils. The chocolate basalt

*There have been reports from Ghana of phytotoxic effects from use of technical bidrin. The point is being studied.

soils in Sabah are very permeable and there could be a danger of translocation, particularly after heavy rainfall. Therefore diuron (Karmex), atrazine (Gesaprim 50) and simazine 50 were all tried at two rates of 4 and 8 lb. per treated acre and compared with lasso (CP 50144 at 4 pints per treated acre) under local conditions with a control treatment of normal estate practice of monthly circle-weeding by hand. The toxicity risk at normal rates and higher rates and the effect of direct herbicide application onto cocoa was also noted. An area was selected for a randomised block trial under light Gliricidia shade. It was treated with paraquat before planting; eight-tree plots were then planted with three-month-old Amelonado cocoa of uniform size and were hand-weeded where necessary. Dominant weeds were *Brachiaria paspaloides*, *Cleome ciliata*, *Eleusine indica*, *Euphorbia hirta*, *Paspalum conjugatum* and *Digitaria* spp. with occasional *Passiflora foetida* and *Axonopus compressus*. Nutgrass, *Cyperus rotundus* and *Kyllinga brevifolia* and less commonly *K. monocephala*, were particularly troublesome in areas where the former abaca canopy had been light and two blocks of the experiment were sited where nutgrass was dominant.

The pre-emergent sprays were applied immediately after weeding with an 062 polijet nozzle producing a 3- to 4-foot swathe at the rate of 30 gallons of the solution to a sprayed acre. The whole plot was sprayed and care was taken to avoid the young cocoa, particularly the growing tip; but some of the lower leaves were unavoidably sprayed. A second round was applied five weeks later but this was not necessary. The effect of the treatment upon weed growth was scored at fortnightly intervals for twenty weeks, i.e. for fifteen weeks after the second application, and upon the cocoa at twelve weeks after planting.

Weed growth was not excessive due to exceptionally dry weather in January and February (3·1 and 2·7 inches respectively) and, except where nutgrass was troublesome, hand-weeding was necessary at five-weekly intervals instead of monthly, as originally planned.

Typical cockchafer damage to cocoa in the field.

In the case of the herbicides, the lower rates gave quite adequate weed control for at least fifteen weeks after their application, with diuron giving the best control; dicotyledons were completely suppressed and very few *Eleusine indica* and *Brachiaria paspaloides* were beginning to appear in plots treated at the lower rate. In the atrazine treated plots several dicotyledons were also beginning to appear and weeding was just necessary at the lower rate. Simazine was slightly more effective, rate for rate, than atrazine, and lasso gave similar weed control to simazine at the lower rate. (Plate 5.)

The lower levels of simazine and lasso did no damage to the cocoa but atrazine at both levels and simazine at the higher rate induced a blotchy chlorosis which developed to necrotic spots especially towards the tip of the lamina; damage to the growing tip was not observed. Both levels of diuron produced marked symptoms; in several cases shoots died back and 15 per cent of the plants subsequently died.

Stem diameter was not affected except by diuron at the high rate. Simazine, atrazine and lasso did not adversely affect the growth of cocoa any more than hand-weeding; simazine in particular appeared to promote cocoa growth. Diuron was positively harmful; the leaves were damaged by contact and there was evidently some translocation of the chemical through the soil to the root system.

As might be expected after the initial spraying with paraquat, none of the treatments controlled nutgrass, which could be removed only by deep forking; the normal hand or chip-weeding treatment with a cutlass employed in the experiment was inadequate. Nutgrass significantly retarded the growth of the young cocoa. As it is now the practice to establish cocoa under light shade, insufficient to suppress nutgrass, this weed is now the most important in young cocoa for which no proper control has yet been worked out.

Thus, the lower rates of all herbicides were evidently quite adequate for the

Cocoa sprayed two months previously with simazine at 4 lb per acre (variation in growth due to Cicada attacks).

control of weeds except nutgrass over a period of at least fifteen weeks. One spraying application could replace two to three hand-weeding rounds and this could be an important factor where labour is difficult to obtain; it may also be cheaper than hand labour, depending on local rates.

4. Summary

Investigations were undertaken in Sabah on the management of young cocoa. For the production of three-month-old seedlings in the nursery polybags of 6×9 in. lay flat size were satisfactory. When filled with basaltic topsoil either from the virgin jungle or from an area which had grown a crop of abaca for some years, growth was equally satisfactory; it was further improved by low rates of a phosphatic fertiliser but high rates impaired germination. For the protection of young cocoa from leaf-eating insects, endosulfan, bidrin and dimethoate were as efficacious as lead arsenate; although not as safe as the others to handle, bidrin and lead arsenate were chosen for sequential application in the nursery, the former being superior to the others in its persistence, but not necessarily the cheapest. On planting into the field and after an initial hand-weeding, simazine at the rate of 4 lb. per acre gave very good and economical weed control for a period of over fifteen weeks without any deleterious effects on the cocoa except where nutgrass occurred, for which no satisfactory control has yet been evolved.

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Rehabilitation of Cocoa Farms
PART 2

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Chupon Regeneration

This is the method most commonly used in Nigeria, especially for rehabilitating old cocoa farms or trees attacked by mirids or infected with virus, provided not more than 30 per cent of the old cocoa trees are infected by CSSV. Regeneration is achieved by encouraging the growth of basal chupons on the main stem. About 50 per cent of the old cocoa trees develop chupons; not many chupons are needed to restore the canopy, four chupons being needed for optimum yield (2, 7). Coppicing does not improve the survival rate of chupons, hence it would be reasonable to encourage and leave chupons already growing before the original main stems are removed.

Nigerian peasant farmers have successfully prolonged the economic lives of old cocoa trees by using this method (Chief Ayorinde, personal communication; 2, 7). For instance, the Ogunwole family have maintained their original cocoa farm planted in 1889 at Idiape, Ibadan, at a reasonable yield level. The chupons still growing on the original trees are shown in the photograph.

Some advantages derived from the use of this method are:

(i) The new chupons start to yield steadily as from the third year (Toxopeus, personal communication).
(ii) The old cocoa trees continue to yield before the new chupons begin to bear pods, thus assuring the farmer of some revenue all the time, and
(iii) The farmer does not invest money on seedlings or a nursery.

Problems encountered in trying to use this method are:

(a) The old cocoa canopy must not be closed, otherwise the growth of the new chupons will be impeded.
(b) The farmer cannot make use of new improved varieties. This is considered a serious limitation especially if the old cocoa variety is susceptible to any disease in the particular locality, and
(c) Since the peasant farmers' cocoa in Nigeria is irregularly spaced, the new stands will also be irregularly spaced. This is a handicap to effective supervision of labour and good farm management.

Improved Chupon Regeneration

Basal chupons growing on old cocoa main stems are later patch-budded or grafted with clonal material from another variety (3, 4, 5, 6, 9). This will permit the introduction of improved, highly tolerant and better-yielding varieties into areas carrying moribund, diseased or highly susceptible cocoa types. This method has been successfully used at the Gambari Experimental Station of the Cocoa Research Institute of Nigeria by Are and Jacob (3) and on São Tomé by Ascenso (4). Patch-budding of the newly regenerated chupons gave higher percentage success than grafting and is preferred since it is easier to do.

It has the advantages and disadvantages enumerated under chupon regeneration above. The additional costs involved in budding operations are, however, likely to be recovered in full from the increased revenue expected from the higher yields of the improved clonal materials.

Essential Factors for Successful Rehabilitation

It is desirable, even on purely economic grounds, that cocoa-producing countries should rehabilitate their derelict farms for the following reasons:

(a) To maintain production and thus generate the much-needed foreign exchange for development since no cocoa-producing country can be regarded as industrialised or advanced.

(b) Lands with suitable soils and terrain for the crop are in short supply in some producing countries, while crop diversification has led to genuine competition for the remaining good lands in other countries.

(c) Rehabilitation will pay off since world supply of cocoa falls short of demand and consumption of cocoa is on the increase in temperate as well as in producing countries and there are no substitutes for cocoa in the world market. Two crops which could have substituted for cocoa in a rehabilitation programme are oil palm and citrus. Oil palm produce, however, has a less attractive world market price and has many substitutes, whereas citrus is being better produced outside cocoa-producing countries.

(d) It will keep many farmers, who may have been forced to look for alternative employment elsewhere, in business.

Financial Consideration

Rehabilitating low-yielding, old and diseased cocoa farms will cost money. Since money of the magnitude needed will be difficult to come by in cocoa-producing countries, external financial aid must be sought. In Western Nigeria, where 13,000 acres of unproductive cocoa are to be replanted over a seven-year period (Western Nigeria Development Project, 1964), the World Bank has been approached for a loan of £1,339,000 out of the £2,224,000 needed for the project. The estimated cost for replanting an acre in the areas without swollen shoot and those with swollen shoot are £97 and £102 respectively. Costs per acre of replanting are approximately 30 per cent higher than those of new planting estimated to be £68 per acre. This was due to the fact that administrative costs were 60 per cent higher per acre than for new planting as a result of the acre intensive supervision required, and that the re-establishment of a cocoa farm requires greater expenditure on labour, shade material and weedicides than does establishing cocoa under forest. The cost estimates were based on the 1963 price for labour, staff salaries and planting material (Western Nigeria Development Project, 1964). To make the best use of such financial asistance, the project has been phased and costed after a detailed survey. It is suggested that the World Bank and the International Bank for Reconstruction and Development should come to the aid of producing countries wishing to carry out large-scale rehabilitation of cocoa farms.

Planting Material

Most areas where rehabilitation is to be done, grow Amelonado cocoa, which grows slowly, coming into bearing in about five years. It is highly susceptible to CSSV, but escapes severe black-pod attack since it bears most of its crop between November and January, the drier months over most of West Africa. The planting materials to replace the Amelonado must therefore be more vigorous, highly tolerant to the prevailing diseases in the area concerned, must

Regenerated chupons from cocoa trees planted in 1889 by Chief Ogunwole at Idiape, Ibadan, Nigeria. (Photo taken in 1967)

come into bearing earlier and must be higher yielding but with acceptable flavour. The Plant Breeding Divisions of the different Cocoa Research Institutes are working hard to provide improved varieties to farmers. Methods for quickly multiplying the improved varieties will have to be devised. Since most farms are planted with seedlings, the use of hybrid seedlings produced from bi-clonal seed gardens using the self-incompatability mechanism must be encouraged, and the use of budded planting materials rather than vegetative cuttings may become more popular since patch-budding gives a higher percentage success than vegetative cuttings (Are and Jacob, in press).

Technical Services

A large number of agronomists and supporting staff will be needed for any successful rehabilitation programme. They will be needed to multiply the improved varieties, supply them to farmers, supervise their planting in the field as recommended and follow the progress of the new farms in an advisory capacity. They will ascertain that farms to be replanted are within the optimum rainfall areas, have suitable cocoa soils and are accessible for transportation of seedlings and for crop evacuation. A special training programme may have to be embarked upon to ensure that adequate supervisory staff will be available. In addition, as farmers are unlikely to be in a position to do patch budding or any form of vegetative propagation on their own, trained personnel will be required to produce the planting materials as well as provide most of the other technical services.

Suggestions for Improvements

Planning and Organisation

To ensure success, accurate costing of operations, assessment of the soil fertility status of the farm and of farmers' loss of income, must be completed a year before any farm is due for rehabilitation. These will determine the credit facilities to be made available to farmers by agricultural credit organisations. The money loaned should be enough to complete all phases of the operation and should be recovered on easy terms, bearing in mind the loss of income to the farmer and the length of time it will take to completely rehabilitate each farm. Part of the loan to farmers should be given in kind in the form of approved planting materials to ensure that only improved varieties are used. Farmers should be encouraged to take part in demonstration tours laid down by Agricultural Research Stations to convince them that rehabilitation will work and to determine the most suitable method to adopt in each case. This will build up confidence, a factor much needed for the success of any project.

Use of Cover Crops

Any rehabilitation method other than growing young cocoa under old trees increases the weed problem. The area becomes exposed and weeds and pests invade it. To avoid the ingress of grasses, cover crops, some of which may have economic value, e.g. beans, melons, could be tried. The use of cover crops will reduce soil erosion which could aggravate the soil fertility problem. Row weeding must, however, be done to keep the immediate surrounding of the cocoa plants free of weeds, thus reducing competition for nutrients.

Results of experiments at Kade, Ghana (8) revealed that no particular cover was superior to natural regeneration, although the use of *Tephrosia* and *Indigofera sumatrana* (both legumes) encouraged early jorquetting and bigger stem diameter of cocoa. Both, however, die early and are replaced by natural regeneration. Mulching and use of legume covers (8) gave higher cocoa yield than natural regeneration. This was attributed to better early growth rather than the residual effects of the cover on the soil.

Shade Supply

Young cocoa needs shade for quick establishment. Experience has shown that farmers prefer to use recommended nurse shade plants which have economic value as they give the farmer some income before the cocoa begins to yield fruit. Farmers in Nigeria, Ghana, Cameroon and Ivory Coast who produce 70 per cent of the world's cocoa, are peasant farmers with very small holdings. They need money during the period of establishment to supplement their meagre incomes, to assist in helping to discharge their civic duties, such as payment of taxes, and above all, pay the school fees of their children. It is therefore suggested that any realistic rehabilitation programme must make use of economic nurse shade plants since all methods except growing young cocoa under old cocoa will lead to reduction of income to the farmer, after making considerable investment of capital in land preparation and establishment of the new cocoa, he may have to wait for three years or more before there can be any steady return on the capital.

Insect Pests and their Control

Most rehabilitation procedures will lead to the exposure of the area concerned.

Experience at Gambari Experimental Station in Nigeria has shown that leaf-eating caterpillars, mirids, and bark-scraping beetles, are some of the insects which initially attack the newly-planted seedlings or regenerated chupons. Other insects of less importance known to attack such farms include thrips, termites, aphids and psyllids. The psyllids and aphids attack the young flushes, while thrips are found mostly on mature leaves. Most of these insects can be controlled by spraying with Gammalin 20. For foliar application, the concentration should be 4-8 oz. active ingredient per acre in 20 to 40 gallons of water. Mirids can be controlled by spraying $\frac{1}{8}$th of a pint of the formulated material in two gallons of water, for every forty trees. Leaf-eating caterpillars are effectively controlled by spraying with Rogor (Dimethoate). Dosage rate is 3-10 oz. a.i. per acre in 20 to 40 gallons of water. The frequency of spraying will depend upon the severity of attack. It is undesirable to spray with Rogor when the trees begin to bear fruit.

Use of Fertilisers

Most cocoa-producing countries do not use fertilisers to maintain or increase yield. Are (1) has reported that since farms to be rehabilitated are mostly over 40 years old and have been producing pods for upwards of 35 years without fertiliser application, such farms are likely to have soil fertility problems. Accurate soil surveys of areas to be rehabilitated and fertiliser trials are needed to improve the performance of such farms. This should be one of the priorities in any rehabilitation programme.

From available data (12), nitrogen and potassium should be applied as a split dose, two-thirds at the beginning of the rainy season and the final one-third five months later just before the main crop begins to mature. Phosphorus, on the other hand, should be applied once, at the beginning of the rainy season.

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International Cocoa Standards

The F.A.O. Study Group on Cocoa convened a Working Party on Cocoa Grading which, at a meeting held in 1963, drafted a Model Ordinance and Code of Practice. After some years of consideration by producers and consumers, during which time several producing countries adopted the standards contained in the Model Ordinance, the Working Party met again in May 1969. At this meeting draft proposals drawn up by the International Standards Organisation were considered, in addition to the earlier F.A.O. draft.

The Working Party reached agreement on standards and it is expected that the Model Ordinance will be adopted by producing and consuming countries generally and that commercial contracts will also incorporate them. At the present time it is impossible to predict just when these changes will take place. The Working Party also agreed that it would be necessary to review the application of the standards and some aspects would require further study. A further session will take place not later than mid-1974.

The following is the text of the Model Ordinance and the Code of Practice:—

Model Ordinance

1. Definitions

"*Cocoa bean*"*:* The seed of the cocoa tree (*Theobroma cacao* Linnaeus); commercially and for the purpose of this Model Ordinance the term refers to the whole seed, which has been fermented and dried.

"*Broken bean*"*:* A cocoa bean of which a fragment is missing, the missing part being equivalent to less than half the bean.

"*Fragment*"*:* A piece of cocoa bean equal to or less than half the original bean.

"*Piece of shell*"*:* Part of the shell without any of the kernel.

"*Adulteration*"*:* Alteration of the composition of graded cocoa by any means whatsoever so that the resulting mixture or combination is not of the grade prescribed, or affects injuriously the quality or flavour, or alters the bulk or weight.

"*Flat bean*"*:* A cocoa bean of which the cotyledons are too thin to be cut to give a surface of cotyledon.

"*Foreign matter*"*:* Any substance other than cocoa beans, broken beans, fragments, and pieces of shell.

"*Germinated bean*"*:* A cocoa bean, the shell of which has been pierced, slit or broken by the growth of the seed germ.

"*Insect-damaged bean*"*:* A cocoa bean the internal parts of which are found to contain insects at any stage of development, or to show signs of damage caused thereby, which are visible to the naked eye.

"*Mouldy bean*"*:* A cocoa bean on the internal parts of which mould is visible to the naked eye.

"*Slaty bean*"*:* A cocoa bean which shows a slaty colour on half or more of the surface exposed by a cut made lengthwise through the centre.

"*Smoky bean*"*:* A cocoa bean which has a smoky smell or taste or which shows signs of contamination by smoke.

"*Thoroughly dry cocoa*"*:* Cocoa which has been evenly dried throughout. The moisture content must not exceed 7·5 per cent[1].

2. Cocoa of Merchantable Quality

(a) Cocoa of merchantable quality must be fermented, thoroughly dry, free from smoky beans, free from abnormal or foreign odours and free from any evidence of adulteration.

(b) It must be reasonably free from living insects.

(c) It must be reasonably uniform in size[2], reasonably free from broken beans, fragments, and pieces of shell, and be virtually free from foreign matter.

3. Grade Standards

Cocoa shall be graded on the basis of the count of defective beans in the cut test. Defective beans shall not exceed the following limits:

Grade I—(a) mouldy beans, maximum 3 per cent by count;
(b) slaty beans, maximum 3 per cent by count;
(c) insect-damaged, germinated, or flat beans, total maximum 3 per cent by count.

Grade II—(a) mouldy beans, maximum 4 per cent by count;
(b) slaty beans, maximum 8 per cent by count;
(c) insect-damaged, germinated, or flat beans, total maximum 6 per cent by count.

Note: When a bean is defective in more than one respect, it shall be recorded in one category only, i.e. the most objectionable. The decreasing order of gravity is as follows:
—mouldy beans;
—slaty beans;
—insect-damaged beans, germinated beans, flat beans.

4. Sub-standard cocoa

All dry cocoa which fails to reach the standard of Grade II will be regarded as sub-standard cocoa and so marked (SS), and shall only be marketed under special contract.

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[1]This maximum moisture content applies to cocoa in trade outside the producing country, as determined at first port of destination or subsequent points of delivery. The Working Party reviewed the ISO method for determination of moisture content and agreed that it could be used, when recommended by ISO, as a practical reference method.

[2]"*Uniform in size*"*:* As a guide not more than 12 per cent of the beans should be outside the range of plus or minus one-third of the average weight. It is recognised, however, that some hybrid cocoa may not be able to meet this standard although fully acceptable to the trade.

5. Marking and Sealing

(a) All cocoa graded shall be bagged and officially sealed. The bag or seal shall show at least the following information:

Producing country, grade or "SS" if sub-standard, and whether light or mid-crop[1], and other necessary identification marks in accordance with established national practice[2].

(b) The period of validity of the grade shall be determined by governments in the light of climatic and storage conditions.

6. Recheck at Port of Shipment

Notwithstanding paragraph 5 (b) above, all cocoa so graded shall be re-checked at port within seven days of shipment.

7. Implementation of Model Ordinance

Methods of sampling, analysis, bagging, marking and storage applicable to all cocoa traded under the above International Standards are set out in the following Code of Practice.

Code of Practice

A. Inspection

1. Cocoa shall be examined in lots, not exceeding 25 tons in weight.
2. Every parcel of cocoa shall be grade-marked by an inspector, after determining the grade of the cocoa on the basis of the cut test (see paragraph C below).
   Grade marks shall be in the form set out in, and shall be affixed according to, Section....of....[3] and shall be placed on bags by means of a stencil or stamp (see also paragraph E below).

B. Sampling

1. Samples for inspection and analysis should be obtained:
   (a) from cocoa in bulk, by taking samples at random from the beans as they enter a hopper or from the top, middle and bottom of beans spread on tarpaulins or other clean, dust-free surface, after they have been thoroughly mixed;
   (b) from cocoa in bags by taking samples at random from the top, middle and bottom of sound bags using a suitable stab-sampler to enter closed bags through the meshes of the bags, and to enter unclosed bags from the top.
2. The quantity of samples to be taken should be at the rate of not less than 300 beans for every ton of cocoa or part thereof, provided that in respect of a consignment of one bag or part thereof, a sample of not less than 100 beans should be taken.
3. For bagged cocoa, samples shall be taken from not less than 30 per cent of the bags, i.e. from one bag in every three.

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[1]Absence of a crop indication means main crop.
[2]Some members of the Working Party felt that it was desirable that the cocoa year also be shown. The Working Party therefore decided that this question should be re-examined at its Fourth Session and that in the meantime indication of the crop year was optional.
[3]i.e. the appropriate reference in national regulations.

4. For cocoa in bulk, not less than five samplings shall be taken from every ton of cocoa or part thereof.
5. In importing countries samples for inspection should be taken from not less than 30 per cent of each lot of 200 tons or less, i.e. from one bag in three. Samples should be taken at random from the top, the middle and the bottom of the bag.

C. The Cut Test

1. The sample of cocoa beans shall be thoroughly mixed and then "quartered" down to leave a heap of slightly more than 300 beans. The first 300 beans shall then be counted off, irrespective of size, shape and condition.
2. The 300 beans shall be cut lengthwise through the middle and examined.
3. Separate counts shall be made of the number of beans which are defective in that they are mouldy, slaty, insect damaged, germinated, or flat. Where a bean is defective in more than one respect, only one defect shall be counted, and the defect to be counted shall be the defect which occurs first in the foregoing list of defects.
4. The examination for this test shall be carried out in good daylight or equivalent artificial light, and the results for each kind of defect shall be expressed as a percentage of the 300 beans examined.

D. Bagging

1. Bags should be clean, sound, sufficiently strong and properly sewn. Cocoa should be shipped only in new bags.

E. Sealing and Marking

1. After grading, each bag should be sealed with the individual examiner's seal. The grade should be clearly marked on each bag. Bags should also be clearly marked to show the grading station and period of grading (week or month).
   For these purposes the following measures shall be carried out:
   (a) suitable precautions will be taken in the distribution and use of examiners' seals to ensure that they cannot be used by any un-authorised person;
   (b) parcels shall be numbered consecutively by the official examiner with lot numbers from the beginning of each month. The parcel number or lot number will be stencilled on each bag in every parcel examined, in the corner nearest the seal;
   (c) grade marks will be stencilled near the mouth of the bag.

F. Storage

1. Cocoa shall be stored in premises constructed and operated with the object of keeping the moisture content of the beans sufficiently low, consistent with local conditions.
   Storage shall be on gratings or deckings which allow at least 7 cm. of air space above the floor.
2. Measures shall be taken to prevent infestation by insects, rodents and other pests.

3. Bagged cocoa shall be so stacked that:
   (a) each grade and shipper's mark is kept separate by clear passages of not less than 60 cm. in width, similar to the passage which must be left between the bags and each wall of the building;
   (b) disinfestation by fumigation (e.g. with methyl bromide) and/or the careful use of acceptable insecticide sprays (e.g. those based on pyrethrin) may be carried out where required; and
   (c) contamination with odours or flavours or dust from other commodities, both foodstuffs and materials such as kerosene, cement or tar, is prevented.

4. Periodically during storage and immediately before shipment, the moisture content of each lot should be checked.

G. Infestation

1. Cocoa beans may be infested with insects which have not penetrated the beans and whose presence is not revealed by the cut test which is employed for grading purposes. Such insects may subsequently enter beans or they may be involved in cross infestation of other shipments.

2. Therefore, when the cocoa is rechecked at port before shipment, as provided under paragraph 6 of the Model Ordinance, it should also be inspected for infestation by major insect pests. If it is found to be infested it should, before shipment, be fumigated, or otherwise treated to kill the pests. Care should be taken to avoid cocoa beans becoming infested in ships and stores from other commodities or with insects remaining from previous shipments.

3. If the use of insecticides or fumigants is necessary to control infestation, the greatest care must be exercised in their choice and in the technique of their application to avoid incurring any risk of tainting or the addition of toxic residues to the cocoa. Any such residues should not exceed the tolerances prescribed by FAO/WHO Codex Committee on Pesticide Residues and the FAO/WHO Expert Committee on Pesticide Residues and by the government of the importing country.

4. Rodents should as far as possible be excluded from cocoa stores by suitable rodent-proof construction, and where direct measures are necessary to control rodents the greatest care must be taken to prevent any possibility of contaminating the cocoa with substances which may be poisonous.

Bathycoelia thalassina

A Potentially Major Pest in West Africa

This insect has for many years been known to feed on cocoa in West Africa but it is only recently that the pest has been studied at Tafo as a result of considerable pod losses there. Significant damage has not been found elsewhere—until this year. The 1969-70 crop at Ikiliwindi has been severely affected, probably halved, by this pest, and there are other reports of crop damage in West Cameroon. The most significant symptom of *Bathycoelia* attack is premature ripening, and reports of this occurring in Ghana have appeared in recent market reports.

Bathycoelia thalassina is a Pentatomid and looks like a large green capsid. The adults are over ½ inch and their mouth parts are nearly 1 inch long (2·2 cm.). The stylets are inserted through the pod wall into the beans; they suck the juices from the beans, at the same time injecting a toxin. Pods attacked in this way bear no obvious outward sign of insect damage, the point of entry remaining virtually invisible. A few days after the attack the pods start to turn yellow, patchily and unevenly, and after this "premature ripening" the pods may turn black. Inside the pod the beans turn brown and are useless. Pods at any stage of growth, except the small cherelles, may be attacked. At Ikiliwindi most of the attacked pods are mis-shaped, having slight constriction or bottle-neck. At Tafo it is considered that this is not a symptom of *Bathycoelia* attack but results from boron deficiency (1).

Eggs are laid on many parts of the tree but only the pods are attacked by adults. When there are no pods the insects disappear, presumably going to their alternative hosts. It follows that Amazon cocoa, bearing pods most months of the year, is more heavily attacked than Amelonado, which is more seasonal in its bearings. At Tafo the incidence of pod damage was 10-15 per cent on Amelonado and 20-30 per cent on Amazon; similar differences occur elsewhere.

Bathycoelia: two adults and one fifth instar.

Mis-shapen pod affected by Bathycoelia.

Cross-section of damaged pod.

At present there are no firm recommendations for the control of this insect. The Cocoa Research Institute at Tafo do not recommend D.D.T. or B.H.C., but their trials have shown that fenitrothion and a new carbamate dioxacarb are effective (2).

This brief note on *Bathycoelia* has been included in this issue of the *Bulletin* as a warning to growers in West Africa. The danger from this pest arises from the nature of the symptoms, which can easily be overlooked or attributed to some other cause.

G. A. R. WOOD.

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A note on contributors

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Cocoa Abstracts

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

May, 1969

Soria, V. J., and Esquivel, O. Algunos resultados del programa de mejoramiento genetico de cacao en el IICA, Turrialba. (Some results of the cocoa breeding programme of the IICA, Turrialba.) Cacao Inst. Interam. Ciencias Agr. 13, 2, p. 1-9 (1968).

The first results are presented of a cocoa breeding programme initiated in Costa Rica in 1959. Using a method of indices developed at Turrialba, about 30 locally selected CC-clones were tested in field trials together with the best introduced clones. Hybrids of clones of different origin generally showed a great initial vigour and an early and high productivity, whereas hybrids of clones of the same origin showed a slow initial growth and a medium late to late and low productivity. The productivity of progenies from freely pollinated clones was not correlated to that of the mother clones. Tables. Graphs. 9 refs.

Alvim, P. de T., and Filho, A. P. de V. Programa de renovação de cacauais na Bahia. (Programme of cocoa replanting in Bahia.) Cacau Atualidades 4, 1, p. 5-9 (1967).

Although 150,000 ha of the total area planted with cocoa in the State of Bahia (Brazil) needs to be replanted, the programme of cocoa replanting, set by the executive committee for 1966-1970, had to be curtailed and deals now only with 35,000 ha due to lack of finances and good planting material. A cost calculation for the replanting of 1 ha of cocoa is presented. Tables. Photo.

Silva, P. O contrôle da broca do ôlho da Eritrina. (Control of the *Erythrina* bud borer.) Cacau Atualidades 4, 2, p. 21-3 (1967).

In nurseries of *Erythrina glauca* and *E. poeppigiana*, used as shade trees in cocoa plantations in the State of Bahia (Brazil), the damage caused by the borer *Terastia meticulosalis* (*Lepidoptera*) is of increasing importance. The life cycle of the insect and the nature of the damage caused to the seedlings are described. Recommended control methods are: (1) avoidance of sowing in the period of Oct.-Mch., in view of the life cycle of the insect; (2) removal of attacked seedlings from the nursery; and (3) monthly spraying with the organophosphorus insecticides Malatol 50 E and ethion. Figs. 3 refs.

Waite, B. H., and Diaz, F. The survival of Phytophthora palmivora in cacao plantations in the chlamydospore stage. Cacao Inst. Interam. Ciencias Agr. 13, 2, p. 10-3 (1968).

Literature on the survival of *Phytophthora palmivora* in cocoa pod tissue is reviewed. In the absence of a food source the fungus survives in the chlamydospore stage. Survival in pods maintained on the soil surface was considerably higher than in pods left hanging on the trees. Pronounced fluctuations in moisture content reduced survival more rapidly in hanging pods than in pods which are in contact with the soil. Invasion of other soil organisms does not seem to influence greatly survival of *Phytophthora* in pods. Total removal or deep burial of all diseased pods would prevent the accumulation of chlamydospores in the top soil. The heaping of infected pods, and fungicidal treatment of the surface of the heaps, is probably a more practical and more economic method of control. Spanish summary. Graphs. 16 refs.

Zentmyer, G. A. Resistance of cacao to Phytophthora palmivora. Cacao Inst. Interam. Ciencias Agr. 13, 2, p. 14-5 (1968).

In California (U.S.A.), 2 methods of testing resistance of cocoa seedlings to *Phytophthora palmivora* were compared. Seedlings of 6 clones from Costa Rica were inoculated. Stem inoculation was done by the insertion of discs 3 mm in diameter, cut from petri-dish cultures of *P. palmivora*, into vertical cuts 5 mm in length, made in the cortex of stems of the seedlings. Root inoculation involved the addition of inoculum to a nutrient solution in jars containing 1 to 2 seedlings. The differences in response between the clones were assessed in terms of mean length of canker in cm present on stems 6 weeks after inoculation, and in the root test by weekly recordings of the percentage of rotted root system starting 6 days after inoculation. The stem test gave significant differences which were similar to those commonly occurring in the field. The results of the root test were less clear-cut. Tables. 6 refs.

Abreu, J. M. de. Problemas entomológicos da cacauicultura no Espírito Santo. (Entomological problems in cocoa growing in the State of Espírito Santo.) Cacau Atualidades 4, 2, p. 18-20 (1967).

An investigation was carried out on the occurrence of insect pests in the cocoa plantations in the State of Espírito Santo (Brazil). The most important pest appeared to be *Selenothrips rubrocinctus*, followed by the weevils *Lordops* sp., *Lasiopus cilipes* and *Naupactus* sp. which feed on leaves and young shoots. Other pests found were: *Colaspis ornata* and *Nodonata* sp. (Coleoptera: *Chrysomelidae*); *Peosina mexicana* and *Sylepta prorogata* (Lepidoptera: *Geometridae*) *Azteca chartifex* var. *spiriti*, *Dolichoderus attelboidae*, *D. bidens*, *Cephalotes atratus* and *Crematogaster* sp. (ants); *Horiola arcuata* (Homoptera: *Membracidae*), and aphids (*Toxoptera* spp.). 5 refs.

Dun, G. S. Cacao flush defoliating caterpillars in Papua and New Guinea. Papua and Nw. Guinea Agr. J. 19, 2, p. 67-71 (1967).

The sharp increase in the area planted to cocoa since the last world war in the Territory of Papua and Nw. Guinea has greatly influenced the insect fauna associated with the crop. The distribution and importance of caterpillar species feeding on cocoa flush is discussed and an outline is given of the type of damage they cause. The history of cocoa growing and the associated caterpillar damage in the territory is discussed. Special attention is given to the importance of shade trees. It was observed that where the tops of the cocoa were in contact with lower branches of the shade tree the caterpillar infestations were much heavier than when the cocoa was planted "under bush" or under a high cover of larger forest trees or under crops such as coconuts and rubber. Where cocoa was planted under *Leucaena* the caterpillar problem has been most severely felt. Table. Photos.

Hernandez, S. A. El cacao. (Cacao.) Agronomía, Venezuela 9, p. 8-28 (1968).

A description is presented of the cocoa industry in Venezuela. It includes information on: history, production, export, production areas, economic importance, botany, cultivated cocoa types, climate, soil, economic and other production factors, propagation, establishment and maintenance, recommended planting material, rehabilitation of old plantings, pests and diseases and their control, and production costs. Tables. Graph. Photos. 4 refs.

Garaj, V. A note on the state of the cocoa processing industry in Ghana. Econ. Bull. Ghana 11, 4, p. 41-6 (1967).

Ghana produced about 38% of world output of cocoa beans in 1966. A small part of its exports (4% in 1966) is in the form of semi-finished products (cocoa-cake, -butter and -powder). It is shown, that under the present price and efficiency conditions, this processing is highly uneconomic; the beans fetch a higher export price than the corresponding quantities of cake, butter, etc. To overcome the difficulties, developed countries should create more equitable price relationships. Better possibilities for Ghana may perhaps be found in the processing of beans up to the final products (chocolates, etc.). Tables.

June, 1969

Sale, P. J. M. Plant physiology. Soil moisture regimes. Ann. Rep. Cacao Res. 1967, p. 36-45 (1968).

A glasshouse pot experiment is being conducted in Trinidad on the effect of soil moisture regime on growth and flowering of cocoa (ICS 95) during wet and dry seasons under 40% light intensity. Soil moisture is brought to field capacity, each time after 15, 50 or 85% depletion has been reached. Mean volumes of water used, plant leaf area, numbers of flushes, flowering cushions, open flowers, healthy cherelles, and numbers and weights of ripe pods are recorded. The results of 1 year's growth showed considerable differences in growth and flowering according to the soil moisture regime. It is suggested that under otherwise favourable field conditions irrigation should be beneficial, especially in areas with a prolonged dry season. Tables. Graphs.

Sale, P. J. M. Plant physiology. The effects of atmospheric humidity. Ann. Rep. Cacao Res. 1967, p. 45-7 (1968).

To study the effect of relative humidity of the air on the growth of young cocoa plants (ICS 95) an experiment was started in Trinidad in Sept. 1967 in controlled environment rooms. The temperature was maintained at 35·5°C and day-length was 16 hrs. in all the rooms. The first plants to flush were those at low humidity (50-60%) and the last (3 weeks later) those at high humidity (90-100%). Low humidity plants had the largest leaves and, consequently, largest total leaf area. High humidity plants had the smallest leaves, whereas several leaves were curled and withered at the tips. However, plants at high humidity produced flower cushions earlier than those at medium (70-75%) and low humidity. Table.

Smith, F. E., and Silva, P. Influência de insecticidas e acaricidas no crescimento de plântulas de cacaueiro (Theobroma cacao L.). (Effect of insecticides and acaricides on the growth of cocoa seedlings.) Rev. Ceres 15, 85, p. 150-6 (1968).

In Bahia (Brazil), the effects of foliar application of several pesticides on the growth of 3-month-old cocoa seedlings were investigated. It appeared that the growth of the seedlings was not adversely affected by the following treatments: (1) BHC (1, 3 and 5% a.i.), aldrin (2 and 5%), folidol (2%), and diazinon (1·5%) applied at a rate of 7 g/plant; (2) BHC (0·05, 0·1, 1 and 3%), aldrin (0·05, 0·1, 1 and 5%), metasystox (0·05, 0·1, 1 and 5%), folidol oil (0·3 and 1%), and emulsificator (2%), applied at a rate of 120 cm^3/plant. However, treatment with folidol oil (5%) at a rate of 120 cm^3/plant reduced the number of leaves. English summary. Tables. 10 refs.

Chalmers, W. S. Plant physiology. Shade trees for cocoa. Ann. Rep. Cacao Res. 1967, p. 47-50 (1968).

Summarized data are presented from the final assessment in the 32-species shade trial with cocoa, established at River Estate in Trinidad between 1952 and 1956. The data refer mainly to age, girth, crown diameter, forking height and total height. Only 6 species can be described as healthy, viz.: *Enterolobium cyclocorpum*, *Gmelina arborea*, *Schizolobium amazonicum*, *Pentaclethra macroloba*, *Inga laurina* and *Erythrina poeppigiana*, the first 3 being by far the fastest growing species. *Erythrina indica*, *E. velutina* and *I. laurina* merit further investigation. There was a marked increase in the number of witches' broom-infected pods in plots where the shade had died out early in the experiment. Tables.

Prado, E. Pires do., and Miranda, E. Ruy de. Deficiência de ferro em mudas de cacau enviveirados. (Iron deficiency in cocoa seedlings in nurseries.) Cacau Atualidades 4, 3, p. 48 (1967; received 1969).

An excessive proportion of organic material mixed into the soil of cocoa nurseries may cause Fe deficiency in the cocoa seedlings due to the transformation of exchangeable Fe into unexchangeable Fe. Spraying of the young leaves of each flush with $FeSO_4$ may correct the deficiency, whereas its occurrence may be reduced by irrigating the seedlings at a reduced rate.

Medeiros, A. Gomes. Normas para contrôle da "podridão parda" do cacau. (Measures for the control of black pod-rot in cocoa.) Cacau Atualidades 4, 3, p. 39-40 (1967; received 1969).

Cultivation measures and chemical spraying are recommended in the State of Bahia (Brazil) for the control of black pod-rot in cocoa. The cultivation measures consist of: (1) complete removal of all fruits still left in the plantation, and burial after treatment with lime or with a fungicide; (2) reduction of eventual excessive humidity in the plantation by better drainage, or pruning of shade-trees; (3) prevention of the spreading of the disease by weekly removal of all affected unripe fruits, combined with weekly harvesting and subsequent burial of the pod husks as mentioned in sub (1). For chemical spraying, copper fungicides are recommended.

Quesnel, V. C. The control of aeration during fermentation. Ann. Rep. Cacao Res. 1967, p. 59-60 (1968).

In Trinidad, experiments conducted with a fermenter designed to measure air flow into a mass of fermenting cocoa have led to the conclusion that during fermentation aeration occurs mainly by diffusion rather than by an upward flow of air mass. In further experiments, temperature rise and appearance of cocoa were investigated in 2 containers (coolers), one with openings at the bottom, and the other with openings at the top. The temperature rise was faster and more uniform throughout the cocoa when the openings were at the bottom, than when at the top. In the first case, the CO_2 produced during the early phase of fermentation, being heavier than air, can easily escape through the openings in the bottom of the container so that O_2 can enter easily. Fig.

July, 1969

Un exemple de collaboration entre la recherche et la vulgarisation. Action IFCC/SATMACI pour la rénovation de la culture cacaoyère en C te d'Ivoire. (An example of collaboration between research and extension. Combined action of IFCC/SATMACI for the renovation of the cocoa cultivation in the Ivory Coast.) Café, Cacao, Thé 12, 4, p. 295-301 (1968).

The combined efforts of the IFCC (French Institute for Coffee and Cacao) and the SATMACI, a semi-governmental body for technical aid in the rehabilitation of the smallholders' cocoa plantings in the Ivory Coast, are described and the results obtained so far are presented. The IFCC conducts field trials to improve plantings which had degenerated due to drought, shallow soil conditions, neglect and capsid attack. The SATMACI organizes and assists in capsid control operations, the regeneration of plantings and training. English, German and Spanish summaries. Tables. Photo.

Rawnsley, J. Biological studies in Ghana in the control of Cadra cautella (Wlk.), the tropical warehouse moth. Ghana J. Agr. Sci. 1, 2, p. 155-9 (1968).

Control of *Cadra cautella* in cocoa warehouses in Accra, Ghana, with pyrethrins was complicated by the fact that, although an almost complete knockdown-effect was achieved, the dying females discharged mature and viable eggs. The moth's parasite, *Microbracon hebetor*, was also highly susceptible to chemicals used against the moth. The almost completely effective control method, evolved after a study of the moth's 60-day life-cycle, was a daily injection of a pyrethrins-fog at the rate of 0·003 mg per litre of warehouse capacity at dusk during about 60 days. French summary. Tables. Graph. Photos. 1 ref.

Fassbender, H. W. Forms of phosphate after nine years of superphosphate fertilisation of cocoa. Agrochimica 13, 1-2, p. 39-43 (1969).

The transformation has been studied of superphosphate applied during 9 years in a NPK fertiliser experiment in cocoa at La Lola Experimental Farm in Costa Rica. It was found that of the total of 1,663 kg P_2O_5/ha applied, only small amounts of water soluble P remained in the upper 7·5 cm of the soil. The greater part was transformed into Al and Fe phosphates. In the upper 7·5 cm some Ca-phosphate was also present. French, German and Spanish summaries. Table. 12 refs.

Krekule, J. Cherelle wilting in cocoa induced by TIBA. Trop. Agr., Trinidad 46, 1, p. 69-72 (1969).

The substances TIBA (2,3,5-tri-iodobenzoic acid) and CCC (2-chloro-ethyl-trimethyl-ammonium chloride) possessing antihormonal activities, were used in Ghana to study the effect on cherelle wilting in cocoa. TIBA induced a significant increase in wilting percentage, whereas CCC did not influence the wilting percentage. The results obtained with TIBA present further evidence on hormonal involvement in cherelle wilt. Table. 15 refs.

Vincent, J. C. Influence du type de séchage solaire sur les qualités physiques et chimiques du cacao. (The effect of the method of sun-drying on the physical and chemical qualities of cocoa.) Café, Cacao, Thé 12, 4, p. 343-8 (1968).

Three types of sun-dryers for cocoa were tested in Cameroon, viz. 2 local dryers consisting of a tray, one with a bottom of matting and the other with a wire-netting bottom, and a newer tilting type of dryer with a wire-netting bottom and a double polyethylene sheet to cover the beans, leaving a space of 8 cm to allow for air circulation. The newer type of dryer can be oriented perpendicularly towards the solar radiation. The beans were spread on the dryers at a rate of 20 kg/m^2. No significant differences could be observed between the samples of dried beans with respect to their physical and chemical characteristics. With the newer dryer no fungus growth occurred under the plastic cover. English, German and Spanish summaries. Tables. Photos. 6 refs.

August, 1969

Soerjobroto Widjanarko. Pollination of cocoa by Forcipomya spp. in relation to endrin spraying. Menara Perkebunan 36, 10/11/12, p. 22-5 (1967; received 1969).

The ceratopogonid midge *Forcipomya* spp. is considered to be the most important pollinating vector in cocoa flowers in Java, Indonesia. Results of an experiment conducted in a 0·3-ha plot showed that frequent spraying with endrin at concentrations of 0·03% a.i. to control the cocoa moth *Acrocercops cramerella* and *Helopeltis* spp. had no negative influence on the degree of flower pollination. Weather conditions, in particular during morning hours, appear to be the main factors having an important influence on the *Forcipomya* activity. Indonesian summary. Table. 8 refs.

Smith, F. E., and Soria V. J. Influencia de pesticidas en la germinación in vitro del polen del cacao. (Effect of pesticides on the germination in vitro of cocoa pollen.) Cacao Inst. Interam. Ciencias Agr. 13, 3, p. 14-5 (1968).

In Brazil, a laboratory experiment was conducted to study the effects of BHC metasystox and 2 copper fungicides on the germination and growth of cocoa pollen. The results showed that no germination occurred of fresh pollen, sown on petri dish culture medium and covered with one of the above pesticides. Only a low percentage of germination occurred of pollen treated with 0·05% metasystox. English summary. Table. 9 refs.

Gavande, S. A. Characterization of soil, aeration status of cacao. II. Experimental results of the dependence of aeration porosity and oxygen diffusion on soil suction. Cacao Inst. Interam. Ciencias Agr. 13, 3, p. 5-11 (1968).

In Costa Rica, a pot trial with 18-month-old cocoa seedlings showed that the need for soil drainage could be determined by characterizing the aeration status through measuring of the oxygen diffusion rate (ODR). The critical soil suction value related to a minium critical ODR level of 20×10^{-8} g/cm^2/min for root growth, as well as the values for the important range from 20 to 40×10^{-8} g/cm^2/min, varied with soil type: at field capacity silty clay soils tended towards inadequate ODR values, while plants in sandier soils did not suffer. A rapid increase of ODR values relates to expected favourable crop response due to aeration, whereas a slow steady increase is associated with a naturally balanced supply of water and oxygen. Spanish summary. Graphs. 9 refs.

Soria V. J., and Esquivel, O. Observaciones sobre resistencia a Phytophthora, Ceratocystis buba floral y "die-back" de cacao en Costa Rica. (Observations on resistance to *Phytophthora*, *Ceratocystis*, "buba floral" and die-back of cocoa in Costa Rica.) Cacao Inst. Interam. Ciencias Agr. 13, 3, p. 11-3 (1968).

Results of research conducted in Costa Rica on resistance of cocoa clones and hybrids to a number of important diseases are reviewed. The clone UF-613 showed resistance to *Phytophthora palmivora*. The resistance of the clones SCA-9, Pound-12, IMC-67 and PA121 to *Ceratocystis fimbriata* appeared to be present as a recessive factor. Crossings between clones susceptible and resistant to "buba floral", a disorder which caused excessive flowering but reduced fruit set, yielded resistant hybrids if the father clone was resistant. The inheritance of resistance to "die-back" was irregular for the clones SCA-6 and SCA-12. 8 refs.

Imle, E. P. Plant material distribution and quarantine measures for cocoa. Gordian 68, 1621B, p. 16-20 (1968).

The author pleads for improved exchange, testing and safe quarantine of existing disease-resistant cocoa planting material, and for pollen distribution to foster breeding and selection work in producing countries. The following cocoa diseases are reviewed from the standpoint of resistance related to distribution, testing and quarantine: swollen shoot, black pod (*Phytophthora palmivora*), watery pod rot (*Monilia roreri*), witches' broom (*Marasmius perniciosus*), *Ceratocystis fimbriata*, and gall diseases (*Fusarium* spp.). The existing sources of resistant planting material and disease-free germ plasm collections, and current research on disease resistance, are discussed. Measures are indicated which may contribute to avoid further spread of diseases and pests. 20 refs.

Silva, P., and Abreu, J. M. de. The banana corm weevil, Cosmopolites sordidus, in the cocoa region of Bahia, Brazil. FAO Plant Protect. Bull. 16, 6, p. 111-3 (1968).

The geographic distribution of the banana corm weevil, *Cosmopolites sordidus*, and the degree of infestation in banana used for shading young cocoa plantations were studied in Bahia (Brazil). Fourteen areas were found to be infested and the highest infestations were recorded at Itajibá and Itapebi situated in the transitional cocoa/cattle-grazing zone, and at Itacaré near the coast. Soil physical properties associated with low rainfall seemed to favour the pest, and its spread is stimulated by the transport of banana suckers for planting. It is concluded that though the degree of infestation as recorded is not very high, the development of the pest should be closely observed so that timely measures can be applied before it becomes a serious problem. Map. 10 refs.

September, 1969

Goldmann, W. Der Weltrohstoffmarket Kakao. (The cocoa world market.) Gordian 68, 8, p. 361-4; 68, 9, p. 400-2 (1968).
Total production and export of cocoa of the main producing countries over the period 1957-1964 are given, followed by a more detailed analysis of the position in Ghana, Nigeria, the Ivory Coast, Brazil and Ecuador. Recent increases in production have caused heavy price falls in the years 1963-1965. Tables. 60 refs. To be continued.

Goldmann, W. Der Weltrohstoffmarket Kakao. 3. Teil: Die Vermarktung des Rohkakaos. (The cocoa world market. Part 3: Marketing.) Gordian 69, 1, p. 30-2 (1969).

This article on the supply of cocoa is a continuation of 2 earlier articles and describes the international marketing mechanism. New York, London, Hamburg and Amsterdam are at present the main markets. Customary practices and regulatory private or government institutions in the main producing and consuming countries are indicated. 42 refs. To be continued.

Richard, M. Un nouveau type de séchoir solaire expérimenté en Côte d'Ivoire. Son utilisation pour le cacao. (A new type of sun-dryer tried out in the Ivory Coast. Its use for drying cocoa.) Café, Cacao, Thé 13, 1, p. 57-64 (1969).

The construction, functioning, characteristics and costs of a tilting type of sun-dryer for cocoa developed in the Ivory Coast are described. The dryer consists of a tray with wooden frame divided longitudinally into 4 channels. The bamboo matting bottom leaves at each end of the channels an opening for air circulation, and has a total useful drying surface of 6·0 m^2. A polyvinyl sheet cover protects the tray from rain. The tray rests along its mid-transversal axis on a horizontal support. It is tilted in such a manner that the sun's rays are perpendicular to the tray surface. Under favourable conditions about 270 kg of cocoa can be dried at a time. The dryer is within the reach of all planters. English, German and Spanish summaries. Table. Figs. Photos.

Verlière, G. Un essai d'engrais sur cacaoyers en Côte d'Ivoire. Etude de la nutrition minérale. (A fertilizer trial in cocoa in the Ivory Coast. Study of the mineral nutrition.) Café, Cacao, Thé 13, 1, p. 11-33 (1969).

In the Ivory Coast, the mineral nutrition of leaves of producing cocoa trees receiving 375 g $(NH_4)_2SO_4 + 150$ g $Ca(H_2PO_4)_2 + 200$ g K_2SO_4 per tree per year was evaluated by foliar analysis, conducted at 6-week intervals during 4 years. In the first part of this paper the seasonal variations of and the effects of N, P and K fertilizing on the N, P, K, Ca and Mg leaf contents are examined. The second part discusses the interrelations found between the elements analysed. The practical implication of the results concerning the time of manuring and choice of fertilizers, to be applied under the conditions prevailing in the Ivory Coast, are outlined. English, German and Spanish summaries. Tables. Graphs.

Muller, R. A., et al. Appréciation de l'efficacité des fongicides contre la pourriture brune des cabosses du cacaoyer due au Phytophthora palmivora (Butl.) Butl. dans les conditions naturelles. Essai de mise au point d'une méthode rapide. (Assessment under field conditions of the efficiency of fungicides against black pod rot of cocoa caused by *Phytophthora palmivora*. An attempt to develop a quick evaluation method.) Café, Cacao, Thé 13, 1, p. 34-54 (1969).

The importance is stressed of developing an accurate method based on certain principles to assess the effects of fungicides on control of black pod disease in heterogeneous smallholder cocoa plantings. First results of a preliminary method are given. This method consists in practice of selecting pairs of neighbouring trees with the same number, type and size of pods, which are disposed on the trees in the same manner and at the same height on the main stem. One of these trees is chemically treated, and the other serves as a control. English, German and Spanish summaries. Tables. Graphs. Photos.

October, 1969

Capriles de Reyes, L., and Reyes, E. H. Contenido de polifenoles en dos variedades de Theobroma cacao L. y su relación con la resistencia a Ceratocystis fimbriata. (Polyphenol content in two varieties of *Theobroma cacao* and its relation to resistance against *Ceratocystis fimbriata*.) Agron. Trop., Venezuela 18, 3, p. 339-55 (1968).

Biochemical studies conducted in Venezuela showed that in cocoa plants resistant to the fungus *Ceratocystis fimbriata*, gentisolyl glycoside (a genistic acid ester) was found to increase in the stems to levels of high fungotoxicity after the plants had been inoculated with the pathogen. Susceptible cocoa plants, on the other hand, showed an important decrease of the ester after inoculation. English and French summaries. Tables. Figs. 14 refs.

Burg, B., van der. Cocoa budding—a neglected technique. World Crops 21, 2, p. 105-7 (1969).

Budding of cocoa using the Forkert method has not become a common practice in producing countries, except Indonesia, since sprouting, early growth, and percentage of success left much to be desired. In Tanzania, under marginal climatic conditions, much better budding results were obtained with this technique after it was slightly revised by completely cutting off the flap of rind from the stock. Sprouting of dormant buds was stimulated by removing a 0·6 cm wide piece of rind of the stock just above the budding; after the scion started growing the canopy of the stocks was gradually pruned back until, after the scion had developed sufficiently, it could be sawn off above the budding. Budding techniques, plant material required, advantages of budding in extension work and for rejuvenating old plantings, and training of labourers are discussed. Photos. 1 ref.